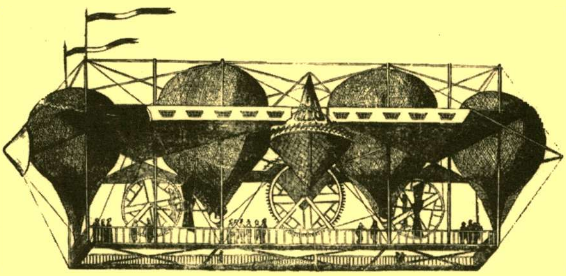
SCIENCE, TECHNOLOGY AND THE 19th CENTURY STATE

Conference Proceedings

Edited by
EFTHYMIOS NICOLAÏDIS and KONSTANTINOS CHATZIS



INSITUTE FOR NEOHELLENIC RESEARCH
NATIONAL HELLENIC RESEARCH FOUNDATION

ATHENS 2000

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AND THE 19th CENTURY STATE

SCIENCES, TECHNOLOGIES
ET CONSTITUTION DE L'ETAT AU 19e SIÈCLE

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AVANT-PROPOS

Le XIXe siècle est le grand siècle des nationalismes, celui qui a inventé " l'Etat-nation ". Il est aussi le siècle de la révolution industrielle et de l'expansion capitaliste, celui de grandes avancées technologiques à base de connaissances scientifiques. Il a également engendré l'Université moderne et l'Institut de recherche spécialisé qui remplaceront l'Académie comme lieu de production (intensive) des connaissances scientifiques. Loin de vivre dans l'isolement, ces trois enfants (Etat-nation, Université, technologies) d'une époque que, probablement, nous n'avons jamais quittée, sont pris dans des réseaux de causalités multiples. Nombreux sont ceux qui se sont penchés sur leurs relations, afin de dénouer les fils qui les unissent. Pour les uns, l'Etat-nation est défini par rapport à la logique de la modernisation économique (industrielle) qu'il permet grâce au développement et au contrôle sur un territoire donné du système éducatif. Pour les autres, la " nationalisation " d'une société résulte des effets conjugués d'une série de technologies matérielles : développement du réseau routier, construction des chemins de fer, développement des moyens de communication de masse. Les aspects " immatériels " et symboliques de l'identité nationale sont analysés dans plusieurs travaux, où l'on trouve des réflexions sur la place de la science ou de la technologie dans l'imaginaire de tel pays (pensons par exemple à l'opposition théorisée par P. Duhem, entre l'esprit ample mais faible, qui est censé caractériser les Anglais, et l'esprit profond mais étroit, propre aux Français).

Les recherches présentées ici ne se rangent pas sous une théorie générale qui tenterait d'expliciter le commerce entre la science, les technologies et la constitution de l'Etat au XIXe siècle, ce qui ne les empêche évidemment pas de mobiliser des éléments développés dans des travaux de facture plus théorique. Leur réunion n'est pas synonyme pour autant, du moins on l'espère, de simple juxtaposition. Car, au delà de leur diversité thématique, les contributions qui forment le présent livre sont unies par la même volonté d'une approche "églobalisante" : sans nier l'importance de " cadres généraux " dans l'étude des relations entre les sciences, les technologies et l'Etat du siècle dernier, elles privilégient une démarche centrée sur des groupes, voire des individus. C'est à travers l'action des agents de la science et de la technologie, ingénieurs et fabricants des instruments, producteurs du savoir et vulgarisateurs, que les auteurs ici réunis essaient d'aborder le triptyque " Science, technologies, Etat au XIXe siècle ".

Le présent volume est le fruit d'une collaboration entre le Centre de Recherches Néohelléniques de la Fondation Nationale des Recherches Scientifiques et le Laboratoire Territoires, Techniques et Sociétés de l'Ecole Nationale des Ponts et Chaussées. Ayant pour objet l'étude de l'apport scientifique et technologique de la France au nouvel Etat grec du XIXe siècle, cette collaboration s'applique à expliciter les mécanismes d'intégration de ce nouvel Etat dans le giron des pays développés de l'époque : création des structures éducatives et technologiques, importation de technologies, autant d'actions censées permettre la modernisation de ce pays en marge de l'Europe industrielle. Ce programme de recherche nous a aussi conduit à des études comparatives entre les réalités de ces structures dans les pays du centre et celles de la Grèce, pays de la périphérie.

La plupart des articles de ce volume ont été présentés dans le colloque du même nom qui a eu lieu les 9-10 juillet 1999 à Syros (Grèce), dans le cadre des Séminaires d'Hermoupolis que le Centre de Recherches Néohelléniques et la Fondation Scientifique et Culturelle des Cyclades organisent depuis une quinzaine d'années. Le colloque a été financé par le Secrétariat Général pour la Recherche et la Technologie, les Archives Helléniques des Instruments de Sciences (programme Archives de la Création du C.N.R.S.) et l'Université Nationale Technique d'Athènes. Ce colloque s'est terminé par une discussion générale sur les communications présentées, coordonnée par Michel Blay (Directeur de la recherche de l'Ecole Normale Supérieure) et Aristide Baltas (Professeur à l'Université Nationale Technique d'Athènes).

Le volume est divisé en trois unités thématiques.

Le siècle des ingénieurs, où sont présentées des études sur la personnalité de l'ingénieur français et de l'ingénieur grec du XIXe siècle ainsi que des études sur leur organisation en corps dans les deux pays.

Le siècle des laboratoires, où sont présentées les politiques d'acquisition d'instruments scientifiques en Angleterre et en Grèce.

Le siècle de l'enseignement, où sont présentées des études sur l'enseignement et la diffusion des sciences dans la Grèce du XIXe siècle, et aussi du Portugal, l'accent étant mis sur les influences de l'Europe de l'Ouest.

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Efthymios Nicolaïdis

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FOREWORD

The 19th century was the great age of nationalism and the one which invented the Nation State. It was also the time of the industrial revolution, capitalist expansion and of great technological advances based on scientific knowledge. It also gave birth to the modern university and the specialized research institute, which were to replace the Academy as the place of (intensive) production of scientific knowledge. Far from existing in isolation, these three offspring (the Nation State, the university and technologies) dating from a period which, in all probability, we have never left, are implicated in multiple networks of causal relationships. Numerous academics have investigated the relationship between these so as to separate the bonds which hold them together. For some, the Nation State can be defined in terms of (industrial) economic modernization permitted by the development and control, within a given territory, of the education system. For others, the "nationalization" of a society is the result of the joint effects of a series of materiel technologies: development of the road network, construction of railroads, development of mass communications. The "immaterial" and symbolic aspects of national identity are analyzed in several works, where the place of science or technology in a given country's "imaginary" is analyzed (consider, for example, the classic opposition formulated by P. Duhem between the ample, but weak imagination, which is supposed to characterize the English, and the deep, but narrow imagination, which is supposed to characterize the French.

The articles presented here do not form part of a general theory which seeks to illustrate the link between science, technologies and the construction of the State in the 19th century, which does not, of course, prevent them from drawing on theories developed in works of a more theoretical nature. However, their grouping together in this work is not, we hope, just a simple juxtaposition. Over and above their diverse themes, the contributions which make up the present book are characterized by the same "deglobalizing" approach: without denying the importance of a general framework in the study of the relationships between science, technology and the State during the 19th century, they favor an approach which is based on groups or even individuals. It is through the action of actors in the fields of science and technology, such as engineers and instrument makers, producers of knowledge and popularizers of it, that the authors of this publication have attempted to deal with the triptych "Science, technologies and the State in the 19th century".

This publication is the result of collaboration between the Institute for Neohellenic Research / National Hellenic Research Foundation and the Laboratoire Territoires, Techniques et Sociétés / Ecole Nationale des Ponts et Chaussées de Paris. As its purpose was a study of the scientific and technological contribution of France to the modernization of the new Greek State in the 19th century, this collaboration seeks to clearly illustrate the mechanisms by which this new State tried to become a full member of the family of rich and powerful European countries of the time: creation of educational and technological structures, importing of technologies which were supposed to enable this underdeveloped country, at the fringes of industrial Europe, to modernize. In order to conduct this research program, comparative studies on the reality of these structures in Western European countries and those in Greece, a country on the periphery, were also carried out.

Most of the articles in this volume were presented in the Conference of the same name which took place at Syros (Greece), within the framework of the Hermoupolis Seminars organized by the Institute for Neohellenic Research and the Cyclades Cultural and Scientific Foundation over the last fifteen years. The Conference was funded by the General Secretariat for Research and Technology, the Hellenic Archives of Scientific Instruments (under the program "Archives de la Création" of the C.N.R.S. - France) and the National Technical University of Athens. This Conference concluded with a general discussion on the papers presented, coordinated by Michel Blay (Director of Research at the Ecole Normale Supérieure-France) and Aristide Baltas (Professor at the National Technical University of Athens).

The volume is divided thematically into three units.

The century of engineers , which presents a study of the characteristics of the French and the Greek engineer in the 19th century as well as studies of their organization into professional bodies in the two countries.

The century of laboratories, which presents the policies for acquiring scientific instruments in England and Greece.

The century of teaching, which presents a study of teaching and the dissemination of the sciences in 19th century Greece, but also Portugal, with emphasis on the influence of Western Europe.

Konstantinos Chatzis

(LATTS, Ecole Nationale des Ponts et Chaussées)

Efthymios Nicolaïdis

(INR, National Hellenic Research Foundation)

THE CENTURY OF ENGINEERS

ANTOINE PICON

TECHNOLOGICAL TRADITIONS AND NATIONAL IDENTITIES A COMPARISON BETWEEN FRANCE AND GREAT BRITAIN DURING THE XIXTH CENTURY

A context of growing competition

During the nineteenth century there was a strong link between technology, between engineering in particular, and the construction of national identities. This link was somewhat paradoxical since the nineteenth century saw the internationalization of technology. Technological knowledge and know how had been generally local. Now they were circulating all over the world. Throughout the century, the evolution of manufacturing processes and technological artifacts was to a large extent the result of this circulation. However, such a circulation was accompanied by a growing political and economical competition between nations. In this context, technology and its engineering component became both dimensions of the various national identities and measures of the degree of excellence of the nations present on the international stage. By the end of the century, this double role was epitomized by great civil engineering works such as the Eiffel tower, the Firth of Forth bridge or the Brooklyn bridge. These achievements were meant to be objects of national pride as well as arguments on the international market of civil engineering expertise[1].

Such a role implied that technology and engineering were to be all at once specific, intimately linked to national cultures, and comparable from one country to another. How were these rather contradictory requirements met with? This question will be the starting point of this article. In order to answer it, I will take French and British engineering as two case studies. Throughout the nineteenth century, French and British engineers were constantly looking at each other, trying to distinguish themselves while being often inspired by their mutual achievements. In other words, French and Great Britain engineering traditions

[1] Cf. D. Billington, *The Tower and the bridge. The New art of structural engineering*, 1983, rééd. Princeton, Princeton University Press, 1985; A. Picon, *L'Art de l'ingénieur. Constructeur, entrepreneur, inventeur*, Paris, Centre Georges Pompidou, Le Moniteur, 1997.

were constructed in close relation one with another.

Technology and National prejudices

Do something like national identities exist? Given the diversity of countries like France or Great Britain the answer is not evident[2]. My purpose here is not to discuss this difficult issue. My starting point will be rather the following observation: whereas the existence of national identities is problematical, the attempts made to create or characterize them cannot be dismissed as mere illusions. Throughout the nineteenth century, a whole range of authors tried to define the French and the British national identities, often in contrast one to the other. Mutual prejudices arose from these attempts. When attempting to understand the relations between France and Great Britain, it is almost impossible to get rid of these prejudices.

In his *Notes sur l'Angleterre*, Hippolyte Taine gave a good account of the most common prejudices regarding the French and the British during the nineteenth century. Taine began by comparing, I quote, "the interior of an English head with a Murray guide. It holds a many facts and few ideas, a lot of useful and precise information, little statistical surveys, numerous figures, accurate maps, short and dry historical accounts, moral and useful advises as a foreword, no general view, no literary ambition." "The French like the ideas for their own sake, added Taine, whereas the English tend to use them as mnemonic or predictive tools[3]."

Revealingly, Taine gave an example of these allegedly contrasting dispositions taken from the scientific and technological field. Stephenson and Foucault were the two figures involved in the comparison.

"The great engineer Stephenson was once asked how he had invented his machines, the locomotive in particular. He answered that it was by dint of conceiving with an extreme precision the different part, their shape, their dimensions, their articulations, their possible movements and the complete set of consequences brought by the replacement of one part, or by the change of a dimension or an articulation. Thus his mind looked like a workshop; all the components were numbered and labeled; he took them one after the other, made them fit, and by trial and error found the right combination. On the contrary, Léon Foucault told me once that having found a theoretical proposition in mechanics that had been overlooked by Huygens and Lagrange, he had followed

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[2] A stimulating discussion of this question can be found in E. Kranakis, *Constructing a bridge. An Exploration of engineering culture, design and research in nineteenth-century France and America*, Cambridge, Massachusetts, The M.I.T. Press, 1997.

[3] H. Taine, *Notes sur l'Angleterre*, Paris, 1871, rééd. Paris, Hachette, 1890, pp. 325-326.

its consequences and these consequences had led him to the principle of his regulator."

"Generally, added Taine, the French understands through the use of deductive classifications, whereas the English thinks in inductive terms, by dint of application and memory, through the realistic representation of a large amount of individual facts, through a mass of distinct and juxtaposed documents[4]."

Taine gave a fairly representative account of the differences between the French and the British attitudes towards science and technology as they were figured out by the nineteenth century. Whereas the French were supposed to be primarily driven by theoretical speculations, the English were allegedly more practical. Whereas the former were deductive, the latter were mostly inductive.

This kind of assessment was rooted in more general beliefs regarding the differences between the Latin and the Anglo-Saxon cultures. In his *Lettres sur l'Amérique du Nord* published in 1836, the Saint-Simonian engineer Michel Chevalier drew a parallel between the passionate character of the French and the more reasonable nature of the English, between the enthusiasm and imagination of the former, and the common sense of the latter[5]. In the Saint-Simonian doctrine, England was made by the way responsible for the material advances of humanity, while France was supposed exert leadership on spiritual matters[6]. Although the English side generally agreed on the importance of its contribution to the material welfare of mankind, the second part of the proposition was met more reluctantly.

The opposition between theoretical and practical orientations, between deduction and induction, was as for it well summarized by the precedence given by the French to mathematics, whereas the English were supposed to refer themselves more often to mechanics, practical mechanics of course. Such a contrast can still be found in Duhem's *LaThéorie physique*. Duhem was the inheritor of a typical nineteenth century prejudice, when he found fault with the use of mechanical representations by the British physicists. "The English mind can be clearly characterized by the extent of its faculty to conceive concrete ensembles and by the weakness of its faculty of abstraction and generalization[7]", declared Duhem for whom abstraction and generalization were undoubtedly French.

This kind of prejudice was for sure grounded into some kind of reality, a

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[4] *Ibid.*, p. 326.

[5] M. Chevalier, *Lettres sur l'Amérique du nord*, Paris, Charles Gosselin, 1836. On Michel Chevalier, see in addition J. Walch, *Michel Chevalier économiste saint-simonien 1806-1879*, Paris, Vrin, 1975.

[6] *Doctrine de Saint-Simon. Exposition*, Première et deuxième années, Paris, Bureau de l'Organisateur, 1830. On the Saint-Simonian doctrine, see for instance S. Charléty, *Histoire du Saint-simonisme (1825-1864)*, Paris, 1896, rééd. P. Hartmann, 1931 ; G. Iggers, *The Cult of authority. The Political philosophy of the saint-simonians*, La Haye, 1958, rééd. La Haye, M. Nijhoff, 1970.

[7] P. Duhem, *La Théorie physique, son objet, sa structure*, Paris, 1906, rééd. Paris, Vrin, 1981, p. 126.

reality even more evident on a technological ground than on a purely scientific one. The French engineering profession emerged in domains such as fortification and engineering that bore almost no relation with mechanical construction[8]. On the contrary, throughout the eighteenth and nineteenth centuries, the construction of machines represented an essential field of activity for British engineers. The founding father of British engineering, John Smeaton, was involved both in civil and mechanical engineering[9]. Trained initially in the making of scientific instruments, he designed steam engines as well as bridges. In this context, the mechanical turn taken by an engineer such as Stephenson was by no mean exceptional. As the French engineer Joseph Dutens remarked in his *Mémoires sur les travaux publics de l'Angleterre* published in 1819, even the canals were designed as machines in England, whereas the French saw them as liquid roads or monuments[10].

But once more, my aim is not to indicate what is true and untrue in the representations of technological traditions constructed in the nineteenth century. My objective is to understand rather how they were constructed in order to allow both for international comparison and exchange and for the alleged existence of national identities.

Differences and complicity

To understand this construction, it can be useful to pay attention at the situation that was prevailing before, in other words to the relations between French and British engineers in the eighteenth century. French and British engineers were for sure quite different at the time. The French engineers were State engineers, organized in hierarchical corps such as the Ponts et Chaussées or the Génie corps. They were trained in specialized schools. They saw themselves as agents of a collective progress, of a fight against nature placed under the aegis of values such as public utility. In France, engineering could already be considered as a profession[11].

The British situation was quite different insofar that engineers were still relatively isolated individuals trained through traditional apprenticeship, often as instruments makers or surveyors. John Smeaton began for instance his career as an instrument maker. In Great Britain, engineering was not yet a fully organized profession[12].

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[8] Cf. A. Picon, *L'Invention de l'ingénieur moderne. L'Ecole des Ponts et Chaussées 1747-1851*, Paris, Presses de l'Ecole nationale des Ponts et Chaussées, 1992.

[9] On Smeaton, see A.-W. Skempton (ed.), *John Smeaton FRS*, London, Thomas Telford, 1981.

[10] J. Dutens, *Mémoires sur les travaux publics de l'Angleterre, suivis d'un mémoire sur l'esprit d'association et sur les différents modes de concession*, Paris, imprimerie Royale, 1819, p. v.

[11] Cf. A. Picon, *op. cit.*

[12] On the history of British engineering, see R.-A. Buchanan, *The Engineers. A History of the Engineering profession in Britain 1750-1914*, Londres, Jessica Kingsley, 1989.

What British engineering lacked in formal organization was counterbalanced by its creativity. From the steam engines to the first iron bridges, British engineers were already paving the way for the industrial revolution, contrary to their French colleagues who remained rather traditional in their approach of technological problems.

Despite these major differences, the French and the British saw themselves as colleagues rather than representatives of contrasting national differences. Their differences had by the way nothing to do with those that historians usually mention when they try to compare French and British engineering. Contrary to a rather common assumption, French engineers were not that versed in theory, in mathematics in particular, compared to their British counterparts. John Smeaton for instance a better scientist than his French equivalent, Jean-Rodolphe Perronet, the founder of the Ecole des Ponts et Chaussées.

They were differences indeed in the way French and British designed roads, bridges or harbors. French roads were for instance rather straight, whereas their British counterparts were much more curved in order to avoid trimming the private properties which they ran alongside. During the second half of the eighteenth century, French engineers seldom built great humpbacked bridges, contrary to the British[13]. Although the United Kingdom already dominated the seas, rational harbors and arsenals such as those designed by the French for Cherbourg and other places could be seen nowhere along its coast[14].

However, those differences were not considered as essential. Revealingly, when he visited England in 1785, the assistant director of the Ecole des Ponts et Chaussées, Pierre-Charles Lesage, remarked almost none of them[15].

The discrepant political, social and economical contexts were seen as more significant than technology itself. The United Kingdom considered itself as more advanced in these matters than absolutist France. A French engineer like Lesage agreed and he wrote in his diary that "no Englishman is excluded from the quality of citizen. Hence the self assurance, the patriotism and the pride of the English people." "Few countries pay their taxes with such a tranquillity, with so little complaint than England; in no other country are so many charities established for the suffering people[16]", added Lesage. It is no hazard if the construction of a clearly identified technological tradition was to rely strongly on this type of differences.

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13 Cf. T. Ruddock, *Arch bridges and their builders 1735-1835*, Cambridge, Cambridge University Press, 1979.

14 On the French designs for rational harbors and arsenals, see A. Demangeon, B. Fortier, *Les Vaisseaux et les villes*, Bruxelles, Liège, Mardaga, 1978.

15 P.-Ch. Lesage, *Journal et observations sur les chemins d'Angleterre et principalement sur les grandes routes*, 1784-1785, E.N.P.C. Ms 48.

16 *Ibid*

Constructing Engineering as a profession

By the very end of the eighteenth century, the creation of the Ecole Polytechnique and the subsequent evolution of the French higher education system began to drive French and British engineering apart[17]. French engineers became learned in sophisticated mathematics and mechanics, whereas their English colleagues were still using more down-to-earth knowledge. Moreover, the French profession was more and more school based, whereas the English one remained faithful to the system of apprenticeship[18].

These emerging differences were not seen by the British engineers as absolutely fundamental. Many of them made an extensive use of the French textbooks, so that they didn't feel really behind their colleagues on a scientific ground. Telford was quite typical of this French influence. Among the books he donated to the Institution of Civil Engineers when he became its president, half were French[19].

Although proud of the technological superiority they had achieved by the end of the Napoleonic wars, the British engineers didn't look for a specificity to be found in their knowledge or even their productions. Their true superiority was moral. There lied the specificity of British engineering.

This specificity was epitomized by a new type of engineering institution: the professional society. The Society of Civil Engineers founded in 1771 and the Institution of Civil Engineers founded in 1818 were neither corps, neither engineering schools[20]. The models they referred to were typical institutions of the United Kingdom: the Parliament, the Royal Society, the political and socials clubs. "Thus our Institution resembles the British Parliament ; where from a variety of talents and acquirements, much useful practical knowledge is derived[21]", boasted the members of the Institution of Civil Engineers shortly after its official recognizance by a Royal Charter in 1826.

What was at stake in these creations was summarized by Telford in his first

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17 On the content of the Ecole Polytechnique curriculum as well as on the influence it exerted on the French higher education system, see B. Belhoste, A. Dahan-Dalmédico, A. Picon, *La Formation polytechnicienne 1794-1994,* Paris, Dunod, 1994.

18 Apprenticeship remained dominant in Great Britain until the last decades of the nineteenth century. Cf. A. Guagnini, "Worlds apart: academic instruction and professional qualifications in the training of mechanical engineers in England, 1850-1914", in R. Fox, A. Guagnini (ed.), *Education, technology and industrial performance in Europe, 1850-1839,* Cambridge, Paris, Cambridge University Press, Editions de la Maison des sciences de l'homme, 1993, pp. 16-41.

19 *Minutes of the proceedings of the Institution of Civil Engineers for facilitating the acquirement of knowledge necessary in their profession and for promoting mechanical philosophy. First session. 1818,* meeting of the 17th of march 1820, I.C.E. N° 93.

20 On these two institutions, see G. Watson, *The Smeatonians. The Society of Civil Engineers,* Londres, Thomas Telford, 1989 ; G. Watson, *The Civils. The story of the Institution of Civil Engineers,* Londres, Thomas Telford, 1988.

21 Institution of Civil Engineers, *Minute book 1826 to 1836,* vol. 2, meeting of the 20th of january 1829, I.C.E N° 93.

speech as president of the Institution of Civil Engineers in 1820. In the Institution, began Telford, "the good sense of the members will always prove that manners and moral feeling are superior to written laws." Then he added: "In foreign countries similar establishments are instituted by government, and their members and proceedings are under its control ; but here a different course being adopted, it becomes incumbent on each individual member to feel that the very existence and prosperity of the Institution depends in no small degree on his personal conduct and exertion[22]."

Good sense, personal conduct and exertion, collective responsibility, those values derived from the British conception of what a profession was about. Through the creation of the Institution of Civil Engineers, this matrix of the British engineering profession, what was at stake was the transformation of a practice into a profession as honorable as law or medicine. Such a project was inseparable from political and social assumptions, from a liberal approach of engineering, an approach very different indeed from the French one.

This liberal approach was in its turn inseparable from a vision of the State as a moral authority in charge of general political, social and economical regulations. With the exception of domains such as the military, the State was not supposed to be directly in charge of technological progress. Professions and associations such as engineers and their institutions were the true actors of this movement towards progress.

It is in this perspective that the British claim for practicality must be probably understood. If it suited the British engineers to be seen as less theoretical and more practical than their French counterparts, it is probably because of their professional orientation, an orientation that they interpreted as their true specificity. Just as lawyers of physicians had to exercise their art, engineers had to be practical. They were not to be confused with scientists.

Constructing Engineering as a vocation

Through the Polytechnic education, the relation between science and engineering was seen as a fundamental component of the French conception. After discovering their technological backwardness after the collapse of the Napoleonic Empire, French engineers often saw science as the only mean to catch up with their rivals. This vision was developed by engineers such as Charles Dupin or Claude Navier, in the memoirs they published after they had visited Great Britain[23].

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22 *Minutes of the proceedings of the Institution of Civil Engineers. First session. 1818*, meeting of the 21st March 1820.

23 On the visits paid by French engineers to Great Britain during the first half of the nineteenth century, see M. Bradley, "Engineers as military spies? French engineers come to Britain, 1780-

But was science the true French specificity? Its universality forbade to see it as a permanent characteristic of the French engineering profession. Sooner or later, the British would catch up with the French scientific excellence. The political and social values promoted by the intensive use of scientific result were perhaps more fundamental.

These values, public utility, universality, impartiality, had been first appropriated by the State engineers. Impartiality was especially important when one had to expropriate people or to choose between projects that altered the value of land. By the end of the eighteenth century, two professional figures had been used by the State engineers as references impersonating utility, universality and impartiality: the army officer and the judge.

"If all men were reasonable, there would be no need for officers or judges, but given the men as they are, what is more useful, a great captain or a great judge?" such was the question asked to the students of the Ecole des Ponts et Chaussées as a subject of French dissertation in the late eighteenth century[24].

The perfect State engineer had to combine the discipline and the sense of duty of the officer with the impartiality of the judge. For both the officer and the judge, professional activity had the character of a call. After them, engineering was be a vocation rather than a profession.

This set of connotations were to survive the evolution of the French engineering profession towards a more liberal conception. Although highly critical towards the State corps of engineers, the Civils that appeared in France towards the end of the 1820s remained partially faithful to the fundamental values of their State predecessors[25]. Throughout the nineteenth century, French engineers saw themselves as relatively special. They were supposed to serve a great cause, the cause of public welfare and progress, with dedication and impartiality.

Such a conception had of course links with a conception of the State as a major partner in the process of innovation. Even as a civil, the engineer was still supposed to be a partner for the administration. Whereas competence and ethics were supposed to come first for British engineers, dedication and authority were perhaps the most fundamental characteristics of French engineers. By the end of the nineteenth century, the immediate transposition of general Lyautey's famous article on "the social role of the officer" into developments on "the social role of the engineer" confirmed the fact[26]

1790", in *Annals of science*, n° 49, 1992, pp. 137-161.

[24] On the French dissertation of the Ecole des Ponts et Chaussées, see A. Picon, *L'Invention de l'ingénieur moderne.*

[25] On the emergence of the French civil engineers, see J.-H. Weiss, *The Making of technological man. The Socials origins of french engineering education*, Cambridge Massachussetts, The M.I.T. Press, 1982.

[26] L. Lyautey, *Du Rôle social de l'officier dans le service militaire universel*, Paris, Perrin et Cie, 1891. Shortly after the publication of Lyautey's essay, a "Rôle social de l'ingénieur" is published by the journal *Etudes*. Its author is the Jesuit Henri-Régis Pupey-Girard, the founder ot an Union sociale des ingénieurs catholiques.

Technological traditions and politics

What I have tried to suggest in this article, is that throughout the nineteenth century, technological traditions had more to do with politics, with representations of what is legitimate, than with the actual content of the textbooks or what was realized by the engineers. Hence their association with the search for national identities. Technological traditions were supposed to be grounded in the fundamental ethics of the people. They had more to do with values than with achievements. Achievements made them however comparable. As a system of values, technology was rooted into the various national experiences. As a set of artifacts, it could be exchanged. This duality is perhaps still present today. After all, what we call globalization is based on the assumption that we can remain ourselves in a continuous process of exchange.

KONSTANTINOS CHATZIS

ENTRE LE SAVANT ISOLÉ ET L'INSTITUTION SCIENTIFIQUE MODERNE : J.-V. PONCELET (1788-1867) ET LA MÉCANIQUE APPLIQUÉE EN FRANCE DURANT LES ANNÉES 1820-1850

Introduction

La Révolution de 1789 dote la France d'une série d'institutions qui vont lui assurer une prééminence scientifique incontestable au niveau mondial pendant les premières décennies du XIXe siècle. Parmi les réalités enfantées par ces années de rupture et de bouillonnement, l'Ecole polytechnique, créée en 1794 [Belhoste 1989 ; Langins 1991], symbolisera, pour longtemps, l'excellence française en matière de sciences. Destinée à former, avec l'aide de ses écoles d'application —, telles que l'Ecole d'application de l'artillerie et du génie (fondée en 1802) [Belhoste et *al.* 1996], l'Ecole nationale des ponts et chaussées (1747) [Picon 1992 ; Chatzis 1997a], l'Ecole des Mines (1783) [Thépot 1991], pour mentionner les plus importantes — les futurs cadres techniques, civils et militaires, dont la République naissante a besoin, l'Ecole polytechnique, prolongée par ses satellites, n'en constitue pas moins un haut lieu d'élaboration et de transmission de connaissances nouvelles. Tout au long de la première moitié du XIXe siècle, elle ne cesse, en effet, de produire et d'abriter, outre une multitude de grands scientifiques œuvrant dans les domaines des sciences pures, plusieurs savants fortement intéressés par la question de l'application de la théorie aux problèmes pratiques [Grattan-Guinness 1990 ; Dhombres et *al.* 1989]. Ces derniers, faisant leur l'espoir du siècle des Lumières : "éclairer les arts par la lumière de la théorie ", vont fonder une bonne partie des sciences modernes de l'ingénieur.

Identifier, d'abord, pour peser et hiérarchiser ensuite, l'ensemble des facteurs dont l'action simultanée a produit cette période d'âge d'or pour la science française, dépasse de loin, il va de soi, les possibilités d'une communication. Notre objectif sera ici beaucoup plus modeste. A travers la trajectoire du polytechnicien Jean-Victor Poncelet (1788-1867), surnommé par ses contemporains le Newton de la mécanique appliquée, nous essayons de concentrer dans le même regard quelques traits saillants des contextes intellectuel et institutionnel qui ont présidé à la fondation de la mécanique appliquée — théorie des machines, résistance des matériaux, hydraulique et mécanismes—, opérée, pour l'essentiel, en France, pendant les années 1820-1850 [Timoshenko 1953 ; Rouse et *al.* 1957].

De la science pure à la science appliquée

Jean-Victor Poncelet est né en 1788 dans la ville de Metz. Polytechnicien de la promotion de 1807, il poursuit ses études d'ingénieur militaire à l'Ecoled'application de l'artillerie et du génie de Metz, en 1810. Mobilisé comme officier pendant les guerres napoléoniennes, il est fait prisonnier en 1812 durant la campagne de Russie. Interné à Saratoff, Poncelet consacre ses heures d'inactivité forcée aux méditations mathématiques. Le fait d'être complètement privé d'accès à la littérature scientifique ne l'empêche pas de préparer, avec les seuls souvenirs des impulsions durables reçues par ses maîtres à l'Ecole polytechnique [Belhoste 1998], une révolution dans le domaine de la géométrie. Une fois rentré en France, il publie, en 1822, son *Traité des propriétés projectives des figures* conçu en exil, qui marque la création de la géométrie projective [Taton 1975 ; Belhoste 1998]. Féru de géométrie, impatient de continuer à explorer les voies qu'il vient d'ouvrir, notre auteur sera, cependant, condamné au renoncement. A l'occasion de la réorganisation de l'arsenal de Metz où il est affecté, après son retour de captivité (1814), on lui demande de s'occuper des roues hydrauliques. Afin d'en améliorer le rendement, Poncelet incurve les aubes et invente la roue qui porte son nom [Belhoste et *al.* 1990a]. Le mémoire qu'il présente à l'Académie des Sciences lui vaut le prix Montyon de mécanique en 1825. Arago [Daumas 1987], à l'époque examinateur de l'Ecole de l'artillerie et du génie, remarque ses qualités de mécanicien, et lui demande, en 1824, de créer un cours de machines à cette école. Poncelet cède aux pressions, non sans une amertume dont il gardera des traces tout au long de sa vie, et entame sa carrière de mécanicien aux dépens de ses travaux de géomètre.

La période messine : 1825-1834

Chargé de créer un cours de mécanique appliquée aux machines, Poncelet, à l'instar d'un autre polytechnicien, C.-L.-M.-H.-Navier (1785-1836) qui, appelé à l'Ecole des ponts et chaussées, s'attelle durant cette période à des tâches similaires [Picon 1992], se trouve devant un quasi-vide. L'Ecole polytechnique lui a certes enseigné de façon approfondie la mécanique rationnelle, formalisée dès 1788 par les soins de Lagrange ; elle lui a appris, en revanche, peu de choses au sujet de la théorie des machines [Chatzis 1994]. L'auteur doit assurer, par conséquent, des tâches de pionnier. Heureusement, il n'œuvre pas complètement seul. Depuis les années 1810, un dialogue entre la théorie des machines et la mécanique rationnelle est timidement noué grâce à quelques polytechniciens, qui " exhument " les travaux des ingénieurs savants du XVIIIe siècle, pour l'essentiel anciens élèves de l'Ecole du Génie de Mézières [Belhoste 1997], tels J.-Ch. de Borda (1733-1799) [Belhoste et *al.* 1990b], Ch.-A. de Coulomb (1736-1806) [Gillmor 1971] et L. Carnot (1753-1823) [Gillispie et *al.* 1979]. Navier en reprend les tenants et aboutissants, et propose, à la fin de la décennie, une synthèse sur la question dans l'une des multiples notes qui parsèment sa réédition de *l'Architecture hydraulique* de B.-F. de Bélidor (1693-1761), ouvrage paru pour la première fois entre 1737 et 1739, paré depuis du statut de classique. S'appuyant sur le travail de Navier ainsi que sur les notes manuscrites aimablement mises à sa disposition par un autre polytechnicien de sa génération, G.-G. de Coriolis (1792-1843), bien avant que celui-ci ne sorte, en 1829, son livre célèbre sur la théorie générale des machines [Chatzis 1997b], Poncelet se met au travail. Le résultat de ses efforts sera le premier enseignement de la science moderne des machines au siècle dernier [Chatzis 1996]. Si l'auteur est devancé par ses deux camarades d'école en ce qui concerne l'élaboration de la notion de travail — pilier conceptuel de la théorie des machines [Chatzis 1997b] —, il les dépasse de loin quant à l'étendue des questions abordées : aucun mécanisme, aucun moteur, figurant dans l'arsenal industriel de son époque, ne semblent pouvoir résister à un traitement rigoureux et systématique de sa part, dispensé à la lumière de l'analyse mathématique et des enseignements tirés de la mécanique rationnelle.

Mais la pureté théorique de la mécanique rationnelle, aussi nécessaire qu'elle soit, ne suffit pas, à elle seule, pour traiter efficacement de questions pratiques. Pour en compléter les blancs, Poncelet se fait expérimentateur. En août 1827 le Conseil d'Instruction de l'Ecole de l'artillerie et du génie, en poursuivant une politique que son ancêtre, l'Ecole du génie de Mézières, avait pratiquée au siècle des Lumières, obtient des crédits pour continuer les recherches expérimentales que Bossut (1730-1814) et Du Buat (1734-1809) avaient réalisées, dans les années 1760 et 1780 respectivement, en matière d'hydraulique [Taton 1964]. Epaulé par son camarade-ingénieur du Génie, J.-A. Lesbros, notre auteur s'engage, de 1827 à 1829, dans une série d'expériences visant à déterminer les lois de l'écoulement de l'eau à travers les orifices [Chatzis 1998]. Examiné et approuvé par l'Académie des Sciences, mine de résultats numériques qui connaîtront une longue carrière, le document final se veut également un manuel du bon expérimentateur. Tout en se référant explicitement aux expérimentateurs du XVIIIe siècle, tels Couplet, Mariotte, Bossut, Du Buat ou Smeaton, avec lesquels il partage la même conception utilitaire du travail expérimental [Licoppe 1996] mais dont les résultats sont parfois entachés, selon l'auteur, de " vices de méthode ", Poncelet souhaite réunir dans un corps de doctrine explicite l'ensemble des conditions qui définissent une expérience réussie. Protocoles d'expérimentation, fixant les conditions de production de résultats considérés comme valides, et " technologies littéraires " [Shapin 1984], c'est-à-dire des moyens d'exposition permettant de transformer le lecteur du compte rendu de l'expérience en participant virtuel de la scène expérimentale et d'obtenir de lui sa confiance et son approbation, occupent dans le document final une place aussi importante que les résultats proprement dits [Chatzis 1998].

Praticien lui-même de la démarche expérimentale, Poncelet devient l'épicentre d'un travail intense d'expérimentation dans le domaine de la mécanique appliquée. Autour de lui, sous sa supervision et à l'aide de ses conseils, une petite équipe de jeunes polytechniciens-militaires effectuera, à travers la France, des milliers de mesures portant sur le rendement des différents types de moteurs hydrauliques — source principale d'énergie à l'époque [Woronoff 1994] — ainsi que sur celui des machines à vapeur, sans oublier les questions relatives au frottement... [Fontanon 1990 ; Belhoste et *al.* 1990a ; Bret 1996]. Plusieurs des collaborateurs de Poncelet, souvent futurs académiciens, seront par ailleurs primés pour ces travaux. C'est le cas de A. Morin (1795-1880), qui obtient le prix du Comité d'Artillerie et plus tard le prix Montyon de l'Académie. L'importance de ces travaux expérimentaux en mécanique appliquée, qui seront accompagnés de recherches en matière de balistique, de poudres et d'explosifs, fait de l'Ecole de l'artillerie et du génie, dans les années 1820 et 1830, l'un des centres de recherche les plus actifs en France. La hiérarchie militaire, locale et nationale, sollicite et soutient les efforts de ces ingénieurs savants réunis autour de Poncelet, même au prix de mesures d'exception. Comme Monge à l'Ecole de Mézières un demi-siècle plus tôt, Poncelet est autorisé à séjourner à Paris, pendant six mois par an en dehors de la période de son professorat, afin de se mettre au courant des dernières nouveautés théoriques.

En même temps qu'il élabore le premier enseignement complet de la science moderne des machines au siècle dernier devant un public d'élèves-ingénieurs sortis de l'Ecole polytechnique, Poncelet s'applique à mettre à la portée des intelligences non rompues au calcul infinitésimal, les notions fondamentales de la mécanique ainsi que ses principales applications à l'industrie. Répondant à l'appel lancé par un autre polytechnicien, Ch. Dupin (1784-1873), qui exhortait de sa chaire de mécanique appliquée aux arts au Conservatoire national des arts et métiers [Fontanon et *al.* 1994 ; Le Moël et *al.* 1994] les jeunes polytechniciens à imiter son exemple et à créer des enseignements industriels adressés au plus grand nombre dans leurs villes de garnison, Poncelet enseigne, de 1827 à 1830, la mécanique industrielle aux ouvriers et artisans de la ville de Metz, en se passant totalement de l'analyse.

Poncelet à Paris

Elu académicien (section mécanique) en 1834, Poncelet quitte Metz et l'Ecole d'application de l'artillerie et du génie pour Paris. Fréquemment sollicité pour produire des rapports sur les travaux soumis à l'Académie dans le domaine de la mécanique, Poncelet devient souvent historien et n'hésite pas à proposer un panorama historique des principales théories concernant le sujet traité [Chatzis 1998]. Avançant dans l'âge, l'auteur va s'adresser, au delà du cercle des mécaniciens, à un public beaucoup plus large, incluant le philosophe et celui qui gouverne la Cité. Elu président de la Classe des Machines lors de l'Exposition Universelle de Londres en 1851, il reprend sa plume d'historien et rédige un rapport monumental, épais de quelques 1200 pages, relatant les découvertes et inventions relatives aux outils et machines manufacturières depuis la nuit des temps jusqu'à son époque. Son but : faciliter l'éclosion des inventions à venir, " *l'esprit, aussi que la nature, ne [marchant] jamais par sauts* "; améliorer les rapports entre les inventeurs et la collectivité [Chatzis 1998]. La hauteur académique ne lui fait pas oublier, par ailleurs, les ingénieurs du terrain, en quête d'outils opérationnels. A leur intention, Poncelet produit plusieurs rapports où il s'évertue à mettre sous forme facilement exploitable (méthodes graphiques, formules simplifiées, tableaux numériques) des résultats contenus dans la littérature technique de l'époque.

Ses occupations d'académicien ne l'empêchent pas, non plus, de poursuivre ses activités d'enseignement. Appelé à la Faculté des Sciences de Paris en 1838, Poncelet enseigne pendant dix ans devant un public composé, pour l'essentiel, d'ingénieurs, d'enseignants du secondaire et d'industriels, une nouvelle mécanique, appelée mécanique physique et expérimentale, à la création de laquelle l'auteur participe activement. Revendiquant ouvertement son originalité, la mécanique physique et expérimentale se présente comme une discipline nouvelle qui ambitionne de remplacer la mécanique rationnelle, illustrée par l'œuvre de Lagrange. Mais pourquoi vouloir créer du neuf ? Œuvre de mathématiciens, la mécanique rationnelle traite des êtres fictifs (solides indéformables et fluides parfaits) que l'on ne rencontre jamais tels quels dans la réalité. On constate alors que très vite ses potentialités pratiques se heurtent à son manque de réalisme. D'où le projet d'édifier une nouvelle mécanique théorique capable, de par sa plus grande adéquation au monde réel, de commercer plus efficacement que la mécanique rationnelle avec les corps de la nature qui interviennent dans les diverses applications de l'ingénieur. Pour fonder cette nouvelle mécanique, plusieurs polytechniciens, parmi lesquels on trouve, outre Poncelet, S.-D. Poisson (1781-1840), Navier, Coriolis, A. Cauchy (1789-1857), A. Barré de Saint-Venant (1797-1886), feront appel à deux types d'opération. Fidèles à la démarche de leurs ancêtres du XVIIIe siècle, ces mécaniciens prêchent le recours intensif à l'observation et l'expérimentation.

Mais friande d'observations et de mesures, la nouvelle mécanique ne sera pas pour autant, à leurs yeux, platement positiviste ; nos polytechniciens s'aventurent dans la voie des hypothèses hardies que ni mesure ni observation directe ne peuvent directement fonder. Ayant accompli leur apprentissage scientifique dans une France dominée intellectuellement par Laplace [Grattan Guinness 1990 ; Fox 1974], ces polytechniciens abandonnent, dans les années 1820, la conception lagrangienne des corps comme des milieux continus — dont les divers éléments, impénétrables les uns aux autres, se gênent mutuellement — au profit d'une conception moléculaire de la matière, censée cerner de plus près la nature véritable des corps physiques : ceux-ci sont désormais appréhendés comme des essaims de molécules, véritables centres de force, maintenues à de petites distances par des forces attractives et répulsives [Duhem 1903].

Le cours de Poncelet à la Sorbonne constitue la première manifestation institutionnelle dans le domaine de l'enseignement de cette nouvelle mécanique [Chatzis 1998]. De par sa qualité, il tranche avec la majorité des autres prestations universitaires de cette période en matière de sciences, médiocres et souvent mondaines, voire inexistantes, jusqu'aux années 1880 [Prost 1968 ; Fox et *al.* 1980 ; Fox 1995]. Non publié du vivant de l'auteur, son cours n'en atteint pas moins, grâce à plusieurs canaux de diffusion, un public beaucoup plus large que son auditoire dans l'amphithéâtre. En 1852, le polytechnicien H. Resal, auditeur du cours, publie un livre de mécanique élémentaire, enrichi d'une annexe qui reprend les leçons de Poncelet consacrées à la cinématique théorique. Le polytechnicien P.-F. Michon, professeur de Construction à l'Ecole de l'artillerie et du génie de 1843 à 1848, utilise les notes du cours pour son enseignement de résistance des matériaux. L'enseignement de Morin au Conservatoire national des arts et métiers contient plusieurs renvois au cours de son maître à la Sorbonne. Saint-Venant enfin, dans son édition critique de 1864 des leçons de Navier à l'Ecole des ponts et chaussées, s'y réfère amplement, en puisant ses informations dans des notes prêtées par Poncelet en 1858. Grâce à ces réseaux informels de diffusion, le cours connaît un grand retentissement.

A juste titre par ailleurs, puisque il abonde en nouveautés. Notons en ici deux, l'une relevant de la “ science pure ”, l'autre ayant des implications directement pratiques. En relevant le défi lancé en 1834 par Ampère [1834] de créer une science du mouvement des corps, abstraction faite des conditions de sa production, Poncelet fonde, à l'occasion de son cours universitaire, la cinématique théorique, et inaugure une tradition dans l'enseignement de la mécanique en France qui débute désormais par la cinématique [Chatzis 1995]. S'appuyant sur la conception moléculaire de la matière que la mécanique physique fait sienne et à laquelle il confère une représentation géométrique originale, Poncelet propose dans son enseignement à la Sorbonne à la fois une explication théorique du phénomène de la rupture par compression et des règles pratiques de dimensionnement pour parer à une telle éventualité. La rupture par compression a posé pendant longtemps problème au physicien et à l'ingénieur. En effet on ne voit pas clairement pourquoi le rapprochement des parties du corps, produit par la compression, peut en être une cause de rupture. Œuvrant à l'intérieur du paradigme moléculaire, Poncelet sera le premier à ramener la résistance aux compressions longitudinales à la résistance aux extensions transversales qui, d'après l'hypothèse moléculaire, les accompagnent obligatoirement quand les faces latérales du corps soumis à la compression sont libres. De l'explication théorique aux règles pratiques, le passage est facile. S'appuyant sur le résultat obtenu par Poisson, selon lequel la dilatation transversale par suite de la contraction longitudinale est pour les prismes isotropes égale à 1/4, Poncelet propose la règle suivante : afin d'éviter la rupture par compression d'un prisme, la contraction de celui-ci ne doit pas dépasser le quadruple de la dilatation reconnue dangereuse dans le cas de la rupture par extension. Si on s'est permis de s'attarder sur ce dernier exemple, c'est parce qu'il est représentatif de la démarche des mécaniciens français de cette période. Au sein de la division du travail entre la théorie (hypothèses relatives à la constitution et au comportement de la matière, suivies de leur exploration mathématique) et l'expérimentation, c'est la première qui prime la seconde. L'essentiel des découvertes faites dans les années 1820-1850 en matière de mécanique [Timoshenko 1953 ; Rouse et *al.* 1957 ; Dugas 1955 ; Chatzis 1997b] sont les produits du “ papier et du crayon ”. L'expérimentation arrive, le plus souvent, dans un second temps, soit pour contrôler les conclusions de la théorie, soit pour fixer ses limites de validité, soit pour produire des coefficients empiriques portant sur des phénomènes que la théorie explique mais ne parvient pas à quantifier d'avance.

En 1848, Poncelet abandonne son enseignement universitaire pour recevoir le baptême de l'action politique. Il devient représentant du peuple à l'Assemblée Constituante où il vote avec les modérés [Tribout 1936]. Nommé par Arago commandant à l'Ecole polytechnique en 1848, il reste à sa tête jusqu'en 1850. Ne voulant pas servir l'Empire, il se laisse mettre à la retraite en 1852. Entre temps, il participe activement aux réformes qui frappent l'Ecole polytechnique en 1851, dont l'objectif est de donner à son enseignement, jugé par les instigateurs du changement trop théorique et trop abstrait pour une école d'ingénieurs, une orientation plus pratique et utilitaire [Belhoste et *al.* 1994]. Si avec la reforme de 1851 le Poncelet-ingénieur, attentif aux besoins de la pratique, a conquis une Ecole polytechnique chavirée depuis sa réorganisation de 1816 dans les eaux de la théorie pure, le Poncelet-savant essuie peut-être, malgré lui, une défaite imprévisible. Réduite désormais à une école formant des ingénieurs généralistes, l'Ecole polytechnique doit abandonner, au moins partiellement, sa vocation (et ses performances) scientifique qui a fait sa gloire au cours de la première moitié du XIXe siècle au profit de l'Ecole normale supérieure [Fox et *al.* 1980].

Conclusion

Polytechnicien, officier au service de Napoléon et adepte, sur le plan intellectuel, de l'un de ses ministres et sénateurs, Laplace, enseignant de la mécanique appliquée dans une école d'ingénieurs mais aussi diffuseur de connaissances scientifiques auprès des praticiens, académicien, professeur à la Sorbonne, administrateur de l'Ecole polytechnique : à travers la carrière de Poncelet une bonne partie du paysage scientifique français de la première moitié du XIXe siècle entre sur scène. Poncelet fait, en effet, partie de cette nouvelle génération de jeunes gens, formés dans les nouveaux établissements fondés dans la foulée de la Révolution, que l'on peut qualifier de scientifiques professionnels [Crosland 1978]. Professionnels dans la mesure où ils ont reçu une formation de haut niveau dans un cadre scolaire et selon une séquence organisée, d'abord ; parce qu'ils acceptent les normes de comportement valables pour l'ensemble de leur communauté d'appartenance, ensuite ; car ils sont rémunérés pour effectuer un travail scientifique, enfin. De ces trois critères caractérisant aujourd'hui un scientifique professionnel, un seul existait en France avant la Révolution, à savoir celui qui concernait les normes de compétence, dont l'Académie royale des Sciences était le dépositaire et le garant [Hahn 1971]. Mais ces ressemblances entre la génération de Poncelet et le scientifique moderne ne doivent pas nous aveugler sur une série de différences tout aussi significatives. Retenons en quelques unes.

Le professeur Poncelet n'a pas suivi de formation post-universitaire : les réformes napoléoniennes ont beau avoir codifié les différents titres scolaires (baccalauréat, licence, doctorat), et fait du doctorat une condition d'accès au grade de professeur d'Université, elles restent sur ce dernier point lettre morte, jusqu'à la Monarchie de juillet au moins [Fox 1995]. Il faut attendre la création du poste d'assistant (agrégé préparateur) à l'Ecole normale dans les années 1840, pour que la France commence à peine à se doter, et le chemin sera long, d'une infrastructure doctorale moderne [Fox et *al.* 1980]. Universitaire atypique, à l'aune de nos critères, Poncelet enseigne souvent devant un public se situant également de façon oblique par rapport aux normes d'aujourd'hui. Si son auditoire à l'Ecole de l'artillerie et du génie est composé " d'étudiants modernes ", formant une population d'âge homogène, suivant régulièrement les cours, fournissant des travaux pratiques et subissant l'épreuve des examens, rien de tel pour son public à la Sorbonne, formé pour l'essentiel d'auditeurs libres de tout âge et de toute profession, dispensés au demeurant de toute obligation scolaire. Le vrai étudiant de l'Université française sera né bien plus tard, en 1877, avec la création de 300 bourses de licence bientôt complétée par celle de 200 bourses d'agrégation (1880) [Prost 1968].

Voici pour ce qui est du Poncelet-professeur. Mais le Poncelet-savant déploie également son activité scientifique dans un contexte historique qui diffère à maintes égards du nôtre. Tout en excellant dans les sciences, la France de Poncelet n'a pas encore réalisé l'articulation de l'enseignement et de la recherche qui marque notre paysage scientifique moderne. L'Ecole polytechnique, temple de la science, ne dispose pas durant toute cette période de laboratoires de recherche [Herlea 1988]. Les quelques centres de recherche de l'époque, au sens moderne du terme, bénéficiant à la fois de ressources matérielles et d'un potentiel humain plus ou moins réguliers (citons entre autres : le Muséum d'Histoire Naturelle de Paris, le Collège de France, l'Observatoire...), ont des liens très distendus avec les établissements d'enseignement. Qui plus est, une partie essentielle de la recherche continue à se faire à l'intérieur de structures, et selon des modalités, qui conservent au fond le style et les coutumes de l'Ancien Régime. La communauté scientifique en France, si elle reçoit désormais, grâce à l'Ecole polytechnique notamment, une formation initiale scolaire de haut niveau, n'en reste pas moins marquée par la figure du savant du XVIIIe siècle, circulant au long de réseaux de relations souvent informelles ou œuvrant à l'intérieur de structures, certes, bureaucratisées, mais dont la fonction première n'est pas la promotion des sciences : services publics, armes savantes [Bret 1994], administration des ponts et chaussées, inspection des finances... En témoigne la soi-disant Société d'Arcueil, qui, pendant l'époque de Napoléon, abritera la plupart des grands physiciens en France, et qui saura fructifier, grâce à la fortune et l'influence personnelles de deux savants-mécènes, Laplace et Berthollet, le capital scientifique de plusieurs jeunes polytechniciens [Crosland 1967]. En témoigne Poncelet lui-même et tous ces ingénieurs-militaires œuvrant dans son sillage : ceux-ci réalisent une grande partie de leurs travaux, couronnés souvent par l'Académie, suite à la sollicitation et grâce au soutien d'institutions que l'on n'associerait pas spontanément au développement du savoir scientifique, tels le ministère de la Guerre ou celui des Travaux Publics, dans la tradition des recherches pratiquées au XVIIIe siècle autour des Ecoles militaires.

Et pourtant, la France de Poncelet brille. Après tout, peut-être que la conception et la pratique actuelles de la profession du scientifique ne sont pas nécessairement les seules conditions possibles de l'excellence scientifique.

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KONSTANTINOS CHATZIS

LA QUESTION DE L'EAU À ATHÈNES, 1830-1930 : L'INGÉNIEUR, LE PREMIER MINISTRE ET LE MAIRE

Introduction

La présente communication porte sur *la question de l'eau à Athènes*, des années 1830 aux années 1930. Par l'expression : " question de l'eau à Athènes ", j'entends les efforts déployés pendant la période précitée pour résoudre le problème du ravitaillement en eau potable de la ville. Cette question sera traitée en deux temps.

Dans un premier temps, je vais exposer les moments les plus marquants de l'histoire de l'approvisionnement en eau d'Athènes, de 1830 à 1930, date où le problème récurrent du ravitaillement de la ville trouve, grâce à la création d'un système de distribution moderne, l'ancêtre direct du réseau actuel, une solution enfin durable. Centrée sur le jeu des acteurs impliqués dans la question de l'eau, cette première partie de la communication décrit un long processus de passation des pouvoirs. Assuré en effet pendant un siècle par *la municipalité elle-même*, en grande partie à l'aide de fontaines publiques distribuant aux athéniens de l'eau gratuite, l'approvisionnement en eau de la capitale grecque va passer, au milieu des années 1920, aux mains d'un service gestionnaire fondé par le pouvoir central (le gouvernement), service qui va vendre à ses abonnés du réseau un bien, devenu désormais objet marchand.

Le passage à la deuxième partie de la communication signale un changement de registre: le récit des vicissitudes de la "question de l'eau à Athènes" sera abandonné au profit d'une problématique plus générale. M'appuyant sur le cas de l'approvisionnement en eau de la capitale grecque, je vais proposer l'exploration future d'un certain nombre de thèmes relatifs à la modernisation de l'Etat et de la société grecs, thèmes peu abordés, me semble-t-il, jusqu'à maintenant. Le fil conducteur de cette exploration sera la figure de l'ingénieur.

Partie I : 1830-1930, un siècle d'histoire

1835-1870 : quand la pénurie et les épidémies s'installent dans la ville

En 1833, le royaume de Grèce se dote de la première loi relative à son organisation municipale, d'après laquelle le ravitaillement en eau des habitants des communes constituées incombe au pouvoir municipal. Athènes ne constituera pas une exception à cette municipalisation de la gestion des eaux. Aussitôt chargés du dossier, les responsables municipaux de la capitale grecque depuis 1834 se trouvent confrontés à un problème grave. Athènes est dépourvue des infrastructures nécessaires en matière d'eau. Quelques fontaines publiques alimentées par ce qui reste de l'aqueduc construit par l'empereur romain Hadrien, ainsi qu'une série de puits privés, creusés dans les cours des maisons, sont les seules sources d'eau disponibles. Sources problématiques à la fois sur le plan quantitatif mais aussi qualitatif, les eaux des puits étant souvent contaminées à cause du mauvais assainissement de la ville.

Pour pouvoir engager les travaux nécessaires en matière de ravitaillement en eau, la municipalité se lance à la recherche de recettes. Elle obtient auprès du gouvernement le droit de vendre à des particuliers intéressés l'eau en provenance de l'aqueduc d'Hadrien. L'abonné reçoit ainsi, quotidiennement et pendant quelques heures de la journée, une quantité fixe d'eau qui correspond à son abonnement annuel, eau qu'il stocke dans un réservoir installé dans la cour de sa maison. Dès les années 1830, s'instaure ainsi pour la ville d'Athènes dans le domaine de l'eau une gestion aux caractéristiques suivantes. C'est *le pouvoir municipal* qui assure le ravitaillement en eau des habitants, soit par l'intermédiaire des fontaines publiques distribuant de l'eau gratuite, soit par l'intermédiaire d'un réseau élémentaire, permettant aux athéniens les plus aisés de recevoir l'eau achetée dans leurs réservoirs privés.

Mais malgré cette première tentative de “ marchandisation ” de l'eau, le faible nombre d'abonnés interdit pendant longtemps d'entreprendre un programme de travaux à la hauteur des besoins d'une ville en constante croissance (la population d'Athènes passe de 14 000 habitants en 1836 à 44 500 en 1870). Pendant 35 ans, de 1835 à 1870, les athéniens vont alors vivre sous la menace constante de la pénurie et d'épidémies récurrentes.

1870 : le réveil

Il faut attendre les années 1870 pour que la municipalité s'engage dans une action conséquente en matière d'eau. Le maire Panagis S. Kyriakos (1870-1879) contracte un emprunt de 300000 drachmes auprès de la Banque nationale, créée en 1841. Grâce à cette somme, la municipalité entreprend une série de travaux qui comprennent notamment : l'installation d'un réseau de distribution moderne, composé de tuyaux en fonte de fer pour diminuer les fuites, qui attire de nouveaux abonnés et fait grimper les recettes de la ville ; la construction de nouvelles fontaines ; un programme de rénovation de l'aqueduc d'Hadrien, laissé jusqu'alors à l'abandon. En même temps, pour subvenir aux besoins de ses administrés, la ville achète de l'eau à des particuliers, propriétaires des puits. Le successeur de Kyriakos, Dimitrios Soutsos (1879-1887), continue, durant les années 1880, la politique volontariste de son prédécesseur, en s'engageant sur trois autres emprunts, auprès de la Banque nationale toujours, d'un montant total égal à 2 500 000 drachmes. Les travaux réalisés feront sentir leurs effets bénéfiques. Le spectre de la disette, quasi quotidienne jusqu'alors, semble avoir épargné les athéniens pendant les années 1870-90.

les années 1890 : de nouveau des problèmes

Eté 1898, la pénurie frappe de nouveau durement. De l'embellie des années 1870 et 1880 à la crise de nouveau. Crise d'origine économique. Un nouvel emprunt de 550 000 drachmes contracté auprès du créancier habituel de la ville, la Banque nationale, fait qu'au début des années 1890 les dettes non payées de la municipalité s'élèvent à plus de 5 000 000 drachmes, somme plus qu'importante eu égard aux recettes de la ville. Voyant ses demandes pour de nouveaux prêts refusées, asphyxiée économiquement, la municipalité se trouve contrainte à dépenser peu en matière d'eau alors que la population augmente constamment (Athènes compte 107 000 habitants en 1889). L'aqueduc d'Hadrien, délaissé de nouveau, bouché suite à des affaissements de terrain, amène, dans les années 1890, des quantités de plus en plus faibles d'eau à Athènes. Des paysans dont les terres se situent le long de l'aqueduc ne manquent pas par ailleurs d'y puiser gratuitement et réduisent de ce fait davantage l'eau disponible aux citadins.

(1890-1926): l'ère des grands projets non aboutis

Face à une pénurie plus ou moins récurrente, le pouvoir central manifeste, en 1890, les premiers signes d'intérêt pour la question de l'alimentation en eau de la ville d'Athènes. Charilaos Tricoupis, le premier ministre des grands travaux, fait appel à l'expérience française. Il s'adresse alors à Edouard Quellennec, ingénieur faisant partie de la mission des ponts et chaussées en Grèce, qui propose comme solution définitive au problème d'approvisionnement en eau de la capitale grecque les eaux du lac de Stymphalie, situé à 150 kilomètres d'Athènes dans la région de Corinthe. Le projet est ambitieux, Quellennec estime la valeur des travaux à 28 000 000 drachmes. Le 9 mai 1890, Tricoupis dépose au parlement grec un projet de loi, qui s'inspire de propositions de Quellennec, proposant de concéder à l'entrepreneur qui va réaliser les travaux nécessaires le monopole de la distribution de l'eau pour Athènes et le Pirée pour une période de 99 ans. Pour rendre la concession attractive, l'Etat garantit à la future société concessionnaire un intérêt annuel de 3% sur les deux tiers du capital engagé (estimé par le gouvernement à 55 000 000 drachmes).

L'intervention de Tricoupis n'a pas produit d'effets immédiat, l'intérêt annuel de 3% garanti n'étant pas jugé, selon toute vraisemblance, suffisant par des entrepreneurs grecs ou étrangers. Mais le projet de loi de 1890 signale le commencement d'une ère nouvelle dans l'histoire de l'eau de la ville. A partir de cette année, une partie de bras de fer s'engage entre le pouvoir municipal de la capitale, défendant une gestion municipale du service d'eau, et l'Etat central qui penche désormais de façon constante vers la solution de la concession de l'approvisionnement en eau d'Athènes à une entreprise privée.

Encouragés par la tentative de Tricoupis, plusieurs entrepreneurs grecs ou étrangers espèrent accéder au statut de futur concessionnaire, et adressent au gouvernement ainsi qu'à la ville, dans les années 1890, plusieurs propositions. Parmi celles-ci, une proposition émanant de deux ingénieurs et entrepreneurs grecs, N. Vlagalis et A. Matsas, à la tête d'une grande compagnie de travaux publics liée au capital européen (*Etaireia ton Ergolipsion*), obtient les faveurs du gouvernement. Poussé probablement par la situation catastrophique de l'été 1899, celui-ci dépose au parlement un projet de convention entre l'Etat et la compagnie. La notification publique du projet de convention, qui a été préparé dans l'extrême discrétion, provoque un tollé général. Le conseil municipal, la presse, mais aussi plusieurs ingénieurs, lors des séances de l'Association polytechnique (*Polytechneikos Sillogos*) notamment, expriment leur désapprobation. Les détracteurs de la convention jugent le projet scandaleusement avantageux pour l'entreprise, et accusent le gouvernement de vouloir délaisser, sur la base d'un simple avant-projet et sans faire appel à la concurrence, l'avenir de la capitale aux mains des intérêts privés.

Le projet finalement abandonné, la question de l'alimentation en eau de la capitale grecque reste ouverte. Mais au tournant du siècle, les données du problème seront modifiées. Effacée dans les années 1890 au profit des initiatives de l'Etat, la ville d'Athènes essaie de reprendre en main son destin en matière d'eau. Entamant son premier mandat de maire de la Capitale en 1899, Spiros Mercouris, présidant aux destinées de la ville pendant 20 ans (1899-1914 et 1929-34), fera de la question de l'eau l'une de ses priorités. Aussitôt élu, il fait venir à la mairie Petros Protopapadakis, ancien élève de l'Ecole polytechnique de Paris et futur Premier ministre, figure importante du monde des ingénieurs grecs de l'époque. Protopapadakis réorganise le service des eaux de la ville et lance une série d'opérations, telles que la rénovation de l'aqueduc d'Hadrien, la récupération de l'eau appartenant à la ville mais " volée " par des particuliers, le creusement de nouveaux puits, la création de nouvelles fontaines publiques, opérations qui vont pallier les manques immédiats des athéniens. Fort de ces résultats, Mercouris s'active pour une solution durable au problème de l'approvisionnement en eau de la capitale. Il mobilise plusieurs réseaux d'experts, composés d'ingénieurs grecs mais aussi étrangers, qui vont réfléchir aux différentes solutions possibles et vont examiner pour le compte de la ville les différents projets proposés. Mercouris va demander en 1907 au gouvernement, alors qu'Athènes compte 167 500 habitants, le vote d'une loi imposant l'abonnement obligatoire, aux frais des propriétaires, des maisons au réseau de distribution d'eau, afin d'assurer la réussite financière de tout futur projet de grande ampleur.

Sourd aux sollicitations d'un pouvoir municipal de plus en plus actif, l'Etat central continue à œuvrer de son côté. Il entre en contact, en 1907, avec la Banque nationale, intéressée par une éventuelle concession de l'alimentation en eau d'Athènes. Quelques années plus tard, en 1913, le gouvernement dépose au parlement un projet de convention ayant comme objet l'approvisionnement en eau de la capitale (et du Pirée). Fidèle à son penchant vers l'option "concession", qu'il justifie en évoquant le favoritisme censé caractériser la gestion municipale, le gouvernement invite les futurs concessionnaires à concourir sur deux options techniques dont l'une est établie par l'expert de la Banque nationale, devenu entre temps l'expert de l'Etat. " Piqués " par l'accusation de favoritisme, Spiros Mercouris, et derrière lui, le Conseil municipal, déclenchent une polémique. La ville proteste contre une politique qui associera pendant trois quart de siècle le destin de la ville aux intérêts du capital privé, tout en passant au crible, par l'intermédiaire de ses experts, les clauses du projet.

Le projet de 1913, sur fond de guerres balkaniques, subira le même sort que celui de ses prédécesseurs. Il faut attendre encore dix ans pour que la question de l'eau à Athènes trouve une solution durable. L'installation de plusieurs milliers de grecs d'Asie Mineure dans la région d'Athènes, suite aux événements de 1922, y est sûrement pour quelque chose (Athènes compte seule 393 000 habitants en 1928). Poussé par une situation catastrophique, le parlement grec vote, le 4 avril 1925, une loi qui confie le financement, la conception et la réalisation d'un lac artificiel de 41 000 000 m^3 sur le site de Marathon à l'entreprise américaine Ulen et son alliée financière en Grèce, la Banque d'Athènes, produit du capital de la Diaspora. Une fois les travaux réalisés, la distribution de l'eau aux athéniens est assurée par la " Société anonyme grecque des eaux ", créée par l'Etat grec. Celle-ci est chargée de fixer des tarifs d'abonnement capables d'assurer, pendant une vingtaine d'années, des annuités d'un million de dollars, qui correspondent à l'emprunt de 10 millions de dollars contracté par l'Etat grec auprès d'Ulen et de la Banque d'Athènes. A partir de 1931, Athènes et le Pirée vont ainsi bénéficier d'un système d'alimentation moderne (*le système actuel*). Après un siècle de gestion locale, l'eau échappe définitivement aux mains du pouvoir municipal.

Partie II : Les ingénieurs et la modernisation de la Grèce

Comme je l'ai déjà annoncé dans l'introduction, dans cette deuxième partie de l'exposé, en m'appuyant sur l'exemple de la " question de l'eau à Athènes ", je vais suggérer l'exploration future d'un certain nombre de thèmes relatifs à la modernisation de l'Etat et de la société grecs, thèmes peu abordés, me semble-t-il, jusqu'à présent.

Mais avant de parler de voies peu explorées, commençons par évoquer des réalités familières, déjà traitées par les historiens spécialisés dans l'histoire économique et technique de la Grèce. Comme dans le cas des autres grands projets techniques du XIXe siècle, tels les chemins de fer, le canal de Corinthe ou l'électrification d'Athènes, la " question de l'eau à Athènes " met en scène des compagnies techniques grecques mais aussi étrangères, des banques grecques et étrangères, des gouvernements grecs et étrangers, plusieurs acteurs pris dans des réseaux d'alliances et d'oppositions. Des réalités parfaitement traditionnelles, pour un pays peu développé, qui essaie de se moderniser à une époque où des capitaux européens mais aussi américains (après la première guerre mondiale) migrent vers la " périphérie " pour chercher à fructifier *via* le financement de grands travaux.

Or, à côté des choses traditionnelles, la " question de l'eau à Athènes " me suggère un certain nombre de pistes de recherche, qui nous font quitter les territoires de l'histoire économique et technique, à l'intérieur desquels les questions relatives aux " grands travaux " sont généralement confinées. J'indiquerai ici trois pistes, qui sont liées, toutes, à la figure de l'ingénieur.

première piste : ingénieur et modernisation politique

L'existence et l'importance de réseaux clientélistes dans la société grecque du XIXe et du XXe siècles sont un phénomène attesté et reconnu par l'ensemble de la communauté des chercheurs grecs, même si l'appréhension exacte du phénomène divise ses membres. Or, la prospérité des réseaux clientélistes va de pair avec deux autres phénomènes. Le premier est l'inexistence, ou la présence atrophiée, de ce qu'on appelle un *espace public* et une *opinion publique*. Le second, c'est l'absence, ou le fonctionnement problématique, d'associations dites "horizontales" qui regrouperaient non pas des individus pris dans des relations de dépendance et de hiérarchie (c'est le cas des réseaux clientélistes) mais des individus " égaux " (exemple type de ces associations : les syndicats, des partis de classe, des associations professionnelles indépendantes...).

La "question de l'eau à Athènes" met en scène un acteur collectif qui a les caractéristiques d'une association de type horizontal, et dont les modes de fonctionnement et d'intervention le situent aux antipodes des réseaux clientélistes. Cet acteur est la communauté des ingénieurs grecs. Ceux-ci revendiquent à la fin du siècle dernier le rôle de conseiller du pouvoir. Mais ils veulent peser sur le cours des politiques publiques, non pas sur un mode clientéliste, mais en mettant en avant une exigence de transparence et " l'usage public du raisonnement " pour parler comme Habermas. Les diverses manifestations de ce monde — associations, revues, mais aussi la façon concrète dont ses membres organisent et gèrent les différents services techniques dont ils ont la charge — constituent une piste à explorer dans le chapitre de la modernisation de la société et de l'Etat grecs.

deuxième piste : ingénieur et histoire des idées

La réception par la société grecque du XIXe siècle de grands mouvements intellectuels nés à l'Occident, tels les Lumières, le Romantisme, les idées libérales ou socialistes constitue l'objet de plusieurs analyses dans le domaine de l'histoire des idées. La "question de l'eau à Athènes" suggère un élargissement thématique de ce dernier domaine. En effet, ayant fait, dans leur majorité, leurs classes à l'étranger, les ingénieurs grecs, à l'occasion de différents projets techniques, importent au pays une constellation de produits intellectuels élaborés dans des pays développés. A travers " la question de l'eau à Athènes ", les ingénieurs grecs ont été le vecteur de transmission des idées et des pratiques du *mouvement hygiéniste* ainsi que de celles du *municipalisme social,* c'est-à-dire du mouvement en faveur de la gestion municipale de différents services techniques urbains (eau, transports...).

Mais le rôle des ingénieurs grecs comme vecteurs de transmission de produits intellectuels venant de l'Occident se manifeste aussi dans le domaine plus abstrait des " styles de raisonnement ", j'entends par là, en suivant le philosophe des sciences I. Hacking, les diverses manières d'argumenter, de justifier, et de mettre à l'épreuve. En débattant du problème du ravitaillement en eau de la capitale, les ingénieurs grecs font souvent appel au *style de raisonnement statistique*, permettant d'établir des rapports de causalité entre des classes de phénomènes grâce à la lecture parallèle de plusieurs séries statistiques. Ce mode de raisonnement ne reste pas cantonné dans le champ des ingénieurs mais il migre dans le champ politique. Ainsi Spiros Mercouris pour défendre son œuvre de maire mobilise des statistiques montrant une nette diminution de la mortalité des athéniens pendant la période de ses mandats, diminution qu'il attribue aux actions menées par la ville en matière d'alimentation en eau.

troisième piste : objet technique et lien social

Un objet technique, loin d'être un simple moyen docile au service des intentions et des stratégies des acteurs sociaux, de par sa matérialité et son fonctionnement, produit du lien social ; il transforme des relations établies, modifie des mentalités traditionnelles, crée des habitudes et des comportements nouveaux.

Pour illustrer ces positions, penchons-nous, une dernière fois, sur le système de distribution d'eau mis en place pour le compte de la ville d'Athènes, par Ulen en 1931 (il s'agit du système actuel, avec robinet à l'intérieur de chaque appartement). Une fois construit et mis en fonctionnement, le réseau affecte l'athénien de plusieurs façons. Tout d'abord, il participe à sa transformation (lente et sûrement inachevée) en *homo economicus.* Rappelons qu'avant la construction de ce réseau, pour une grande partie des athéniens, l'eau était un bien sans prix marchand, distribué gratuitement par l'intermédiaire de fontaines publiques. Avec le réseau moderne et ses compteurs individuels, l'athénien paye désormais en fonction de sa consommation réelle, et pénètre dans l'univers du marché.

Le même réseau transforme également l'athénien en client anonyme d'une administration impersonnelle avec laquelle il ne développe pas de relations de type clientéliste. D'après plusieurs témoignages, le mode de distribution d'eau valable au XIXe siècle, basé (en partie) sur des réservoirs privés dans les cours des maisons, était la source des relations de type clientéliste entre les abonnés existants et les agents du service municipal. Rappelons que le remplissage des réservoirs nécessitait l'ouverture de vannes manipulées par des agents particuliers (appelés *idronomeis* en grec), et qui marchandaient avec les abonnés la quantité d'eau à fournir. Le réseau mis en place par Ulen, fonctionnant de *façon automatique* — l'ouverture du robinet amenant sans l'intervention d'agent intermédiaire l'eau chez soi — supprime les relations de face à face entre l'abonné et l'agent du service, relations susceptibles d'engendrer des rapports de type clientéliste.

Notule bibliographique

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BRUNO BELHOSTE

INGÉNIEURS CIVILS CONTRE INGÉNIEURS DE L'ÉTAT: LA CRÉATION DE L'ÉCOLE CENTRALE DES ARTS ET MANUFACTURES ET LE TOURNANT DE 1830

Définir ce qu'est un "ingénieur" n'a rien d'évident. Voilà un mot-titre qui est utilisé en Occident depuis maintenant près de 1000 ans, qui a été traduit dans toutes les langues du monde, qui désigne aujourd'hui un métier universellement répandu, clairement défini, croit-on souvent, par un statut social, une formation, une culture. Pourtant, si le mot "ingénieur" paraît recouvrir une réalité déterminée - un ingénieur concevrait et dirigerait des opérations techniques, par opposition à un savant, qui ne s'intéresserait qu'à des savoirs théoriques et à un artisan qui exécuterait un travail purement pratique -, une étude comparative ou historique montre rapidement que sa fonction lexicale est en réalité mal définie, sans dénomination référentielle précise. Le mot-titre "ingénieur" apparaît plutôt comme un mot-valeur, ayant une signification dénotative assez pauvre - quoi de commun en effet, aujourd'hui, entre l'ingénieur-manager sorti d'une grande école parisienne et l'ingénieur étroitement spécialisé qui a été formé à l'Institut technique de la soie à Wuhan - et, d'autre part, une très forte signification connotative - on dira par exemple que le mot ingénieur évoque en même temps le génie du créateur et l'ingéniosité du bricoleur, qu'il désigne une figure de passeur entre des mondes socio-culturels différents, celui des savants et celui des entrepreneurs, ou celui des maîtres d'ouvrage et celui des travailleurs.

Si j'ai fait cette remarque très générale sur la fonction lexicale du mot-titre "ingénieur" en prologue à un exposé dont le sujet est tout à fait circonscrit dans le temps et l'espace — il s'agit de la France des années 1820-1830 —, c'est parce que le débat qui m'intéresse ici porte précisément sur la signification et les usages du titre : qui peut prétendre à cette époque user pour soi du titre d'ingénieur ? par quelles voies peut-on légitimement avoir accès à ce titre ? Et quelle autorité est-elle en droit de le conférer ? Si le mot lui-même est alors un enjeu, c'est qu'il mobilise avec lui tout un champ lexical, formant autour de lui comme un halo sémantique et instituant symboliquement tout le champ socioprofessionnel des activités techniques supérieures[1].

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[1] La notion de champ, développée en particulier par Pierre Bourdieu en sociologie, est un outil d'analyse précieux pour l'historien qui veut élaborer une théorie du monde social indépendante des

En dépassant les limites de la sémantique historique, attentive aux seules structures de la représentation pour emprunter les moyens de l'histoire sociale, c'est précisément des transformations de ce champ socioprofessionnel, considéré comme une structure institutionnelle, dont je voudrais parler ici, avec la conviction que seule une telle analyse historique permet d'exhiber les référents objectifs des représentations symboliques qui font exister le monde social dans l'esprit des acteurs eux-mêmes.

Les ingénieurs des services publics et l'École polytechnique

Dans la France du début du XIXe siècle, le mot-titre ingénieur, de vieille origine, s'est trouvé investi de nouvelles valeurs, en référence à la technocratie, progressivement constituée au sein de la sphère étatique au cours du XVIIIe siècle et considérablement renforcée et institutionnalisée à l'occasion des grandes réorganisations révolutionnaires. La technocratie, ou bureaucratie technique, le mot lui-même est un anachronisme[2]. Une des caractéristiques surprenantes de la technocratie, au XVIIIe et XIXe siècles est en effet de ne pas disposer de représentations adéquates d'elle-même, ce qui se traduit par une grande pauvreté lexicale - il manque une terminologie d'époque pour en saisir la réalité -, et de fonctionner ainsi, malgré une forte institutionnalisation, de manière quasi-invisible. Pendant longtemps, la technocratie est conçue seulement comme l'ensemble des services techniques de l'État, que l'on désigne en France depuis la Révolution sous le nom de services publics. Ce n'est que très progressivement, à partir de la fin des années 1820, avec le débat autour des ingénieurs civils (au sens français du terme), qu'une représentation de la technocratie va progressivement émerger, en même temps que le champ socioprofessionnel des activités techniques supérieures va s'autonomiser par rapport à l'État.

Au XIXe siècle, le personnel d'encadrement de la plupart des services publics est réuni en corps, chacun ayant son mode de recrutement et d'avancement, son organisation hiérarchique et ses traditions de service. Cette organisation

représentations des acteurs historiques eux-mêmes. De manière générale, un champ désigne le système des relations sociales associé à un domaine d'activité spécifique. Ce n'est pas une réalité empirique mais une construction théorique permettant d'étudier et d'expliquer les données historiquement observables que sont les institutions, les représentations et les actions associées au champ. Par exemple, le champ socioprofessionnel des activités techniques supérieures dans la France du début du XIXe siècle est une construction d'historien, à laquelle il est impossible de référer une quelconque représentation d'époque. Mais l'absence d'une "conscience de champ" avant les années 1830 est précisément un effet de la structure du champ lui-même, scindé à cette époque entre un pôle technocratique dominant (mais dominé dans l'appareil d'État) et un pôle artiste, non seulement dominé mais nié dans son existence.

2 Le terme *technocracy* a été forgé au XXe siècle par l'américain Thorstein Veblen.

corporative, héritée de l'Ancien régime, n'est d'ailleurs pas propre à ces services, puisqu'on la retrouve dans toutes les parties de l'appareil d'État français : Justice, Finances, Armée et Marine, Université. Tout en étant distinct en tant que mission et administration, les service publics tendent à se confondre avec les corps techniques qui les servent. C'est le cas, par exemple, des Ponts et chaussées, qui sont à la fois une administration ayant à sa tête un directeur général nommé par le gouvernement et un corps d'ingénieurs que gère et représente le Conseil général des ponts et chaussées. De manière générale, la structure technocratique des services publics est enveloppée dans l'organisation corporative traditionnelle qui la rend invisible, organisation qui perdure tout au long du XIXe siècle et même, comme on sait, au-delà.

Qu'en est-il, dans ces conditions, du mot-titre "ingénieur" en France au début du XIXe siècle ? À vrai dire, on n'est jamais à cette époque ingénieur tout court : on est ingénieur des fortifications ou du génie militaire, ingénieur des ponts et chaussées, ingénieur des mines, ingénieur du génie maritime, ingénieur-géographe, c'est-à-dire membre d'un corps attaché à un service public. C'est dire que le titre d'ingénieur est accaparé par les corps techniques. Mais, comme le champ lexical relatif à la technocratie est alors très mal structuré, le titre d'ingénieur ne recouvre pas lui-même l'ensemble des missions qu'elle sert. On constate en effet qu'il existe des corps techniques qui ne sont pas eux-mêmes des corps d'ingénieurs. Les artilleurs, par exemple, sont des officiers militaires qui n'ont pas le titre d'ingénieurs. En France, le mot-titre "ingénieur" est donc sémantiquement faible au début du XIXe siècle. Il appartient sans conteste à la sphère étatique, mais, du fait qu'il reste attaché, à l'intérieur de cette sphère, à l'organisation corporative de la fonction publique, il ne peut servir à désigner univoquement la figure du technocrate. Il reste libre ainsi, comme on va voir, pour d'autres usages, et susceptible de devenir un enjeu symbolique pour d'autres groupes professionnels.

Mais avant d'aborder ce point, il reste à comprendre ce qui constitue malgré tout, au début du XIXe siècle, le dénominateur commun à tous les ingénieurs d'État : qu'est ce qui rapproche les ingénieurs des différents corps et justifie l'emploi du même titre à leur propos ? Autrement dit, il reste à se demander s'il existe, à l'intérieur même de la sphère étatique, une figure idéal-typique de l'ingénieur qui transcende l'organisation corporative et administrative. La réponse, je crois, est oui, même si cette figure, que l'on saisit par exemple à travers l'idéologie saint-simonienne, ne trouve pas d'expression linguistique adéquate. Il faut en chercher les racines dans le système de recrutement et de formation, qui constitue l'élément structurant de la technocratie française depuis l'origine. Ce système s'est réorganisé et renforcé pendant la Révolution autour de l'École polytechnique nouvellement créée, et c'est pourquoi, je l'appellerai, faute d'une dénomination d'époque, le système polytechnicien.

Le système polytechnicien peut être décrit à la fois comme un système de recrutement des corps techniques fondé sur un concours et un classement, et comme un système de formation comprenant un enseignement théorique général, à l'École polytechnique, et des spécialisations en aval dans les écoles d'application dépendant des services publics. Les ingénieurs des corps sélectionnés par ce système partagent un ensemble de valeurs et de connaissances. Dans cet ensemble, je retiendrai deux éléments qui me paraissent particulièrement significatifs pour l'identité professionnelle de la technocratie : l'élitisme corporatif et la référence aux sciences.

L'élitisme corporatif, hérité des armes savantes, procède d'une stratégie de distinction dont le but est de séparer socialement l'expertise des services d'État de l'univers des arts et métiers. Cette stratégie vise en premier lieu les hommes de l'art opérant dans le domaine technique où intervient chacun des services publics. Le meilleur exemple est donné par l'attitude des ingénieurs des ponts et chaussées vis-à-vis des architectes et des ingénieurs civils tout au long du XIXe siècle. Bien que les domaines de compétence et d'intervention des uns et des autres se recoupent très largement, le corps n'a eu de cesse de marquer sa différence, afin d'interdire tout empiétement ou réduction de son monopole sur les travaux publics. Le souci de la distinction s'affirme également par rapport au personnel technique subalterne des services, auxquels n'est accordée aucune possibilité effective de promotion dans les corps.

Cet élitisme corporatif repose lui-même pour l'essentiel sur le mode de recrutement et de formation. L'entrée dans les corps s'effectue par l'examen et l'école, soit exclusivement comme dans le cas des Mines et des Ponts et Chaussées, soit très majoritairement comme dans le cas de l'Artillerie et du Génie. C'est cette barrière du concours scolaire, considérée comme une garantie d'excellence, qui justifie l'élitisme des corps, tant vis-à-vis des personnels subalternes que vis-à-vis des acteurs intervenant dans leur domaine de compétence. Elle constitue en retour, pour les hommes de l'art, le symbole de l'arrogance des ingénieurs d'État.

La référence aux sciences constitue le second élément fondamental définissant l'identité de l'ingénieur d'État. L'accumulation d'un capital scientifique par les corps procède de la conviction que l'expertise technique doit résulter de l'application des sciences théoriques au domaine pratique. C'est là une croyance qui s'oppose point par point aux conceptions dominantes dans l'univers des métiers où les savoirs professionnels sont censés être directement tirés de l'expérience pratique. Ce rationalisme technologique s'est imposé en France dès le dernier tiers du XVIIIe siècle au sein des milieux éclairés liés à l'appareil d'État. Au XIXe siècle, il constitue l'idéologie par excellence de la technocratie, dont il justifie l'interventionnisme au nom du savoir scientifique. Au niveau du service, la théorisation des questions pratiques, spécialement sous une forme mathématisée, se traduit d'ailleurs davantage par une rationalisation de l'activité bureaucratique, reposant elle-même sur la quantification des besoins et des ressources, que par une transformation des procédés et des objets techniques en usage, les administrations s'avérant généralement à cet égard assez conservatrices. Quoi qu'il en soit à cet égard, la forte culture scientifique de l'ingénieur d'État, en lui donnant une stature d'ingénieur-savant, marque sa distinction fondamentale par rapport au simple praticien formé sur le tas.

La fondation de l'École centrale des arts et manufactures

Malgré ses prétentions, la technocratie du début du XIXe siècle ne recouvre évidemment pas l'ensemble du champ socioprofessionnel des activités techniques supérieures. Il subsiste en France, comme en Angleterre, un milieu indépendant de techniciens concepteurs et inventeurs, formés sur le tas, que nous appellerons artistes ou hommes de l'art, non organisés mais très actifs dans le domaine du génie civil et de la mécanique pratique. Ce milieu, dont se sont progressivement détachés les ingénieurs des corps techniques au cours du XVIIIe siècle, est en position d'infériorité intellectuelle et sociale par rapport à la technocratie d'État. Les péripéties de la période révolutionnaire, en particulier la suppression de l'Académie des sciences en 1793 et des anciennes écoles d'ingénieurs l'année suivante, a révélé l'hostilité latente du milieu vis-à-vis des structures technocratiques et de leurs représentants, mais les hommes de l'art n'ont longtemps ni les moyens idéologiques, ni les ressources institutionnelles pour contester l'hégémonie de la technocratie sur le champ des activités techniques supérieures. Comme l'écrira beaucoup plus tard l'un d'entre eux, Eugène Flachat, cité par Georges Ribeill, en évoquant la période d'avant 1830, “il fallait tout conquérir et nous étions sans force et sans influence ; il nous fallait disputer pied à pied le terrain sur lequel devait s'exercer notre activité, et nous n'étions que des hommes obscurs, nouveaux venus dans une carrière dont le nom n'existait même pas”[3]. Dans ces conditions, rares sont ceux, parmi ces hommes, qui osent revendiquer pour eux-mêmes le mot-titre “ingénieur”, monopolisé par les corps techniques.

La situation évolue cependant rapidement après la chute de Napoléon et la reprise des relations commerciales et intellectuelles avec l'Angleterre. Les années qui suivent sont, en France, des années de prise de conscience de la véritable “révolution industrielle” réalisée outre-Manche depuis les années 1780, et du rôle que joue la technique dans cette révolution. Chez les ingénieurs des corps comme chez les hommes de l'art, les principaux acteurs de cette mutation sont identifiés : ce sont les “inventeurs”, ceux qui se désignent eux-mêmes comme des “engineers”, ou “civil engineers”, pour se distinguer des “military

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[3] Voir G. Ribeill, “Profil des ingénieurs civils au XIXe siècle. Le cas des centraux”, in A. Thépot, *L'ingénieur dans la société française, Paris: les Éditions ouvrières*, 1985, pp. 111-125, p. 111, note 1.

engineers", et qui correspondent, *mutatis mutandis*, aux hommes de l'art qui exercent en France à la même époque.

C'est donc à partir de la Restauration, que le mot-titre ingénieur commence à être adopté en France par des techniciens indépendants, timidement d'abord, puis à voix haute et forte. Des hommes comme Marc Seguin, le constructeur de ponts suspendus, Eugène Biot, l'initiateur du premier chemin de fer en France, ou Alexandre Corréard, le directeur du *Journal du génie civil* fondé en 1828, sont les premiers à revendiquer le titre sur l'exemple anglais. À la veille de 1830, le titre d'ingénieur civil s'est diffusé assez largement chez les hommes de l'art intéressés aux activités industrielles : industries métallurgiques et construction mécanique, turbines et machines à vapeur, chemins de fer, pour citer les principales. On notera qu'en traversant la Manche, le titre lui-même a changé de sens : alors qu'en Angleterre, il désigne l'ingénieur non militaire, en France, où il existe aussi des ingénieurs d'État non militaires, il désigne les ingénieurs qui ne sont pas dans un corps. À l'opposition lexicale *military engineer/civil engineer* se substitue ainsi une nouvelle opposition lexicale *ingénieur civil/ingénieur des corps d'Etat.*

C'est dans ce contexte qu'une nouvelle école d'ingénieurs, la première entièrement privée, ouvre ses portes à Paris en 1829 : l'École centrale des arts et manufactures. "Cette école, annonce le premier prospectus de l'école, rédigé par Jean-Baptiste Dumas, est destinée spécialement à former des ingénieurs civils, des directeurs d'usines, des chefs de fabrique et de manufactures".

Comme l'ont montré les travaux de plusieurs historiens, parmi lesquels je citerai tout particulièrement ceux de Georges Ribeill et de John Weiss[4], la création de l'École centrale des arts et manufactures constitue un événement majeur et décisif dans la transformation du champ socioprofessionnel des activités techniques supérieures en France et son adaptation à l'âge industriel. Elle marque d'ailleurs une date non seulement en France, mais partout en Europe, car il s'agit du premier exemple d'école destinée spécifiquement à former des ingénieurs pour l'industrie. Jusqu'alors, non seulement les hommes de l'art se trouvaient en position de dominés par rapport à la technocratie des corps, mais ils n'avaient même pas la possibilité d'intervenir légitimement dans le champ. À partir des années 1830, en revanche, le champ socioprofessionnel des activités techniques supérieures devient bipolaire, avec d'un côté un pôle technocratique qui reste longtemps dominant, et de l'autre un pôle industriel, en position dominé mais qui s'affirme peu à peu socialement et idéologiquement. Dans le champ ainsi structuré, l'École centrale des arts et manufactures est la référence pour les ingénieurs civils, quelle que soit leur formation initiale, de même que l'École polytechnique constitue la matrice de la technocratie. En

[4] G. Ribeill, art. cit., et J.H. Weiss, *The Making of Technological Man. The Social Origins of French Engineering Education*, Cambridge: MIT Press, 1982. Voir également K. Chatzis, "La naissance d'une nouvelle figure : l'ingénieur civil et l'École centrale", préprint.

particulier, c'est l'École centrale qui impose définitivement en France l'usage du titre, en référence au *civil engineer* anglais.

Qui sont donc les fondateurs de l'École centrale ? Ce sont trois enseignants, peu connus jusqu'alors : Olivier, Péclet et Dumas. Théodore Olivier est un artilleur, ancien élève de l'École polytechnique, revenu en 1827 de Suède où il était parti enseigner la géométrie descriptive. Eugène Péclet est un ancien élève de l'École normale, qui a fréquenté Saint-Simon (il lui a présenté Augustin Thierry) avant d'enseigner la physique à Marseille. Jean-Baptiste Dumas, enfin, est un chimiste protégé de Thenard, qui donne des conférences à l'Athénée et exerce les fonctions de répétiteur à l'École polytechnique. Ces trois hommes ont un certain nombre de points communs. Ils sont plutôt jeunes — Olivier et Péclet ont 36 ans et Dumas 29 ans en 1829 —, et dynamiques ; ils sont convaincus qu'il faut promouvoir un enseignement utilitaire des sciences en direction des industriels ; ils pensent que les écoles existantes, en particulier l'École polytechnique, ne peuvent remplir cette tâche. Les trois hommes sont aussi complémentaires : Olivier appartient à la technocratie, même si sa position y est marginale. Il est marqué par son passage à l'École polytechnique et se considère comme un disciple de Monge. Péclet appartient à l'Université, tout en étant marqué par l'influence de Saint-Simon. Enfin, Dumas, malgré sa jeunesse, est déjà très introduit dans les milieux scientifiques parisiens.

Nous ignorons comment les trois hommes se sont connus. Il est probable qu'ils s'ignoraient avant 1828, puisque ni Olivier, ni Péclet n'étaient alors à Paris. C'est sans doute au cours de l'été 1828 qu'ils se sont rencontrés, et ceci par l'intermédiaire d'un quatrième personnage, François Binet de Saint-Preuve, qui va disparaître rapidement de la scène mais dont je voudrais évoquer la figure, car elle éclaire le contexte institutionnel de la fondation de l'École centrale.

Binet est, comme Péclet, un ancien élève de l'École normale dont la carrière sous la Restauration s'est déroulé dans l'enseignement privé parisien où il est professeur de mathématiques. Bien que l'Université, institution d'État créée par Napoléon, ait le monopole de l'enseignement de niveau secondaire, des personnes privés sont autorisés à ouvrir des établissements d'enseignement, appelés pensions ou institutions, à la condition d'envoyer leurs élèves suivre les cours des collèges royaux (c'est le nom que l'on donne alors aux lycées) et de payer une taxe, appelée la rétribution universitaire. À Paris, la principale institution est alors le collège Sainte-Barbe, situé place du Panthéon, et c'est là qu'enseigne Binet. Il prépare ses élèves, qui suivent par ailleurs les cours du collège Louis-le-grand, au concours de l'École polytechnique.

En 1827, Binet décide de fonder sa propre institution et il obtient pour cela à la fin de l'année, comme il est d'usage, une autorisation provisoire de l'Université[5]. Son projet est original, car il ne s'agit pas à proprement parler

5 AN : F17 210, registre des institutions et pensions de l'académie de Paris.

d'un établissement de type secondaire. Binet veut créer plutôt un établissement d'enseignement industriel, qu'il baptise "École d'industrie manufacturière". On ne sait rien de précis sur ce projet initial, mais les activités antérieures de Binet, le fait qu'il place son établissement dans le cadre de l'enseignement secondaire, laissent penser qu'il ne s'agit dans son esprit d'une sorte de collège industriel pour former des hommes de l'art.

L'obligation d'envoyer les élèves suivre les cours de l'enseignement classique dans les collèges royaux est néanmoins une entrave à la création d'un établissement de ce genre. Ils ont besoin de savoirs utilitaires : français, langues vivantes, application des sciences. Étudier le latin et la géométrie d'Euclide serait pour eux une perte de temps et d'argent. La situation, heureusement, se débloque avec l'arrivée en 1828 d'un nouveau ministre, Vatimesnil, à la tête de l'Université. Vatimesnil est un libéral, favorable à une limitation du monopole universitaire en faveur des écoles privées à vocation industrielle ou commerciale. Dès juillet 1828, il annonce qu'il donnera des autorisations pour l'ouverture de tels établissements et que ceux-ci seront, par exception, exemptés de l'obligation d'envoyer leurs élèves suivre les cours des collèges royaux et de payer la rétribution universitaire.

C'est sans doute à ce moment que Binet, à la recherche de professeurs pour son école, contacte Olivier, Péclet et Dumas. On ne sait rien malheureusement de cette première rencontre. Ce qui est sûr, en revanche, c'est qu'au début du mois d'octobre 1828 paraît dans le journal *Le Globe*, sous la plume de son directeur Dubois, une note annonçant qu'une école d'industrie manufacturière, accueillant entre 50 à 100 élèves, aurait obtenu de Vatimesnil l'autorisation d'ouvrir dans des locaux situés à la Sorbonne[6]. Son directeur serait Binet et ses professeurs Péclet, Dumas, Olivier et un architecte, Gourlier, qui se retirera peu après.

Ce projet va évoluer rapidement au cours des mois suivants. Alors que Binet avait envisagé, semble-t-il, d'établir une sorte de collège industriel, ses associés conçoivent un établissement beaucoup plus ambitieux, désigné dans la note du *Globe* comme "une École polytechnique civile". Il faut trouver pour une telle entreprise un financier capable de mobiliser les fonds nécessaires. Binet, qui est professeur, ne possède pas les moyens financiers, ni même les relations pour les réunir. Un homme va faire l'affaire : c'est l'avocat Lavallée, que connaît Dumas et qui est prêt à se lancer dans l'aventure. Binet, qui craint de perdre le contrôle de son école préfère alors se retirer de l'association et poursuivre seul son projet d'une "École industrielle et manufacturière".

Les obstacles à l'ouverture de la nouvelle "École polytechnique civile" se dégagent alors rapidement. Vatimesnil appuie fermement le projet.

[6] *Le Globe*, 8-11 octobre 1828. Voir Ch. de Combérousse, *Histoire de l'École centrale des arts et manufactures depuis sa fondation jusqu'à ce jour*, Paris, 1879, et F. Pothier, *Histoire de l'École centrale des arts et manufactures d'après des documents authentiques et en partie inédits*, Paris, 1882.

L'autorisation d'ouverture est accordé à Lavallée le 23 décembre 1828. Un mois plus tard, le 20 janvier 1829, un acte d'association est signé entre Lavallée, propriétaire de l'École, et ses associés professeurs, Olivier pour la géométrie, Dumas pour la chimie, Péclet pour la physique, auxquels est venu s'ajouter un camarade de promotion d'Olivier devenu ingénieur civil, Philippe Benoît, pour la mécanique, qui se retira peu après. L'École doit accueillir entre 300 et 400 élèves. Le capital de l'entreprise s'élève à 100 000 francs apporté par Lavallée. Les autres associés apportent leur compétence et leurs relations dans le milieu scientifique et technique. Un local est trouvé dans le Marais : c'est l'hôtel de Juigné, loué au chef d'institution Favart. L'École obtient le soutien moral de puissants protecteurs, chez les savants, les industriels, les banquiers et les ingénieurs. Le 26 mars 1829, une ordonnance royale dispensant les élèves des établissements privés d'enseignement industriel de fréquenter les classes des collèges, donne un cadre légal à la nouvelle école[7]. Quelques jours plus tard, une circulaire ministérielle annonce la fondation de l'École centrale des arts et manufactures, c'est le nom choisi par les fondateurs, et un prospectus présentant l'École est largement diffusé.

Les péripéties entourant la fondation de l'École centrale des arts et manufactures restent encore mal connues aujourd'hui. Ce que nous savons permet néanmoins de tirer dès maintenant quelques conclusions intéressantes.

D'abord, l'École centrale des arts et manufactures a été fondée par des *outsiders* : aucune personnalité d'importance n'a lancé ou dirigé l'entreprise. Les premiers professeurs sont eux-mêmes des hommes de second plan. Ensuite, le rôle de l'Université a été décisif. C'est dans le cadre de l'Université que l'École centrale des arts et manufactures a été créée, grâce à la protection du ministre de l'Instruction publique, et tout à fait indépendamment du système polytechnicien qui alimente la technocratie, pour ne pas dire contre lui. C'est l'Université également qui fournira les premiers élèves de l'École, envoyés par les professeurs de mathématiques spéciales des collèges royaux. Enfin, l'École centrale des arts et manufactures bénéficie dès le début du soutien des milieux libéraux. Celui, décisif comme on l'a vu, de Vatimesnil, mais aussi celui des grands notables, industriels, banquiers et savants, largement représentés dans le premier Conseil de perfectionnement de l'École formé en 1829.

Reste à évaluer l'attitude de la technocratie d'État. Les armes savantes ne sont pas concernés par cette école purement civile. Quant au corps des Ponts et chaussées, il peut, à bon droit, se sentir directement visé. Il semble donc avoir affiché sa neutralité en restant entièrement à l'écart d'un projet qui n'a pas sa sympathie. En revanche, le corps des Mines s'y montre clairement favorable. Il est même en force dans le premier Conseil de perfectionnement, où il occupe le

[7] Voir sur cette ordonnance, B. Belhoste, *Les Sciences dans l'enseignement secondaire français, textes officiels*, tome 1 : 1789-1914, Paris: INRP et Economica, pp. 127-128.

quart des sièges. La sollicitude du corps des Mines reflète son intérêt pour les affaires industrielles. Les ingénieurs civils sont considérés par les ingénieurs des mines non pas comme des concurrents mais plutôt comme des auxiliaires et des relais dans le développement de l'industrie nationale.

Il n'y a donc pas d'hostilité systématique des ingénieurs d'État à l'égard de la nouvelle "École polytechnique civile". C'est là un point fondamental. En effet, compte tenu de la position hégémonique occupée par la technocratie dans le champ socioprofessionnel des activités techniques supérieures, la nouvelle école n'aurait sans doute pu réussir sans l'appui d'une au moins de ses fractions. Allons plus loin : ce n'est pas la montée en puissance des nouveaux ingénieurs civils qui a provoqué la naissance de l'École centrale des arts et manufactures et permis son succès — celle-ci, si je puis dire, n'était pas nécessaire —, c'est principalement une crise interne, institutionnelle et idéologique, que traversent la technocratie d'État et le système polytechnicien qui l'alimente au cours de la décennie 1820.

Le débat sur la vocation de l'École polytechnique

Il n'est pas question d'examiner ici tous les aspects de cette crise profonde et complexe[8]. Je me contenterai d'en évoquer rapidement un aspect important, que j'appellerai la crise de vocation de l'École polytechnique. Pour cela, je considérerai d'abord la réponse que les fondateurs de l'École centrale des arts et manufactures ont prétendu donné à cette crise en 1829, puis celle qui a été apporté au sein même de l'École après la Révolution de Juillet 1830.

Quand le journal *Le Globe* annonce en octobre 1828 l'ouverture prochaine d'une "École polytechnique civile", il faut prendre la formule au sérieux. L'idée des fondateurs, probablement à l'instigation d'Olivier, est en effet d'établir une école telle que Monge, le créateur de l'École polytechnique, l'avait conçu pendant la Révolution. Le nom d'École centrale des arts et manufactures est lui-même une allusion au premier nom de l'École polytechnique, l'École centrale des travaux publics. Que signifie ce retour aux sources pour Olivier et ses associés? Essentiellement deux choses. D'une part, que la nouvelle école soit entièrement indépendante de la technocratie, et que son but général, comme l'avait voulu Monge, soit de former des concepteurs et des inventeurs de tous les genres. C'est pourquoi le mot-titre "ingénieur civil", emprunté aux anglais, ne désigne pas seulement, aux yeux des fondateurs de l'École centrale des arts et manufactures, des praticiens civils formés sur le tas, comme outre-Manche, mais aussi et surtout ce que la langue de Monge, c'est à dire celle des Lumières,

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[8] Je renvoie sur ce point, comme sur beaucoup d'autres soulevés dans ce texte, à mon livre en préparation : *La Formation d'une technocratie. L'École polytechnique et les polytechniciens jusqu'en 1870.*

appelait des "hommes de génie". D'autre part, que l'unité de la théorie et la pratique soit restaurée dans un enseignement global des sciences appliquées, que la création des écoles d'application et l'omnipotence des mathématiques ont remis en cause à l'École polytechnique. En proposant pour leur nouvelle école ce programme d'enseignement inspiré par Monge, il est certain que les fondateurs rejoignent les préoccupations de beaucoup de polytechniciens hostiles à l'orientation théoriciste de l'École polytechnique. Il n'est donc pas surprenant qu'ils aient trouvé un appui auprès de nombreux savants et ingénieurs réformateurs liés au système polytechnicien.

Jusqu'en 1830, l'École polytechnique elle-même ne paraît affectée ni par le débat sur sa vocation qui se développe subrepticement en dehors d'elle, ni par la création de l'École centrale des arts et manufactures, trop faible encore pour constituer une menace. C'est la Révolution de juillet 1830 qui va mettre brutalement la question en avant, à l'intérieur comme à l'extérieur de l'École polytechnique. Le dilemme est alors le suivant : l'École polytechnique doit-elle élargir ses débouchés, en formant des ingénieurs civils, voire des professeurs de sciences, ou doit-elle se spécialiser définitivement en assumant son rôle d'école spéciale de la technocratie. A première vue, la question paraît tranchée, la quasi totalité des élèves entrant depuis longtemps dans les services publics à la sortie de l'École. Mais en réalité, l'École a conservé une vocation généraliste qui en fait beaucoup plus qu'une école spéciale des services publics et lui donne le statut d'une véritable Université scientifique et technique. Le double jeu de l'École polytechnique, qui consiste à prétendre former des ingénieurs et des savants de tous les genres, c'est là son but général, tout en soumettant son recrutement et son plan d'études aux seuls besoins des services publics, c'est son but spécial, contribue de manière décisive au système de domination de la technocratie d'État sur l'ensemble du champ socioprofessionnel des activités techniques supérieures.

Néanmoins les exigences des services publics, et tout particulièrement des armes savantes, d'un côté, le développement de l'industrie, de l'autre, rendent le grand écart entre but général et but spécial de l'École polytechnique de plus en plus problématique. Il faut choisir. Les uns, nombreux dans les services publics, sont favorables à un repli de l'École sur son but spécial, quitte à laisser la formation des ingénieurs civils à la seule École centrale des arts et manufacture. Les autres, très actifs dans l'Association polytechnique créé pendant l'été 1830, voudraient couper le lien étroit entre l'École polytechnique les services publics pour en faire un grand établissement national scientifique et technique, ce qui rendrait l'École centrale des arts et manufactures inutile.C'est Arago, devenu au lendemain de la Révolution de juillet le maître du jeu à l'École polytechnique, qui fait pencher la balance en faveur des services publics. L'École polytechnique devient alors une école purement militaire destiné exclusivement à alimenter la technocratie d'État. Le choix d'Arago n'est pas inspiré par une hostilité vis-à-vis des ingénieurs civils ou une indifférence vis-à-vis des besoins de l'industrie. Il est dicté par le souci de sauvegarder le monopole de l'École polytechnique sur le recrutement des services publics, menacé par un chantage des armes savantes.

Celles-ci se plaignent en effet de n'attirer que les élèves les plus faibles et les moins bien classés. Elles exigent donc que soient prises en compte leurs réclamations, en particulier à propos du classement et envisagent, sinon, de ne plus recruter à l'École polytechnique. En tout état de cause, elles refusent catégoriquement de voir la part militaire réduite par la création de nouveaux débouchés pour les élèves dans l'industrie. En contrepartie de la militarisation complète de l'École, Arago convainc en 1830 les armes savantes de renoncer à leur menace. En même temps, il obtient que l'enseignement donné à l'École soit placé entièrement sous le contrôle des savants de l'Académie.

Le choix d'Arago, fait sous la pression des armes savantes, est un tournant. Il confine définitivement l'École polytechnique dans le cadre du système polytechnicien de recrutement et de formation de la technocratie d'État et laisse le champ libre à l'École centrale des arts et manufactures comme principal lieu de formation scolaire des ingénieurs civils. Au cours des années suivantes, ni les débats récurrents autour du statut de l'École polytechnique, ni les difficultés que connaît l'École centrale des arts et manufactures ne remettront en cause ce choix fondamental.

Si l'on considère dans son ensemble le champ socioprofessionnel des activités techniques supérieures, le tournant de 1830 ne semble remettre en cause rien de fondamental : ni la séparation canonique entre ingénieurs d'État et hommes de l'art, ni la domination structurelle de la technocratie sur le champ. Mais, en permettant le développement, sur le modèle même de l'École polytechnique, d'une formation scolaire spécifique pour les hommes de l'art, rebaptisés ingénieurs civils, elle ouvre la voie à un rééquilibrage institutionnel et idéologique du champ et à l'émancipation d'un pôle industriel autonome, capable de contrebalancer le pôle technocratique dominant.

CHRISTINE VARDAS

LES OFFICIERS DU GÉNIE EN GRÉCE, PRÉCURSEURS DES INGÉNIEURS CIVILS.

La proposition de participer aux travaux du séminaire que m'a faite mon ami Efthymios Nicolaïdis m'a donné l'occasion de me pencher de nouveau sur une étude que j'avais engagée voilà plusieurs années[1]. Cette étude avait comme thème les officiers du Génie et elle était en rapport avec la problématique plus générale de mon DEA, rédigé il y a vingt ans et intitulé "L' armée et la constitution de l' Etat national grec". Elle était aussi en rapport avec un article que j'avais intitulé "Des militaires engagés en politique dans la Grèce de la fin du 19e siècle"[2]. A l'époque, cette étude se limitait au cas d'un des trois officiers que je vais vous présenter aujourd'hui, ce qui la rendait peut être peu représentative. C`est d`ailleurs dans le cadre de mon métier d'historienne-archiviste que j'ai rencontré mes trois officiers, les deux derniers récemment, vraiment par hasard, dans les archives que je traitais. Le thème du séminaire m' a paru constituer un agréable défi: reprendre et systématiser les informations et éléments que j'avais recueillis. La plus belle coïncidence dans cette histoire, c' est que les trois officiers du Génie avaient le même âge, qu' ils se sont trouvés dans la même classe à l' Ecole des Evelpides, que deux d' entre eux (Lycoudis et Schinas) ont poursuivi des études en France et que le même Schinas a été député du parlement grec à la même époque que le troisième, Drossinos.

Les officiers du Génie provenaient tous de l' Ecole Militaire des Evelpides qui a été fondée en 1829 par Kapodistrias et administrée dans ces premières années par des officiers étrangers comme l' Italien R.Saltelli, le Français H.Paugier, le Bavarois E. Reyneck et plus tard par les Grecs Spyromilios, Karatzas, Zymbrakakis et Kolokotronis. Le fonctionnement de l' Ecole se basait sur celui de l'Ecole Polytechnique de Paris, fondée en 1795. L' Ecole a fonctionné d' abord à Nauplie (1829-1834), puis à Egine (1834-1837) et au Pirée (1837-1894) et enfin à Athènes, dans un bâtiment qu' elle a quitté récemment, et qui avait été construit grâce à l'argent offert par le bienfaiteur national

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[1] Mes remerciements sont adressés à Efthymios ainsi qu` à mon ami Breton, Christian Louedec, qui a contribué avec ferveur à la version française du texte de ma communication.

[2] Christine Vardas, "Militaires engagés en politique en Grèce à la fin du 19e siècle", dans la revue *Mnimon*, vol. 8, pp.47-63.

Georges Averoff. Le mode d' admission à l' Ecole et la durée des études ont varié selon les époques: ainsi du temps du roi Othon, l' admission était régie par approbation royale et les études duraient huit ans alors que la monarchie constitutionnelle de Georges I, a accordé une plus grande importance à l'orientation scientifique et a acceuilli que les étudiants sortant du Gymnase, pour une durée d' études de cinq ans. En règle générale, l'entrée à l' Ecole se basait sur des critères d'origine familiale (enfants de combattants de la Guerre d' Indépendance etc.) et sur des critères économiques, étant donné que les dépenses exigées pour ces études étaient particulièrement élevées.[3] Ces critères ont contribué à la formation d'une élite d'officiers qui ont joué un rôle important sur le plan militaire aussi bien que politique dans la constitution de l' Etat.

Voici les matières qui étaient enseignées aux débuts du fonctionnement de l'Ecole: grec, francais, mathématiques, dessin, exercices de manoeuvres et de tir, art militaire, technique de fortification, techniques de tir et de construction, topographie, plans de bâtiment et d' engins, gymnastique. En 1887 le programme a été enrichi: on y enseignait au total 24 matières.[4] La formation scientifique et technique offerte par l'Ecole des Evelpides aux ingénieurs a constitué un privilège exclusif de celle-ci jusqu'au vote de la loi "sur l'organisation de l'Ecole des arts industriels d' Athènes", couramment appelée Ecole Polytechnique. Cette loi, votée en 1887 par le gouvernement Trikoupis, prévoyait le fonctionnement d'une Ecole d' ingenieurs civils au sein de cette Ecole qui avait été fondée en 1837.[5] Je ne vais pas ici m' attarder sur l' histoire de l' Ecole Polytechnique: je soulignerai seulement que la date de fondation des facultés des sciences exactes témoigne, à elle seule, du rôle tardif qu' ont joué la science et la technique dans la formation de l' Etat. Soulignons encore que sur six directeurs de cette Ecole civile tout au long du 19e siècle, quatre ont été des militaires[6]. En Grèce, le corps du Génie a été institué par le décret du 18 juillet 1829 "sur un corps d'officiers en fortification et en architecture"[7], la même année que l' Ecole des Evelpides. L'administration du Génie a été confiée au lieutenant-colonel français Garnot, assisté par six officiers grecs formés en Europe. Les autres postes devaient être complétés peu à peu en fonction des nécessités et selon les aptitudes présentées par les candidats. La mission du corps

[3] Pour l' Ecole des Evelpides voir Epam.Stassinopoulos, *L' histoire de L' Ecole des Evelpides, 1828-1953* et *Album de l' Ecole Militaire des Evelpides, 1828-1991.*

[4] Pour le programme analytique des cours de l' Ecole des Evelpides, voir M. H. Panas, *Annuaire statistique de 1887.*

[5] Voir K. Biris, *Histoire de l' Ecole Polytechnique, 1836-1936.* Athènes 1957 et *Technika Chronika*, numéro 181, vol. 16, 1939, consacré au Centenaire de l' Ecole Polytechnique.

[6] Directeurs de l' Ecole Polytechnique au XIXe siècle: 1) Fr. Zetner (1836-1843)-militaire, 2) L. Kaftantzoglou (1844-1862)-civil, 3) Direction collective (1862-1863) G. Metaxas-militaire, St. Krinos-civil, I. G. Papadakis-civil, 4)D.Skalistiris (1864-1873)-militaire 5)D.Antonopoulos (1873-1876)-militaire, 6) G.Mauvrogiannis (1876-1878)-civil, 7) A. Theophilas (1878-1901)-militaire.

[7] Pour le corps du Génie voir *Grande encyclopédie militaire et navale*, Athènes 1933, p.536.

était l'étude et l'élaboration de plans pour la construction, l`entretien et l' amélioration des fortifications ainsi que la construction et la surveillance de ponts, de routes, de bâtiments militaires et autres travaux architecturaux, aussi bien pour l' armée que pour les autres services du domaine public[8]. La structure administrative et la composition du corps du Génie ont connu diverses évolutions fonctionnelles et numériques, entraînées par les réglements successifs de l'armée et leurs continuelles modifications. Cela a abouti à ce que le corps soit composé à la fin du 19e siècle de la manière suivante: une Inspection, quatre directions du Génie à Athènes, Corfou, Nauplie et Larissa, une division du Génie, une section de topographes, une compagnie de télégraphistes et une autre de pompiers. L'une des compagnies de la division était destinée à former la compagnie responsable des chemins de fer.

C'est en effet l'armée, et seulement l'armée, qui a été porteuse de la connaissance scientifique et technique dans le nouvel Etat grec, pour la constitution et le fonctionnement duquel les structures des Etats européens occidentaux servaient de modèle. Cette situation a préoccupé certains militaires. En effet, ceux d' entre eux qui avaient été formés et instruits en Europe ont réalisé et souligné les problèmes entraînés par le fait que l'armée n' était pas totalement séparée des institutions civiles, ce qui résultait des conditions particulières de la formation de l 'Etat [9].

Les objections et les doutes sur le rôle du Génie commencèrent à être exprimés après le règne d'Othon. Ainsi en 1866, le ministre de l' armée, Zymbrakakis, parlait dans un rapport au roi du caractère "complètement défectueux" du réglement en vigueur pour le Génie: ce réglement instituait que les travaux publics sont effectués par les officiers, alors que dans tous les Etats européens, le Génie effectue uniquement des travaux militaires, aussi bien en temps de paix qu' en temps de guerre. Et il continuait en rejetant, comme non fondée, l'objection selon laquelle il n' existait pas de personnel civil compétent pour l' exécution des travaux publics. Il expliquait qu'on pouvait engager pour les besoins des autres ministères les officiers non indispensables aux tâches militaires, les jeunes citoyens que l' Etat avait envoyés étudier en Europe et ceux qui étaient formés à l'Ecole Polytechnique.[10] Quelques années plus tard, Panos Koroneos, qui lui aussi fut ministre de l'Armée, faisait dans une très intéressante présentation critique de la question militaire en Grèce la remarque suivante:"...le fait de conserver un corps de nombreux officiers ingénieurs affectés à d' autres besoins de l' Etat qu`à ceux de l' armée, les besoins relevant d' habitude du génie civil, hormis l' absurdité de faire ainsi inscrire au détriment du budget militaire des dépenses qui ne sont pas de son ressort, comporte pire encore: cela empêche

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[8] Etat Major de l' Armée, *Histoire de l'organisation de l' armée grecque, 1821-1954.* Athènes 1957, p.19.

[9] A ce sujet voir K. Tsoukalas, "Etat et société en Grèce au XIXe siècle" dans *Aspects de la société grecque au XIXe siècle.* Sous la direction de K. Tsaoussi. Athènes 1984, pp. 39-54.

[10] Ch. Zymbrakakis, *Rapport à Sa Majesté le Roi.* Athènes 1866, pp. 8-11.

la formation de spécialistes.".[11] Koroneos est ici préoccupé non seulement par les domaines de compétence mais aussi par le budget de l' Etat et par la spécialisation professionnelle. Dans son mémorandum de 1884 au premier ministre et ministre de l' Armée Trikoupis, l' officier du Génie Ioannis Sechos mentionne qu' en 35 ans de service dans l'armée il n' a jamais vu de plans topographiques des positions d' importance militaire pour la Grèce, ni d'études de fortifications, ni de recherche sur les transports militaires, ni rien d'autre concernant l'objectif réel du Génie, qui se limite aux plus simples travaux architecturaux. Il en conclut que le corps du Génie ne s'occupe point de sa tâche principale qui est le renforcement militaire et la sécurité du pays.[12]

C'est probablement un résultat de ces préoccupations que le vote en 1878 de la loi "sur la création d'un corps d'ingénieurs civils"[13], proposée par le ministère de l'Intérieur, au sein duquel avait déjà été institué cinq ans auparavant le Département des Travaux Publics, sous la direction du commandant du Génie, Dimitri Skalistiri, diplômé de l'Ecole des Ponts et Chaussées.[14] Ce corps d'ingénieurs civils avait comme but d' aider à la réorganisation et à la consolidation du service des travaux publics avec du personnel civil, du fait que la loi ne permettait d'engager des militaires dans ce corps qu`à l`occasion de sa création et qu`elle prévoyait par ailleurs la posssibilité de nommer des ingénieurs étrangers. En fait c'est de manière formelle que la loi a contribué à la séparation de l'armée et de la société civile, car en réalité les ingénieurs continueront pour longtemps encore à provenir des milieux militaires. La création du corps des ingénieurs civils date de la même année que le nouveau réglement de l'armée de 1878, qui limitait les tâches du Génie aux seuls besoins militaires: ces mesures traduisaient la volonté d'une organisation plus européenne et plus moderne de l' Etat. Notons à ce propos que le réglement militaire de 1878 a apporté d'importants changements dans l'organisation de l'armée, l'un d'entre eux consistant en l' introduction du système de conscription générale à la place du tirage au sort et de la possibilité de remplacement, qui étaient en vigueur depuis cinquante ans.[15]

Observons maintenant de près la vie et les activités des trois officiers que j'ai mentionnés plus haut.

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[11] P. Koroneos, *La question militaire en Grèce.* Athènes, 1871, pp. 44-45.

[12] Archives Ch. Tricoupis (E.L.I.A.), carton 12, Mémoire I.Sechou à Tricoupis.

[13] *Efimeris kyvernisseos* (Journal du Gouvernement), numéro 27, 4 Mai 1878.

[14] D. Skalistiri (1816-1883) a enseigné la Construction des ponts à l' Ecole des Evelpides (1846-1865) et la Mécanique à l' Ecole des Arts (Polytechnio) dont il a été directeur de 1865 à 1873, date à laquelle il a assumé la première direction du Service des Travaux Publics.

[15] Pour la question du recrutement militaire voir Christine Vardas "Le recrutement militaire en Grèce du XIXe siècle. Exemple: Mairie de Nauplie 1870-1877", dans la revue *Ta Istorika*, vol. 3, no 6, 1986, pp. 369-386.

Petros Lycoudis (1844-1913)

Petros Lycoudis est né à Nauplie en 1844. Il était le fils de Stylianos Lycoudis,[16] qui fut l'un des premiers élèves de l'Ecole des Evelpides, et de Maria Kydonaki-Kallergi.

Lycoudis est entré à l'Ecole des Evelpides en 1859, en même temps que Vassilios Drossinos et Nicolaos Schinas. Ses frais annuels d'études étaient de 500 drachmes. Il s'est engagé dans le corps du Génie en 1865 et a servi dans les directions de Nauplie et Corfou. A la lecture de ses rapports à la direction du Génie d'Argolide, nous apprenons qu'en 1867 il s'occupait, entre autres, des travaux de réfection de l'église d'Agios Andréas dans le fort de Palamidi. En juin 1869, alors qu'il se trouvait à Corfou, Lycoudis est envoyé pour formation en France par le ministère de l'Armée. Dans ses archives nous retrouvons sa carte d' admission à l'Ecole des Ponts et Chaussées et l'autorisation du ministère français de la Guerre de servir en tant qu'officier étranger au sein du premier régiment du Génie à Metz. Son séjour en France fut marqué par les évènements de la guerre franco-prussienne, qui lui donna l'occasion d'observer et de commenter les préparatifs militaires et les différentes étapes de la guerre depuis la capitale française où il finit par séjourner. Dans huit lettres très intéressantes, écrites entre février et septembre 1870, il raconte à son père les détails concernant l' Ecole et ses élèves, l'ambiance sociale et politique qui régnait parmi les Français, les mouvements militaires et les combats. Il livre aussi des détails techniques sur les armes utilisées par les belligérants, sur la fortification de la capitale, et fait des comparaisons, des commentaires et des prévisions sur la marche des évènements.[17]

Lycoudis a été rappelé en Grèce avec d'autres officiers grecs en février 1871, au moment où commençaient les évènements de la Commune, et il réintégra le service du Génie. Il semble avoir rencontré des problèmes avec le service et la mutation qu'on lui proposait. En effet, d'après ce qu'il écrit à son père en 1874, il éprouve du mécontentement et de l'indignation pour son métier et pour les conditions qui régnaient en Etoloacarnanie, où il se sentait comme en exil. Décrivant les coutumes des habitants de la région quant à la nourriture, à la

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[16] Stylianos P. Lycoudis (1807-1884) a été admis à l'Ecole des Evelpides aux frais personnels de Kapodistrias. Il a abandonné l' Ecole pour participer en 1829 au siège de Nafpaktos. Il a été directeur de l' Arsenal à Nauplie, commandant de la garde de Chalkis (1856), Nauplie (1864) et Corfou (1869). Il a été mis en retraite de l' armée avec le grade de lieutenant-colonel en 1872 et a vécu le reste de sa vie à Corfou, où il est mort.

[17] Tous les documents auxquels je me réfère par rapport à P. Lycoudis font partie du fonds Lycoudis qui se trouve à E.L.I.A., cartons 1-2. Voir aussi *Archives de la famille Lycoudis. Inventaire*. Préparé par Christine Vardas. Athènes 1996. Les lettres envoyées de Paris sont datées: 27 jan./8 févr. 1870, 28/10 avril 1870, 3/22 juillet 1870, 4/16 août 1870, 5/17 août 1870, 11/25 août 1870, 18/30 août 1870 et 24 août/5 septembre 1870.

propreté, aux loisirs et à l'ordre, voici ce qu'il écrit: "...c'est le diable qui m'a fait officier sans troupe. Si je trouvais 2 ou 3 hommes, je pourrais imposer l' ordre. Un tel métier à 100 drachmes pour qu'on m'envoie au milieu des cannibales, je n'en veux pas..." (lettre du 13 septembre 1874). Une semaine plus tard, il poursuit ses plaintes en se demandant comment son père veut le consoler en lui parlant "de l'estime qu'on a pour mon métier, comme si celui-ci était estimé en Grèce ou comme si quelqu' un pouvait en vivre décemment" (lettre du 20 septembre 1874). Par la suite, il décrit ses visites aux forts de Vonitsa et d'Arta, à la garnison d'Anninos et aux garnisons défensives des Turcs qui se trouvaient sur la ligne des frontières (lettre du 24 octobre 1874). A la fin de cette même année, il est tellement à bout qu'il demande à obtenir un congé de cinq mois ou sinon à quitter le service. L'année suivante, il est nommé professeur en fortifications à l'Ecole des Evelpides. En avril 1878, le ministre de la Marine lui confie l'étude des fortifications de Salamine et du Pirée, ce qui lui permet de visiter à plusieurs reprises l'îlot de Psitalia pour en rédiger les plans topographiques. Il demande également au ministre l'achat des canons pouvant être utilisés en ces lieux. Cette étude, Lycoudis la reprendra plus tard, entre 1885 et 1889, alors que celle sur les canons, il y consacra tous ses efforts, jusqu'à la découverte d'un nouveau système de fonctionnement du canon démontable, qui a obtenu des prix aux expositions internationales de Paris (1900), Liège (1905) et Bordeaux (1907). Un prototype du canon démontable Lycoudis a été construit par la société Krupp en 1907. Il faut signaler qu`une proposition d' amélioration du canon démontable de 75 millimètres avait été déposée en 1893 par l'officier d'artillerie Panayotis Danglis, avec lequel Lycoudis était en conflit pour des raisons d'usurpation de son invention.

Après la signature du traité de Berlin, Lycoudis a participé en 1879 aux négociations qui ont eu lieu à Préveza et à Constantinople pour la cession par la Turquie de territoires à la Grèce. En 1880 le premier ministre Trikoupis qui appréciait beaucoup les capacités de Lycoudis l'envoie comme attaché militaire de la représentation grecque à la conférence de Berlin, et un an plus tard Lycoudis participe au comité international pour le tracé des nouvelles frontières. Dans ses lettres à son père en 1881, il exprime ses réflexions sur son service et ses collègues, et nous en retenons que les continuels déplacements, la charge de travail et de responsabilités l'avaient fatigué et qu'il était préoccupé par le manque de préparation pour la participation au comité du tracé des frontières. En même temps il se préoccupe de la question des promotions, à propos desquelles il est convaincu que la disproportion entre le Génie et les autres corps a augmenté et qu' il en arriverait à voir nommés comme ses supérieurs des gens qu'il avait eus comme élèves trois ans plus tôt (lettre du 24 juillet 1881). A l'issue des travaux du comité, le père écrit plein de fierté à son fils chéri:"...Comme j'aurais aimé, Pierrot, apprendre de toi aussi à quel point les étrangers ont été satisfaits de tes connaissances et de ton travail considérable et ponctuel. J'ai entendu beaucoup d'éloges de la part des autres. Que tu ne te vantes pas devant les étrangers, je l'admets. Mais pourquoi priver ton père de la joie de te voir distingué comme le plus méritant et d' entendre les délégués du comité te combler d' éloges et t' accorder toute leur confiance?"

Pendant la guerre gréco-turque de 1897, Lycoudis se trouvait à l'Etat Major mais deux ans plus tard il demandait à être mis en disponibilité. Les dernières années de sa vie, il les consacra à la défense et à la réalisation de son invention, qui rencontrait de la méfiance en Grèce, ce qui se vérifie par le fait qu'il a été reconnu et honoré par l'Etat grec seulement après sa mort. Il est mort à Athènes en 1913 et a été enterré, comme il le souhaitait, sans uniforme ni honneurs.

Vassilios Drossinos (1843- ?)

Sur la vie de Vassilios Drossinos, je n'ai pu trouver que peu d'informations. Il est né en 1843 et a intégré l' Ecole des Evelpides en 1859 en payant 750 drachmes par an. Il a été élu député de la circonscription de Trézène pour la période 1892-1895.[18]

La première fois que j' ai trouvé mention du nom de Drossinos, c'est quand celui -ci a été invité par la ville de Nauplie à entreprendre, contre rémunération approuvée sur le budget, les travaux municipaux pour l'année 1875, en agissant "avec zèle et empressement".[19] En 1877, grâce à la loi sur les municipalités, Drossinos est nommé ingénieur de la ville avec un salaire de soixante drachmes[20]. Dans une circulaire du ministère de l'intérieur sur "les indemnités des ingénieurs" il est dit que celles-ci, doivent être proportionnelles à la valeur du service rendu par les ingénieurs à la ville, service étant notifié au ministère afin de définir sa valeur.[21] En effet le poste d' ingénieur municipal n'était pas encore institué: c'étaient les ingénieurs départementaux qui couvraient les besoins des municipalités, mais il semble que la ville de Nauplie, étant prospère, avait suivi l' incitation du ministre de l' Intérieur Dimitri Voulgaris. En effet, dans une circulaire de 1868 adressée aux préfets et sous-préfets, ce ministre disait que la municipalité constituait un corps autonome qui devait avoir parmi ses employés un ingénieur "disponible et toujours prêt" pour l'entretien des routes. Il poursuivait en précisant qu' il était temps que les pouvoirs municipaux comprennent la chose suivante: s'ils étaient réellement attachés aux travaux d'utilité publique qui apportent la prospérité à leur région, ils devaient cesser de s' adresser à l' administration centrale pour lui demander son aide.[22]

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18 Parlement grec, *Registre des mandataires, sénateurs et députés 1822-1935*. Athènes, 1986.
19 Archives municipales de Nauplie, carton Π/32, 1874.
20 Ibidem, carton B/4, 1877.
21 Ministère de l' Intérieur, *Collection de circulaires*, 1867-1869, p.202.
22 Ibidem, pp. 121-123.

A la même époque, concrètement en automne 1876, Drossinos offrit ses services à Henry Schliemann qui menait des fouilles archéologiques à Tirynthe et à Mycènes. De la correspondance entre les deux hommes, il ressort que Drossinos avait entrepris pour le compte de Schliemann l'étude topographique de Tirynthe et qu'il se trouvait en même temps confronté à des problèmes, du fait qu' il était absent de son service. Il informe Schliemann que sur ordre du ministére, il devait aller à Athènes et il lui conseille de profiter de ses liens amicaux avec le premier ministre Epaminondas Deliyorgis pour le faire intervenir et lui faire obtenir une autorisation régulière afin qu' il achève ses plans topographiques et les dessins des tombeaux de Mycènes.[23] La démarche de Schliemann n' a pas débouché sur cette autorisation mais sur le remplacement de Drossinos par un autre lieutenant du Génie,Vassilios Brouskos, qui reçoit l'ordre d' offrir son concours au célèbre archéologue (ordre du 11 novembre 1876). Mais une semaine plus tard, le ministre de l'Intérieur envoie un télégramme à Schliemann, qui se trouve à Argos, pour lui dire que "Ministre Armée considérant emploi officier pour service privé comme contraire à réglements militaires ne peut répondre favorablement à demande".[24] Ces diverses données permettent de se faire une image parlante de la situation qui existait alors dans l'administration grecque, dont les décisions et les actes se trouvaient à la merci des relations politiques et des influences personnelles.

Drossinos a continué sa collaboration avec Schliemann en contrôlant, en 1880, les travaux de construction de sa maison à Athènes, oeuvre de l' architecte Ernst Ziller, et en opérant la gestion financière des travaux. Sa rémunération mensuelle était de 336 drachmes, donc au-dessus du salaire moyen qu`avait fixé la loi "sur la constitution d' un corps d' ingénieurs civils".[25] Dans une lettre écrite de Lamia, Drossinos informe Schliemann qu' il a reçu l'ordre de quitter d'urgence Athènes du fait que l' armée ne lui a pas renouvelé sa permission, malgré les démarches des deux hommes auprès du ministre compétent. A la fin de sa lettre, dans le contexte des mouvements de l'armée grecque pour la libération de la Thessalie, il se rappelle de son patriotisme en parlant de "l' éventuelle guerre entre nous et les barbares, dont j' espère que nous la mènerons comme de dignes descendants de nos ancêtres".[26]

Le troisième cas d' officier que je vais vous présenter est plus court, car mes sources d'archives étaient plus limitées.

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[23] Archives H. Schliemann, Bibliothèque Gennadeion, Correspondance, carton 72, 2/14 novembre 1876.

[24] Ibidem, 18 novembre 1876.

[25] Le salaire le plus bas, que définissait la loi, était de 190 drachmes pour les ingénieurs de province et le plus élevé, celui de directeur des travaux publics s' élevait à 550 drachmes (article 2 de la loi du 1878 "sur la constitution d` un corps d`ingénieurs civils").

[26] Archives H. Schliemann, Bibliothèque Gennadion, Correspondance, carton 76, 19 août 1880.

Nikolaos Schinas (1844-1912)

Nikolaos Schinas, fils de Théologos Schinas provenait de la famille phanariote bien connue qui avait donné des hommes de lettres et des politiciens. Lui-même indique comme étant son village d' origine, Makrynitsa dans le Pelion. Il est né en 1844 et c' est comme boursier qu' il est entré à l'Ecole des Evelpides. Il a poursuivi sa formation en France (probablement à l' Ecole des Ponts et Chaussées), et a intégré le Génie en 1865. Il a été professeur en fortifications à l'Ecole des sous-officiers et en 1909 administrateur de l'Ecole des Evelpides puis commandant de la garde d' Athènes.[27] Il a été élu député de Volos aux élections de 1890 et 1895. Au scrutin de 1890 il est arrivé en seconde position sur la liste des élus avec une différence de 100 voix par rapport au premier, Kartalis, candidat du parti de Trikoupis, qui avait obtenu 3.000 voix.

J' ai pu lire sa correspondance avec le commerçant en coton Nikolaos Kazoulis, établi à Alexandrie. Trente-quatre de ses lettres ont été sauvées, qui vont de décembre 1888 à janvier 1891 et sont écrites sur un papier à lettre sur lequel figure un sceau en relief qui m' a permis de l'identifier puisqu`on y lit son nom et sa qualité: Nikolaos Schinas, officier du Génie.[28] Dans ces lettres, nous apprenons qu'il contrôlait la construction de la maison du frère de Nikolaos Kazoulis, Pavlos, mort entretemps. Cette maison se trouvait à Athènes au coin des rues Kifissias et Koumbari 2, en face de ce qui est devenu le musée Benaki, et sa construction avait été confiée à l'entrepreneur L.P. Sgoutas. Schinas écrit surtout sur le déroulement des travaux, et sur l'inconséquence et les demandes d'argent de l'entrepreneur, qui n'honorait pas les engagements du contrat signé. Schinas s'était aussi chargé des plans pour la modification de la propriété Kazoulis, modification qui exigeait l'achat d'une partie du terrain voisin, qui n'était pas sans problèmes.

Schinas se réfère également à diverses activités de son service dans le Génie et c'est ainsi que nous apprenons (lettre datée 13-1-1889) qu' il alla pour trois jours à Patras parce qu' il devait entreprendre la description détaillée des trajets en Epire et en Albanie accompagnée d`une carte. Ses travaux nombreux et variés, auxquels s'est ajoutée une mission confidentielle du Ministère de l`Armée, ne lui ont pas permis à cette époque de se rendre à Alexandrie.[29] Toujours en 1889, il voyage en Europe et visite Bucarest, où des membres de la famille Schinas s`étaient établis avant la Guerre d`Indépendance, ainsi que Vienne, où avait été ambassadeur son oncle Konstantinos Schinas, homme

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[27] Grande Encyclopédie Grecque (Pyrsos), vol. 22.

[28] Archives Nikolaos Kazoulis, E.L.I.A., carton 1.

[29] Notons ici que d`après la notice biographique de l`Encyclopédie sur Schinas celui-ci réussit, après la concession de l`Epire et de la Thessalie par la Turquie à la Grèce, et avec l`approbation secrète du gouvernement, à parcourir à pied et sous un déguisement toute la Macédoine et l`Epire. Il rédigea en 1887 le "Voyage en Macédoine" et trois ans plus tard les "Voyages en Epire".

politique et historien connu, qui avait été le premier doyen de l'Université grecque. Dans une lettre du 6 avril 1890, il écrit à Kazoulis qu'il doit donner une conférence au Club du Génie, fréquenté par des officiers de tous les corps, sur l'armée roumaine et sur d'autres thèmes concernant la Roumanie. Schinas parle aussi de deux excursions que lui et sa soeur Sophia ont faites, tous deux à cheval. Pour la première, ils sont partis d'Elefsina, sont allés jusqu' à Thèbes et Chalkis pour revenir à Tatoï et parcourir ainsi plus de 200 km. Pour la seconde, ils sont allés à Thèbes, où Schinas devait assister à des exercices militaires (lettre du 12 et du 27 mai 1889). Je voudrais ajouter que j' ai trouvé un rapport de Schinas à Trikoupis "sur le plan de construction d'un camp militaire de l'Artillerie" quelque part dans Athènes[30] et une note indiquant qu' il a terminé les premiers plans d'un camp pour un régiment d' Infanterie, qui devait coûter 1.300.000 drachmes (lettre du 2 mars 1890). Je trouve également très intéressant de mentionner ce qu'il écrivait sur la politique et la société, car cela montre un officier préoccupé par les questions sociales, comme du reste la majorité des officiers grecs. Dans sa lettre à Kazoulis du 17 février 1890, il lui dit que ses amis, qu'ils soient dans la majorité ou dans l'opposition, l' invitent à participer aux élections de 1890 mais qu'il leur déclare ceci: " quand je voudrai entrer au parlement, je désire le faire sans aucune couleur politique et sans appartenir à personne. Il ajoute: "...il est mauvais de se mêler de politique mais cela est nécessaire et même indispensable si l' on peut paraître utile pour peu que ce soit". Ailleurs, il commente les valeurs morales de l'époque en se référant à l'enrichissement facile et en remarquant les effets désastreux pour ceux qui se ruinent en dépensant des sommes inconsidérées à la bourse et aux jeux de hasard.

En concluant cette esquisse des trois officiers nous voyons apparaitrent les traits principaux de leurs activités: le penchant de Lycoudis pour la science et la technique de l'ingénieur, l' application de Drossinos aux travaux du domaine municipal et privé, l' éducation, le cosmopolitisme et les préoccupations socio-politiques de Schinas. Je crois pouvoir dire qu' à eux trois, ils donnent une image représentative de l' officier du Génie dans la Grèce du XIXe siècle.

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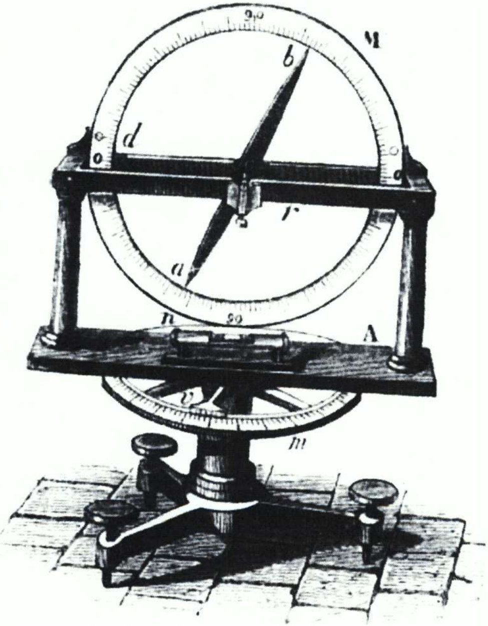
30 Archives Ch. Trikoupis, E.L.I.A., carton 12.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THE CENTURY OF LABORATORIES

JIM BENNETT

STATE POLICY ON SCIENTIFIC INSTRUMENTS IN NINETEENTH-CENTURY BRITAIN

The question of the influence of state policy on the manufacture of scientific instruments in nineteenth-century Britain raises historiographical issues that must be addressed before we can approach the historical ones. The fundamental methodological question concerns what can be included in the category of 'state policy'. Is it restricted to what was enshrined in legislation and administered by the immediate agencies of government? If so, the easy response to an enquiry about state policy would be that there was none, or scarcely any – certainly not enough to form a coherent set of objectives and a means of achieving them

There are two rejoinders to this that might, nonetheless, rescue the subject. One would be that in the British case, having no policy was not a matter of neglect or oversight, but was itself a policy. The prevalence of a *laissez-faire* attitude in general to economic management with regard to manufacturing industry in the period meant that there was nothing special about the position of scientific instruments, and deliberately leaving their manufacture to be shaped by market forces was already a matter of policy.

A more interesting rejoinder might be to suggest that not all policy is enshrined in legislation and enforced by direct government action: the category is not as useful to the historian as it might be if we confine it to this restrictive meaning. Official or semi-official bodies, or well-established and respected institutions, such as learned societies, universities, national observatories and so on, take initiatives and organise programmes that are indicative of a consensus of attitudes adopted by influential figures and organisations. If we are to make progress in appreciating public science in nineteenth-century Britain, we cannot restrict our attention to what was codified in legislation. We might look also for a general consensus of attitudes in influential circles that might be said to amount to a tacit policy, existing alongside a government understanding that no policy exists. The historiographical issue, then, concerns the extent to which it is legitimate to expand the notion of 'policy' in this way.

The question of whether there could or should be a state policy with respect to science and scientific instruments was a real issue within the scientific community. Certainly some scientists called for increased government support:

Charles Babbage is perhaps the best known British example of someone who lobbied strongly for such support in relation to the development of an instrument, his difference engine. Others argued the case for government action more generally in relation to scientific education, technical training and research: an example of someone who adopted this position would be Norman Lockyer.

Lockyer was secretary of the Devonshire Commission, a Royal Commission appointed by the British government to conduct a comprehensive enquiry into science education and public support for research. Concern over scientific training in Britain had been current at least since the Great Exhibition of 1851 had demonstrated that there was serious competition from manufacturing industry on the Continent, and had grown in strength after what was taken to have been a lamentable performance at the Paris Exhibition of 1867. Colonel Alexander Strange, who as a military surveyor had worked on the Survey of India, was a leading advocate for reform in British public science, and began his campaign for endowment for research at a meeting of the British Association in 1868. His surveying experience had given him a special interest in instruments and after his retirement in 1861, he was appointed 'Inspector of Scientific Instruments for India' and put in charge of a depot at Lambeth where an observatory was erected for testing instruments.

Thanks to the lobbying energies of Strange, the British Association adopted a resolution 'that a Royal Commission to inquire into the relations of the State to science is very desirable'. Strange pursued his goal through other institutions as well and such a commission, under the chairmanship of the Duke of Devonshire was established in 1872. The Commission came out in support of radical reform in secondary education, believing that Britain needed to take fundamental steps to catch up with her rivals in the provision of scientific training, and also advocated state support for scientific research. There was not an commensurate level of effective action, but one practical outcome was a government grant for research, of £4,000 per year, to be administered by the Royal Society.[1]

But not all scientists supported these moves. A proposal from Strange, for example, of the establishment of a state-funded observatory for 'the Physics of Astronomy' was opposed by an influential grouping within the Royal Astronomical Society and in the subsequent bickering both Lockyer and Strange resigned from the Council.[2] Amid subsequent fallout from the actions of the Devonshire Commission, the Society convened a special meeting 'to consider the question of the Endowment of Research by the Government', and had before it a resolution:

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[1] D.S.L. Cardwell, *The Organisation of Science in England* (London, 1972) ch.5.

[2] J.L.E. Dreyer and H.H. Turner, eds, *History of the Royal Astronomical Society 1820-1920* (London, 1923), pp. 173-8.

That, in the opinion of this Society, the granting of public money for scientific research in cases where it does not appear that results useful to the public will be obtained, or where the researches proposed are likely to be undertaken by private individuals or public bodies, does not tend to the real advancement of science.

Another resolution opposed the foundation of a 'Physical Observatory' at the national expense, while yet another actually proposed a withdrawal of existing funding for the Committee on Solar Physics at South Kensington. Eventually the meeting decided that the Royal Astronomical Society had no business expressing an opinion on questions such as these, and thus avoided an even more damaging split on the substantive issue.[3]

So, in Britain a significant number of *scientists* were profoundly opposed to the idea of government support for scientific research, believing both that research would be compromised through such an arrangement and that tax revenues would be misappropriated. Science was not the legitimate concern of the state, except where there was a clear and immediate utilitarian end, such as at the Greenwich Observatory, where a programme of observations was directed at navigational applications.

Thus far we have seen that the absence of an overt state policy does not necessarily mean that we cannot identify factors operating at an equivalent level in commerce and society, that the question of the proper role of the state was a live issue in the period, and that attitudes adopted by the scientists are not always those that might be expected. The issues involved are complex, but our immediate subject is scientific instruments, so we must now ask where they fit into the picture.

The activity of instrument making sits in a strategic position between the various issues at play: research, education, manufacturing culture, and government policies not directly concerned with science but related to trade, tax, export and revenue. The instrument maker had to address each of these spheres of interest and to find ways of connecting them profitably. Research had to be linked with manufacture, for example, in the production of new instruments. Education and technical training were linked to the maker's need for skilled labour in his workshop and design development in his own area of expertise. Since no maker would have had a university education, which in any case in Britain would have been irrelevant to his needs, the viability of other forms of training was of vital importance to the fortunes of the trade. Developments in science education might also provide the maker with sources of high-volume sales, as might developments in areas of professional practice, such as surveying, engineering, analytical chemistry, the excise, medicine, etc. The maker had to try to keep in touch with as many of these trends as possible, while at the same time,

3 *Ibid*, pp. 207-11.

government legislation on trade, excise, customs, labour, and so on, were necessarily part of his working life.

Instruments often became iconic objects in relation to these issues, as with Babbage's difference engine, the astronomical instruments commissioned for Greenwich, the spectroscopic equipment necessary for the Solar Physics Observatory, or the instruments that carried the national fortunes at international exhibitions.

At the beginning of the century Britain was at the height of her reputation in instrument manufacture and London makers dominated the international trade. The year 1800 saw the death of Jesse Ramsden, Britain's most celebrated and innovative maker, who had achieved an extraordinary reputation throughout the world of science. The reasons for British success in the latter part of the eighteenth century have probably not been fully identified and part was due to a succession of talented individuals, but certainly important were organisational or institutional features that recur in the careers of the leading makers. These were commissions for prominent and prestigious instruments from the Royal Observatory, grants and rewards from the Board of Longitude, commissions for surveying instruments from the Board of Ordnance, and in particular access to influential circles of the scientific community through fellowship of the Royal Society. Leading makers, such as Dollond, Short, Nairne and Ramsden were Fellows of the Royal Society, they published in the *Philosophical Transactions*, and some were successful candidates for such awards as the Copley Medal. In general they acquired a position and respect not accessible to makers in, say, France, where there was much more government commissioning of instruments and more direct patronage, but considerable less status for makers.[4]

The representative of this tradition in the early decades of the nineteenth century was Edward Troughton, Fellow of the Royal Society, Copley Medalist, builder of major instruments for the Royal Observatory, and contributor of papers to the *Philosophical Transactions*. But in fact by the 1830s this tradition in Britain was under threat and the cult of the great maker was beginning to dissolve. A movement to reform the Royal Society argued that British science was in decline and that radical reform of its institutions was needed. Some reform did take place and the makers may have suffered in the process, for they ceased to be elected to fellowship. Taken by itself, this seems strange, as the makers did not belong to the class of inactive, social members who were the target of the reformers: the makers may instead have been victims of changes in attitude that were consequent on the Industrial Revolution, accompanied as it was by a reduction in respect for manual work. Although a couple of later makers

4 J.A. Bennett, 'Instruments and the "Decline of Science in England": the Effect of Institutional Change on the Élite Makers of the Early Nineteenth Century', in P.R. de Clercq, ed., *Nineteenth-Century Scientific Instruments and their Makers* (Leiden and Amsterdam, 1985) pp. 13-27.

did become Fellows of the Royal Society, such as Thomas Jones and William Simms, no-one again reached the position of respect achieved by Troughton. The general status of the makers declined and along with this their access to the leading scientists. They did belong to some of the newly created societies, such as the Royal Astronomical Society, they did contribute to lesser journals, and they did win prizes from other organisations, such as the Society of Arts, but they gradually lost their place among Britain's scientific élite.

In parallel with this increasing marginalization of the makers, Britain's position declined in relative terms, as other centres of production, in Germany and France, became more important, but the effects were not obvious to the British until the Great Exhibition of 1851. Because of the international character of the Great Exhibition, and because of its public competitive aspect with entries judged in subject classes by international juries, this was the occasion when the British were jolted out of their complacency, though in fact they did not formulate a very effective response.

If we consider the pattern of the award of medals at the Exhibition, in particular the 'Council Medals' that were supposed to reward originality, the British performance was poor in the traditional instrument-making disciplines – prestigious areas such as astronomy, navigation and surveying – while the one field where they could be pleased with the result was in microscopy.[5]

Two instances can be used to demonstrate British complacency. William Simms, the surviving partner in the leading precision instrument makers Troughton & Simms, had not bothered to contribute, but when the Exhibition opened and the inadequacy of the British contribution became apparent, he was persuaded to mount a display even though the Exhibition was already underway.[6] It was then doubly embarrassing when he was not awarded a Council Medal. In a lecture on the results of the Exhibition, Lyon Playfair, one of the chief advocates of educational reform, linked complacency with a traditional notion of hereditary right: 'Our manufacturers were justly astonished at seeing most of the foreign countries rapidly approaching and sometimes excelling us in manufactures our own by heredity and traditional right.'[7]

Commentators who detected the British decline tended to blame two things – the lack of status for practical men of science and the poor quality of scientific and technical education. In instrument making these two factors were linked. Here success depended on combining a knowledge of manufacturing with an appreciation of the needs of scientific customers. The old master and apprentice model for training makers worked well when the leading makers were part of the élite scientific community, but when this was no longer the case, Britain had no

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[5] J.A. Bennett, *Science at the Great Exhibition* (Cambridge, 1983).

[6] *Lectures on the Results of the Great Exhibition of 1851* (London, 1852), p. 401.

[7] *Ibid*, p. 194.

educational structures comparable with those of France and Germany that could fill the gap.

The same problem exercised a later Royal Commission, appointed in 1881 to investigate technical education. A generation after the lessons of the Great Exhibition, the same anxieties fill the conclusion: Britain may have leading scientists equal to any, but nothing 'corresponding to the rank and file that they have in Germany.' This absence of adequate training limited the capabilities of the manufacturing side of scientific production, while at the same time it closed off a potential source of market growth: 'in this country there does not at present exist any institution which is adequately supported and has all the most recent appliances for practical science teaching.'[8]

This is an appropriate moment to introduce the figure of George Airy, the long-standing and influential Astronomer Royal from 1835 to 1881. What he saw at the Great Exhibition had a very significant influence on instrumentation, for he introduced at the Royal Observatory, Greenwich, self-recording magnetometers of the type that had won a Council Medal, and the 'American transit register', another recipient of a Council Medal and a means of recording astronomical transits automatically using a chronograph and electromagnetically operated pens. He combined this latter technology with Charles Shepherd's electromagnetic clocks, another exhibit at the Great Exhibition, and used the telegraphic lines of the burgeoning railway network to distribute Greenwich time throughout the country.

Airy was Astronomer Royal for a large part of the century and for much of this time he and his assistants could be said to have been, strictly speaking, the only government scientists. Airy self-consciously and deliberately took on this role, which he defined as 'British Scientist' and which he appropriated to himself. He did not confine his interests to the Observatory, but sat on many committees and commissions and adjudicated on a variety of matters that lay outside astronomy but which he deemed to be of public interest.[9] Like many of the British astronomers of his era, he had a profound and detailed interest in instruments. If there was a British government towards scientific instruments in the nineteenth century, it was represented by Airy.

One class of instrument that Airy was directly concerned with was marine chronometers. He became involved with this because the Observatory had the responsibility of rating the many chronometers used by the Royal Navy. Airy became a kind of clearing-house for advice on new designs and he went on to devise his own improvements to chronometers. He was also involved with the effects of iron ships on steering compasses, but of particular interest is Airy's method of commissioning instruments for the Royal Observatory: it was very different from that of his predecessors and clearly reflects the altered status of the makers.

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[8] Cardwell, *op. cit.*, p. 136.

[9] J.A. Bennett, 'George Biddell Airy and Horology', *Annals of Science*, 37 (1980), pp. 269-85.

When Edward Troughton built two major instruments for the Observatory in 1810 and 1816, when Nevil Maskelyne and John Pond respectively were Astronomers Royal, Troughton was, in effect, in a position to tell the Astronomer Royal what was needed, to design the whole instrument, and have it built and installed by his workmen under his command.[10]

When Airy needed a major instrument, the operation was entirely different. The design was due to Airy, who then ordered different parts from different makers – the mechanical structure from a firm of engineers, usually Ransomes of Ipswich, the fine mechanical or instrumental work, such as the circles and their division, the micrometers, &c, from Troughton & Simms, the object glass from a specialist optician, possibly in France or Germany, the driving clock, in the case of an equatorial, from a clockmaker, such as Dent. Airy alone was in control of an example of the 'division of labour' policy that had been successfully applied to British manufacturing industry.

When Airy published his account of a major instrument, he did not necessarily even mention the makers. Formerly the maker would not only have designed and built the instrument, he would have published the description in the *Philosophical Transactions.* It is a small, but in Victorian England significant, fact that Airy kept the letters he received from instrument makers in a file marked 'correspondence with tradesmen'.

If Airy's attitude and practice represents the new status of instrument makers in Britain (and in his role as 'British Astronomer' we come as near as we can to a state policy on the matter), and if the consequences of this were brought to light in 1851 and confirmed by later exhibitions, what reactions were there, either from the government or from prominent organisations or societies? It is worth remembering that, despite the state ceremonial and the patronage of Prince Albert, the Great Exhibition was the initiative of one of these organisations, the Society of Arts.

Not untypical of Britain, there was a response but not one thorough enough to be widely effective. There were partial, piecemeal initiatives, some from societies, but including state action in the creation of the Department of Science and Art, which ran classes for technical training, took over the collections that remained from the Great Exhibition and elsewhere, and formed the South Kensington Museum. This was an educational establishment with sections for art and science, the latter of which became the Science Museum. One important exhibition organised at South Kensington was the Special Loan Collection of Scientific Apparatus, opened by Queen Victoria in 1876.[11] There was, at last, some state initiative, but on a relatively small scale by comparison with Britain's Continental rivals.

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[10] For the Greenwich instruments, see D. Howse, *Greenwich Observatory: the Buildings and Instruments* (London, 1975).

[11] S.V.F. Butler, *Science and Technology Museums* (Leicester, 1992), pp. 19-26.

Even late in the century it is still useful to look to influential models, where respected practice is embodied by significantly placed individuals in British society. One would be William Thomson (Lord Kelvin), who dealt with the growing gap between scientific and manufacturing expertise by means of a partnership with the instrument maker James White. Each could make his own contribution to the necessary engagement between the laboratory and the manufactory.

Does what we have seen amount to a policy? Probably not, but it may still be useful to recognise that types of policy substitute are at work, even if they are conducted loosely by voluntary organisations with common interests rather than directed by agencies of the state. These bodies do have regulatory functions, either managed through professional legitimation in the manner of a guild, or social recognition in the manner of a learned society, or technical reputation through prizes, appointments and publications in the manner of an institute. The different national characteristics of instrument making traditions are influenced by state policy, but in Britain it is the relative absence of policy that is significant, together with the relative importance of unofficial but highly regarded individuals and quasi-public organisations.

EFTHYMIOS NICOLAÏDIS

SCIENTIFIC INSTRUMENTS, LABORATORIES AND THE 19TH CENTURY GREEK STATE

Introduction

In the part of the European periphery constituted by the post-Byzantine Greek world, the history of modern scientific instruments begins at the end of the 18th century. Until then, Greek scholars had almost no contact with experiment and observation.

The only known scientific instruments collection of the post-Byzantine period before the end of the 18th century, is this of Chrysanthos Notaras (c. 1663-1731), Patriarch of Jerusalem from 1707 until his death. In 1684, Notaras wrote a treatise on the astrolabe and the astrolabe-quadrant, based on Ottoman and Arabian sources and he constructed as well these instruments. Note that the astrolabe-quadrant, called also Profatius' astrolabe, was very common among the Ottoman Turks, because easier to construct. Notaras constructed also instruments for surveying, which are described and illustrated in his book *Eisagogi eis ta geografika kai sfairika* (Introduction to geography and the sphere) printed in Paris in 1716. We have testimonies that Notaras' instruments were kept at Jerusalem's Patriarchate untill the 1930ies, but unfortunately we have not for the moment succeeded to find them.

At the end of the 18th century, scientific instruments were considered as a vehicle of the new experimental philosophy which begun to be widely taught in the Greek Colleges of the Ottoman Empire and of the Greek Diaspora. At that epoch, due to the generosity of sponsors (mainly Greek merchants), these Colleges begun to be furnished in instruments for the teaching of experimental physics and chemistry. These instruments were purchased mainly in Paris and Vienna, as testified by the correspondence between the professors of these schools and the Greeks of Diaspora who bought and sent the instruments.

The Greek Colleges of the Ottoman Empire were familiar with experimental physics at the beginning of the 19th century. We have testimonies of the existence of School laboratories in the Greek Colleges of Constantinople, Smyrna and Kydonies in Asia Minor, Bucharest and Jassy in Romania, Odessa in Russia, the island of Chio, Ampelakia and Milies in Thessaly, Jannina in Epirus, Astros in Peloponesus. Using science for political purposes, that means to prove the superiority of the Enlightened Europe on the Ottoman Empire, some scholars of these schools often organized public demonstration experiments; in Smyrna for example, those were organised each Saturday. These small school laboratories were even noticed by European travellers, as Pouqueville who wrote in his *Histoire de la Regénération de la Grèce*, printed in 1825, that, as far as it concerns the Kaplaneion College in Jannina, it owned "some globes...and some chemical instruments", but "the college and the laboratory of physics were destroyed". As for the Chios' College, Levi Parsons and Pliny Fisk, noticed during their visit in 1820 that it had a good chemical laboratory

Note that from the above-mentioned Colleges, those of Jannina, Chio, Astros and Milies are located in the contemporary Greek State.

As among these Colleges, only the school of Astros did belonged to the new and small Greek State founded during 1828 and 1832, it would not be excessive to affirm that almost no scientific instruments existed inside the boundaries of this State. If one excepts instruments for co-ordinates determination at sea, like sextants or octants, the only ones known is a refractive telescope of the 18th century, imported and used by the scholar Theophyllos Kaïris, which is today preserved at the library-museum of the island of Andros and some demonstration instruments for experimental physics which belonged to the school of Astros, not preserved today.

The foundation of the independent Greek State was based on the model of the European Nation-State of the 19th century. Scientific and technical education was among the main symbols of this model. A Nation-State of the 19th century had to have at least four institutions to prove its participation to the scientific and technological ideological model: a University, a School of Engineers, a Military School and an Observatory. And this system should be based on a centrally organised secondary level education, which should furnish an important cursus of Physics and Mathematics. Following the ideology of the Greek revolution, all these institutions were to be founded as soon as possible in the independent Greek State.

Science and technology of the 19th century had their symbols. Those were the scientific instruments, and after the second half of the century the great scientific laboratories. The courses of experimental physics in the secondary level education were generalised during the century. Already, during the 18th century these symbols were presented to the public by demonstration experiments. During the 19th century this presentation will reach much more people by the illustrated articles of the press. To own scientific instruments became a *sine qua non* condition for a State to be considered as Modern. One should not forget this context when trying to understand why the small and poor new Greek State will spend a lot of money to furnish the new institutions with instruments which were scarcely used or even not used at all.

The Observatory of Athens: the sponsors and the State

Since the foundation of the Observatory of Paris and of Greenwich Observatory at the 17th century, those institutions became main State symbols determining time and measures and giving the needing scientific prestige to their States. The ideological foundations of those institutions during the 19th century are well presented in the statutes of the Poulkovo Observatory founded in 1833: "a) to furnish observations such precise and perfect as possible aiming to the perfection of Astronomy as science; b)to furnish observations indispensable to geographic and scientific enterprises; c) to co-operate to the perfection of practical astronomy in its applications to geography and navigation and to offer the possibility to training into the geographical determination of the lands."

In 1840, the rich Greek of Diaspora, George Sinas, who was also Consul of Greece in Vienna, discussed with his friend Prokesh-Osten, Ambassador of Austria in Athens, about what could he offer to contribute to the development of the newly founded Athens' University. Prokesh-Osten, who during 1837 had at his service as translator the physicist and astronomer George Vouris, proposed to Sinas to contribute to the foundation of an Observatory. At the mind of the Austrian ambassador, this institution would mainly be useful to the Greek navigation. In fact, the only co-ordinates which will be determined by the institution will be that of its own place; the survey of the Greek lands and coasts will be for long enterprised by English or French officers. On another hand, the Observatory will play an important role in two other fields not mentioned by Prokesh-Osten, those of meteorology and seismology.

For such an important State affair as the foundation of an Observatory, the King of Greece would not be absent. Othon gave to Sinas the higher State decoration and he was personally involved in the foundation. He asked the Architect and town-planner of Athens Eduart Schaubert to furnish the plans of the building; as for the place, Lycabettus, the higher hill of the town, was proposed.

The difficulties of the land and the non approval of the first draft of the building modified these first plans. A more soft hill, that of the nymphs and a new style for the building were chosen. Both had also a clear ideological meaning.

The hill of the nymphs was the place were the first Athenian astronomer, Meto, observed during the antiquity. As for the building, the first draft proposed by Schaubert was of a Middle-Age style recalling the German romanticism; the approved second draft was made by Schaubert's collaborator, Theophil Hansen and was of a pure neo-classical style. One can admire today the symmetry of this beautiful building, recently restored, constructed with materials recalling Ancient Athens: stone from the hill of the nymphs, cyan marble from Hymettus, white marble from Penteli. The symbols are those of Ancient Greece; Ancient Greek astronomers are painted and around the vault the twelve Gods of Olympus.

The case of the Observatory of Athens is that of a main State institution depending almost entirely on private funds. Except the salary of its first director, George Vouris, paid by the State, as he was also a professor of the Athens' University, all other expenses were covered by Sinas family. By George Sinas at first, and after his death in 1853 by his son Simon Sinas and after the death of this later in 1876, by his wide Ifigenia. The family Sinas paid also the salary of the third and the most important, during the 19th century, director, the German Julius Schmidt.

George Vouris who travelled in Vienna for that purpose ordered the first instruments of the Observatory during 1845. From then on and until 1852, Vouris made several visits to Europe to order more instruments and make contacts, all expenses covered by George Sinas. After that date, there will not be some important new order until the last decade of the 19th century. These first instruments will be restored in 1861 at the request of Julius Schmidt and as usually Sinas family covered the expenses of that restoration.

If one considers the instruments installed during the first years of the foundation of the Observatory, one could conclude that this small Institution was pretty well furnished for the standards of that time: A Plossl equatorial refractor of 6.2 inches aperture, a Starke meridian circle of 3.7 inches aperture, two clocks, Berthoud and Kessel, a Kessel chronometer, five small telescopes for comet hunting, two barometers Kapeller and a series of other meteorological instruments.

This first period of the Athens Observatory, that of an important State institution founded and entertained by a private person ended at 1890, during the effort for modernisation of Greece maid by Tricoupis Government.

During this first period, a single man, its Director and sole astronomer, ran the Observatory. This institution contributed to the prestige of the small capital of a small State, was a part of the symbols of modernity of that State, but was not really integrated into the educational and scientific structures of that State. Schmidt scarcely participated to the Greek scientific community. He did not really trained other astronomers neither founded a team. This is why, after his death in 1884, the observatory did almost not functionned under the rule of his assistant Demetrius Kokkides. Schmidts's main achievement, the map of the moon, one of the best made before the satellite era, was made by him alone. Nevertheless, with the instruments he possessed, he made the first complete series of meteorological observations in Greece and also for the first time he centralised and organised the seismological observations.

The second period of the Observatory is that of its direct dependence from the State, and corresponds to the Tricoupis' modernisation period. During that period, a new effort has been made to order scientific instruments to cover the gap between the non-existent Greek university laboratories and those which flourished in West Europe. In that modernisation effort, a private State institution had not more its place. By special decree a new director was named in 1890 at the Observatory, Demetrius Eginitis, who came from the Observatory of Paris. Real State services of Meteorology and Geology were then organised and a State policy to cover the luck of funds was pronounced. After the bankrupt of Greece in 1893, a National Committee was founded in 1896 under the direction of Prince George, to provide funds for the renewal of the instruments of the Observatory. The Committee obtained 250,000 Drs from Greeks of the Diaspora as D. Dorides, A. Syngros, M. Koryalenios, P. Stephanovik, E. Zarifis, K. Mavromikhalis, A.Skouze, N. Chrysovelonis. With this money, Eginitis expanded the Observatory and acquired in 1896 the great transit circle of Gautier, 15 cm aperture and 2 m focal length (named after Andreas Syngros), and in 1900 the big equatorial Gautier of 40cm aperture (named after Dimitrios Dorides). C. Ionides gave his private telescope, an equatorial reflector Browning of 20 cm aperture.

The history of the modern Greek State is may be the history of its sponsors and this is quite clear as far as it concerns the scientific instruments. The history of the donations can be traced until today as the instruments and the buildings keep the names of the donators: Syngros meridian, Dorides equatorial, and simply Sinas to indicate the ancient building of the Observatory.

Second level education: many instruments for a few professors

Inside the boundaries of the actual Greek State, the only known instruments coming from school laboratories before the foundation of the Greek State, are kept in the small collection of the Library-Museum of the village of Milies, in Thessaly. These are some simple school demonstration instruments. The scholar Anthimos Gazis sent them from Vienna at the beginning of the 19th century.

The other known instrument of the beginning of the 19^{th} century, is a refracting telescope, which belonged to Theophilos Kaïris, probably bought in Paris during his stay there in 1810. Theophilos Kaïris (1784-1853) has been professor at the Colleges of Kydonies and Smyrne in Asia Minor before the Greek Revolution of 1821. After that Revolution, he founded a School at the island of Andros in 1836. The instrument is kept in the Kaïris Library-Museum.

As mentioned above, at the foundation of the Greek state, educational institutions, which followed the image of those of Western Europe, were created, and first of all primary and secondary schools. Education and science became then a State affair, as well as the acquisition of scientific instruments for educational purposes.

Soon after king Otton's arrival, a decree proclaimed the foundation of the first secondary level school, that of Nauplion, were courses began in March 1834.

Among the lessons were included physics and chemistry. From 1833, a similar school existed here in Hermoupolis and in 1835 more than 10 secondary level schools were functioning in the new State. The 1837 programme includes the course of physics from the 3rd class of the Gymnasium and that of Chemistry from the 4th. As far as it concerns scientific instruments, they were officially introduced in the secondary level education by the programme of 1836; a decree of the year 1855, included in the programme two hours of experimental physics in the 2nd and 3rd classes of the Gymnasium. From then on, the State will import from Western Europe scientific instruments to furnish the school laboratories. For example, in 1860, at the Gymnasium of Nauplion there existed six glass-cases in which the instruments were kept. Many of these are preserved till today as a magnificent Ramsden apparatus, some electrical machines, a microscope, instruments for hydrostatics, hydrodynamics, aerostatics, aerodynamics etc.

The main problem concerning the teaching of experimental physics in the Gymnasiums, was not the acquisition of the scientific instruments. These were furnished by the State although its great financial difficulties, or by private donations. To have a laboratory in the Gymnasium was for each Greek town a sign of modernity, so an effort was also made in a local level. The real problem consisted in the lack of teachers capable to present experiments to their pupils.

For the Gymnasium of Plaka for example, we know from the Archives that scientific instruments were sent in 1857, and that the professor of physics George Paulides was asked by letter from the Ministry to begin the teaching of experimental physics. In that letter, the Ministry expressed the vow that the professor would be prepared enough for that course. But, almost twenty years later, in 1874, the minister of Cult and Public Education will note, in a letter addressed at all the Greek schools, that the course of experimental physics was in reality never taught until then in the Gymnasiums. The Minister expressed the opinion that this situation was due to the lack of a suitable schoolbook and that this book was at least printed and was to be sent to the Gymnasiums.

We assist here at a non-correspondence between the technical capacities and the human or organisational capacities. The Greek Gymnasiums had to follow the West European example, they had to have a school laboratory and a course of experimental physics and chemistry. The State and the donators followed that ideal and they furnished the schools with the suitable apparatus. But at the same time the State did not trained the school professors to teach that course and not even considered seriously that problem before 1874. And even after that date, the training will be highly theoretical, based more on school manuals than on real laboratory training in Athen's University.

The origin of the school instruments of the 19th century varies, being essentially French. Note that one of our main difficulties to study the history of these instruments is to find their constructors, as very often there are not mentioned.

As we approch to the end of the 19th century, the schools collections multiply. During those times, the Greek State expanded to Thessally and new Gymnasiums were founded. Nevertheless, the preserved instruments are few. Unfortunately, most of them were destroyed when the schools did received new ones, mainly during the 1920ies and 1930ies. During those years many school instruments were ordered to a single constructor, Max Kohl, an enterprise founded in 1876. We find Max Kohl's scientific instruments in the Greek collections from the end of the 19th century. Note that some of the instruments constructed at the end of the 19th century came in the Greek Gymnasiums later than that date. Indeed, they were received after the World War I, when Germany gave to Greece scientific instruments in order to repair the War damages.

With the new expansion of the Greek State to Macedonia during the 1910'ns, more Gymnasiums were founded. In their collections we still find 19th century instruments, probably gave by Greeks of Diaspora or due to German donations after the World War I.

We wish also to mention a private school collection of the late 19th century, the small one of Hill's Girls' school, an institution founded in 1838. The collection has been constituted at the end of the century, as Physics were not taught to Girls before the 1870ies.

An interested small collection is that belonging originally to the Merchant School of Volos, in Thessally. Among these instruments, there are some interesting small demonstration machines for hydrodynamics. The collection is preserved at the National Archives of the town of Volos.

The scientific laboratories: for education purposes only

The laboratories of the Physics and Chemistry department of the University of Athens, which was included at those times in the Faculty of Philosophy (the Faculty of Science was founded in 1904), began to be furnished with instruments from the 1850'ies. In fact, the physics laboratory was seriously organised only after 1890, during the period of Greek State modernisation. At those years, Timoleon Argyropoulos, who had studied in Paris, founded the first important university physics laboratory. Concerning the chemistry laboratory, this began to be organised after 1866 by Anastasios Christomanos (1841-1906), who previously had worked in German chemical laboratories.

The collection of 19th century scientific instruments of the Athens' University is very rich. Note that it would be interested to follow the origin of the scientific instruments of these laboratories, which testifies the bounds of the Greek professors with the country of their studies but also the technological influence of West European countries on Greece. Until the French - German war of 1870, the origin was mainly French; after that date German instruments began gradually to be imported and from the beginning of the 20th century Swiss instruments too.

The existence of the 19th century collection of Athens' University is not only due to the laboratories founded by Argyropoulos and Christomanos. As mentioned before, after the World War I, Germany gave to Greece a lot of scientific instruments, mainly from German universities. Many of these instruments date from the end of the 19th century. Strange enough, due to this event, we can reconstruct the history of German universities' laboratories at the end of the 19th century by studying the Greek collections!

Another university laboratory collection of the end of the 19th century is that of the National Technical University of Athens. After the reform made by Demetrius Scalistiris at 1864 aiming to the transformation of this former school of crafts and arts to an engineering university, scientific laboratories began to be founded. The tradition of that institution was mainly French during the 19th century. Scalistiris, as many other directors and professors of the Technical University, has been foreign pupil of the French Ecole Polytechnique. As a consequence, most of the 19th century instruments of the National Technical University's collection are from France.

By the end of the 19th century, the rising of Greek industry and mining leaded to new technological needs. Some private laboratories for measures, tests and chemical experiments were then created. Unfortunately, the state of research is too poor to present even an overview on the history of the private Greek laboratories of the end of the 19th century.

In the small and young Greek State, very few people composed the scientific community. When the numbers are modest, the institutions depend much more on personnel contributions. The functioning of the Observatory of Athens, for example, depended only on the skill of its director, that is why we had periods of intense activity followed by periods of total stagnation. We could make the same remark as far as it concerns the Physics and Chemistry Laboratories. The creation of these Laboratories at the second half of the 19th century has not been followed by the creation of real research teams. They have been used as teaching Laboratories even by the most active professors, as Argyropoulos and Christomanos. It will not be excessive to affirm that research was introduced to Greek Universities a whole century later, during the 1970ies.

Our policy for the preservation and the study of the instruments

Till recently, only instruments dated before the Greek revolution were considered by the State as national heritage, and so were carefully preserved and exposed in Museums (like this of Milies). Gradually, the interest have expanded to the first instruments of the Observatory of Athens and of the Athens' university, but the main corpus of the instruments of the 19th and of the beginning of the 20th century has been neglected. Only some personal initiatives have contributed to the preservation of a number of these instruments.

To contribute to the preservation and show off the scientific instruments located in Greece, the National Hellenic Research Foundation has created the Hellenic Archives of Scientific Instruments. These archives concern the scientific instruments of the Greek collections of the post-Byzantine period, until 1950. The aim of these Archives is to construct a virtual Museum in multimedia, giving information on the instruments, on the institutions where these instruments belonged and on the men involved with the history of these instruments in Greece. For each instrument we give the following information:

Pictures of the instrument, its Title, its Dimensions, its construction Materials, its Constructor and the Date of construction, a Technical description, a description of its Functioning, the History of the instrument, its Origin, its today's Location, and eventually some remarks on its condition. Our policy is to give the more possible links to the user: from the instrument to the institutions, the constructors, the scientists, etc and *vice versa.*

Note that we will also try to constitute files for the instruments which have not been preserved, but for which we have some information and eventually pictures.

The internet site of our Archives, which has been inaugurated in January 1999, is: http://www.eie.gr/hasi.

Our virtual Museum has been supported by the Programme Archives de la Creation, of the Centre National des Recherches Scientifiques in France. We wish here to thank Michel Blay who was at the origin of this Programme, as well as Costin Miereanu who continued to coordinate it.

Our next step will be to create a permanent exhibition in the Hermoupolis Museum of Technology, which is being created by the National Hellenic Research Foundation in the island of Syros. In this Museum, we aim to organize a summer school and a permanent training for those interested to the history and the preservation of scientific instruments.

The Hellenic Archives of Scientific Instruments of the National Hellenic Research Foundation, will also organize in 2002 in Athens, the 21th International Scientific Instrument Symposium.

GEORGE N. VLAHAKIS

INTRODUCING SCIENCES IN THE NEW STATES: THE ESTABLISHMENT OF THE PHYSICS AND CHEMISTRY LABORATORIES AT THE UNIVERSITY OF ATHENS.

The treasure was there.
It was hidden.
Keith Jarret, *Treasure Island.*

Introduction

Greece became an independent state in 1832, after a long period under the rule of the Ottoman Empire, which lasted over four centuries. Therefore it is interesting from the point of view of the history of science to trace the first steps of the introduction and development of sciences in a new state, in a country just liberated, as was Greece at that time, and to compare this procedure with the relevant situation in the other countries of South-Eastern Europe.

The present study gives the reader an idea about the status of scientific activities in an area which belonged to the European periphery but also served as a regional center for South-Eastern Europe during the second half of the 19th century. During that period, scientific activities also related to the institutionalization of science and the gradual vanishing of the "isolated scholar" scientist of the previous period[1]. Scholars of that type were responsible for the introduction of Physics and Chemistry in the wider Greek intellectual area, which covered most of the Balkans during the 18th and the first quarter of the 19th centuries. Due to a long-term research project carried out by the Institute for Neohellenic Research/National Hellenic Research Foundation, the dissemination and development of sciences such as Physics, Chemistry, Mathematics, Geography, Medicine etc. has already been studied

[1] The dissemination of physics and chemistry in 18th century Greece is analyzed in: George N. Vlahakis, A note for the penetration of Newtonian scientific thought in Greece, *Nuncius,* 2/1993, pp. 645-656 ; George N. Vlahakis, "The appearance of a new science in 18th century Greece. The case of Chemistry", *Nuncius,*1/1995, pp. 33-50.

extensively for the period 1700-1821, a period known as "Neohellenic Enlightenment" or "Neohellenic Revival"[2].

The basic target of Greek scholars' efforts during the Neohellenic Revival was to defeat ignorance and superstition by disseminating the basic principles of science among as many people as possible, following a Baconian approach to the role that science should play as a component of society[3]. Greek Scholars were more interested in grasping the nature of science, in understanding its methods, and using already existing scientific products for "social purposes" than in producing new knowledge. For that reason, the production of original scientific theories was not one of the priorities of the Greek scientific community during the aforementioned period. It is this early attitude towards science that, even later and during more normal political periods of Greek history, governed the scientific activities in this part of Europe. As a result, during the 19th century pure scientific research never became one of the priorities of the governmental bodies in Greece, which financed relevant efforts in a rather hesitating way. In conclusion, it becomes obvious that during the Neohellenic Enlightenment (1700-1821) the lack of original scientific production was not due to the weakness of Greek scholars but, in some degree, was a conscious choice. Original knowledge was expected to be produced in a future stage, when a "scientific market" would be formed and the society would be mature enough to support the expenses of primary scientific research. A stage related directly, in a theoretical level at least, to the establishment of a University in the independent Greek State. It is unquestionable that, compared with the situation during the Ottoman occupation, the priorities and the needs for scientific development in the new state should not be only different but more urgent as well. Therefore, in an independent country a critical mass of well-trained scientists is unavoidable, if social, cultural and economical progress are seriously taken under consideration by the relevant authorities. But for those who know the Greek reality well enough, things almost never happen as they are supposed to do.

It would then be rather extraordinary if the scientific activity in Greece was an exception to this rule. The significant activity relating to Physics and Chemistry during the last decades before the War of Independence, which started in 1821, actually fell rapidly to nil after the foundation of the Greek state[4]. No

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[2] The period has been characterized as "Neohellenic Enlightenment", by one of the best 20th century historians of modern Greece K.Th. Dimaras. "Neohellenic Revival" is an expression coined by 19th century Greek scholars.

[3] This "Baconian" approach of the role of the sciences in the University has been prevailed throughout the period of the Neohellenic Revival. Prof. I. Karas has discussed the general climate of the scientific development in Greece in several studies, as: Iannis Karas, *Οι θετικές επιστήμες στον ελληνικό χώρο (15ος-19ος αι.)*, (The natural sciences in the Greek area (15th-19th century), Athens, Zaharopoulos, 1991, pp. 232-262.

[4] More than 170 scientific books had been published before 1821. This number falls logarithmically

attempt to promote the introduction of sciences in the Greek speaking regions of Southeastern Europe was undertaken any longer, not even the mere translations of European textbooks, as one can see from the bibliography regarding Greek 19^{th} century books of Physics published after 1850.

I. The Institutions : the University of Athens

The University of Athens was established in 1837 by King Othon. Physics and mathematics from the very beginning were incorporated in the Faculty of Philosophy. Chemistry was only part of the Physics department. This organization of the academic fields, reflecting the hegemony of the philosophy over the other disciplines, lasted during the course of the 19^{th} century. This may give us a clear idea about the delay of the academic reformations in Greece, given that such patterns had been abolished in European universities since mid or late 18^{th} century[5]. The majority of the Greek University professors continued to believe that: "Philosophy [is the] first born daughter of the Hellenic intelligence, the science of the sciences, the main academic science", an expression coming from K.A. Venizelos (?-1862), professor of Chemistry at the University of Athens for a short period. Consequently, given that even professors of physical sciences viewed the disciplines they were engaged in to be subfields of philosophy, it was very difficult to claim for their organizational autonomy form the Faculty of Philosophy. As far as Chemistry is concerned, its incorporation into the Physics Department can probably be explained by the following reasons. The first one has to do with the fact that Chemistry was "younger" in the Greek area than Physics, which was considered an ancient Greek achievement because of the long lasted Aristotelian tradition, and therefore a "period of maturation" under the umbrella of Physics was necessary before chemistry would be an independent academic discipline. The second reason has to do with equilibrium among the professorships within the University. Stroumbos, the professor of Physics, was older and more powerful than the young Venizelos, professor of Chemistry.

Although this was the general climate, rather early the need to buy some scientific instruments became evident, if the University truly wanted to be considered an institution where experimental physics and chemistry could be taught in an significant degree.

The Head of the University for the year 1841-42, M.N. Kostis (1805-1861), professor of Medicine, will note in an address delivered before the Senate just

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to zero when the War of Independence started. A detailed index of these books will be appeared soon in CNR/NHRF site in the Web.

5 George N. Vlahakis, "The Introduction of Classical Physics in Greece: The Role of the Italian Universities and Publications", *History of Universities,* 1998, pp. 157-180.

four years after the foundation of the University:

> "We provided also for the development of the other collections of the University, four hundred drachmas for the Chemical Laboratory. The same amount of money was provided for the Cabinet of Physics. Gentlemen, this cabinet is in good situation. The brilliant and luxurious instruments closed in the boxes, the electric machine and the air pump, both donations of a wealthy Greek, have been assembled and are ready for the experiments of Physics"[6].

Two things become obvious from the reference above. The first one is that the first instruments for the University were not bought by the State but they were donated by a wealthy Greek, and the second one that they were restricted only to an electric machine and to an air-pump. Let us note that donations were very common at that time. Once again, this gives the impression that during the 19th century science in Greece remained in the situation that characterized the status of scientific practices during the 18th century. Experiments were considered to be part of the teaching process, having only a demonstrational character. The students did not perform themselves any experiment.

Trying to find the reasons for that delay in the development of sciences, the professors of the University realized that one of the possible explanations was the incorporation of physics and chemistry in the Faculty of Philosophy.

During the year 1881-82 Panagiotis Kyriakos (1835-1900), Head for that year, commented :

> "The existing lack of several branches of physical sciences in our University syllabus obliges us to define more faculties for the satisfaction of many scientific and social needs in the future. The foundation of such faculties should not be considered a luxury for any reason because (...) we must develop also new opportunities for studies for the young people, in order to avoid unbecoming situations due to young people's preference to study only a few disciplines"[7].

The above words make clear that the autonomy of the faculty of Physics and Chemistry, which finally took place in 1904, was not only considered a factor for the development of these sciences but also a key action to prevent the majority of the students from following Law and Medicine Schools, while the Greek society of that time was not able to absorb all the graduates from these schools. That is a phenomenon which proves that the Greek governments did not define the number of the students in every school by taking into consideration the real needs of the society but that this decision was too often based on political criteria.

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[6] M.N. Κωστής, *Λόγος εκφωνηθείς τη 4η Οκτωβρίου 1842, Υπό του πρώην Πρυτάνεως Μ.Ν. Κωστή, παραδίδοντος εις τον διάδοχόν του την διεύθυνσιν του Οθωνείου Πανεπιστημείου*, (Address delivered on October 4, 1842, by the former Head M.N. Kostis handing over the direction of the University to his successor), Athens, 1842.

[7] Panagiotis Kyriakos, *Λόγος εκφωνηθείς υπό του πρώην Πρυτάνεως Π. Κυριακού, παραδίδοντος εις τον διάδοχόν του την διεύθυνσιν του Εθνικού Πανεπιστημίου* (Address delivered by Pan.

II. The individuals

During the period under examination, that is the 19th century, the first professor of physics was Dimitrios Stroumbos (1806-1890). He studied physical sciences at the University of Geneva and at the Ecole Polytechnique in France. He was appointed full professor in 1855[8].

Stroumbos was succeeded by Timoleon A. Argyropoulos (1847-1912). Argyropoulos had graduated from the University of Athens and studied physics for five years at the University of the Sorbonne (France). He became lecturer in 1884, assistant professor in 1855, and full professor in 1890[9].

As for Chemistry, the sole scientist who was responsible for the real introduction of that science in Greece, was Anastasios K. Christomanos (1841-1906). He was born in Vienna. He studied at Vienna Technical University (1858), at the Gessey University, at the University of Berlin, at the Technical University of Karlsruhe and at the University of Heidelberg. He became assistant of Bunsen during the research program of the latter on spectral analysis. He worked as a chemist in the paints factory "Milidinger". In 1862 he took the position of teacher of Physics in the Academy for teachers in Athens. He was appointed at the University of Athens as lecturer of general chemistry in 1863, assistant professor in 1866 and full professor in 1869. According to the historian of sciences Michael Stephanides[10], the Stockholm Academy proposed to Christomanos to submit candidacy for the Nobel Prize in Chemistry[11].

These three professors and their activity marked the standards for the physical sciences in the underdeveloped Greece of the 19th century.

We would like to deal with these central figures of the Greek University because in Greece, even in the few cases when there were institutions for the promotion of science, these institutions were qualified on the basis of the personal contribution of the individuals who were involved in their functioning. And it is not a matter of chance, if after the retirement of these individuals, the link breaks between the scientific institution and the scientific activity, and no long term scientific tradition can possibly be formed. The particular characteristic of the professors at the University of Athens, with the partial exception of Christomanos, was that though they had given promising signs for contributing seriously to the development of sciences they were involved in

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Kyriakos handing over the direction of the University to his successor), Athens, 1883, p. 13.

8 Michail Stephanides, *Εθνικόν και Καποδιστριακόν Πανεπιστήμιον Αθηνών. Ιστορία της Φυσικομαθηματικής Σχολής*, (*National and Kapodistrian University of Athens. History of the Physics and Mathematics School*), Athens, 1952, pp. 8-9.

9 *Ibid.*, pp. 19-20.

10 *Minutes of the Faculty of Philosophy*, 17th February 1906, p. 85. For the role of Michael Stephanides see: Panagiotis Michailaris, Towards the formation of the scientific personality of Michael Stephanidis, *Sciences in the Greek Area*, Athens, 1997 (in Greek).

11 *Ibid.* (see note 8), pp. 12-14.

during their postgraduate studies, after their return to Greece they contented themselves to the role of popularizers of science.

As was mentioned before, physical sciences at the University of Athens had been incorporated in the Faculty of Philosophy. A Faculty where, as I. Karas has stressed out, "the place of free thinking has been occupied by the devotion to the ancients". In this rather conservative climate arose a new effort to establish a new "enlightenment" movement during the 19th century, a movement having more or less the same principles of what was called "Neohellenic Revival" (1700-1821).

From the middle of 1860s onwards, new attempts for the development of knowledge provided by the University took place. The ideological framework for these efforts is described in an excellent Address delivered in 1897 by Anastasios Christomanos under the title "Physical Sciences and Progress". Its content, according to our opinion, is the manifest for a new intellectual crusade to liberate Greece from the status of a country belonging to the European Periphery. He wrote characteristically:

> "Our nation [is] under a process of revival. We revive (...) by devotedly keeping our traditions, through which we are connected with our beloved ancestors, on the one hand, and by competing with the leading nations of contemporary civilization and hoping to surpass them, on the other hand"[12].

This paragraph might be easily attributed to any of the Greek scholars of the Neohellenic Revival, such as Koumas, Theotokis, Korais etc. But, in our opinion, Christomanos was actually influenced by similar opinions expressed during the last three decades of the 19th century in Germany, where sciences and especially physics and chemistry were considered to be a decisive tool for the development of the German nation. Describing the development of Chemistry in Germany he wrote: " During the last two years in particular six huge chemical laboratories have been built in Germany, in the cities of Berlin, Bonn, Aachen, Leipzig, Munchen and lately in Vienna"[13]. Christomanos did not content himself with the theoretical approach of the scientific knowledge. He claimed that this knowledge should lead to the improvement of people's everyday life through the production of relevant industrial goods or its application in other fields like medicine.

Christomanos has often referred to the advantages of the recent inventions of his time, such as telephone and telegraph. He has even foreseen that "the improvement of light-telephone is a mater of time, when with great velocity and

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12 Christomanos, *Φυσικαί Επιστήμαι και Πρόοδος. Λόγος απαγγελθείς εν τω Εθνικώ Πανεπιστημίω τη 17η Δεκεμβρίου 1896 υπό Α.Κ. Χρηστομάνου, αναλαμβάνοντος την Πρυτανείαν του έτους 1896-97,* (Physical Sciences and Progress. Address delivered at the University of Athens on October 17, 1896 by A.K. Christomanos undertaking its direction), p. 4.

13 *Λόγος εκφωνηθείς τη 25η Οκτωβρίου 1870 ημέρα της επισήμου εγκαθιδρύσεως των νέων αρχών του Εθνικού Πανεπιστημίου υπό του πρώην Πρυτάνεως κ. Παύλου Καλλιγά,* (Address delivered on October 25, 1870 by the former Head Pavlos Kalligas), Athens, 1870, p. 171.

without distinction of time and space everybody may communicate with each other from any distance"[14]. He has also considered cinema and photography to be technologies useful for the sciences: " [things] that have never been seen by the best human eye, even through perfect glasses and telescopes, may be discovered by the photography (...)"[15]. This opinion was quite interesting. It was more than a simple reference to recent inventions for the amusement of the public as it informs us that (some) scientists understood very quickly the benefits they might gain from the use of such inventions in experimental sciences. It is also proved that Christomanos after his return to Greece continued to get adequate information on the improvements in chemistry as he described the recently discovered elements Helion and Argon and the recent progress within Aluminium metallurgy (which reduced the price of this valuable metal significantly) as well as Pasteur's discoveries[16]. Christomanos believed that all the above novelties and especially the practical use of electricity were the result of the proper exploitation of the principle of conservation of energy, a principle expressed in the mid-1840s[17]. In parallel, Christomanos gave the reader of his address a slight idea for the materialistic foundation of the physical reality: "The matter has existed, exists and will exist. Chemistry is the history of the matter's phases"[18].

The materialistic approach of the nature seems to be unconsciously incorporated into the Greek savants' interpretation schemes of the cosmos's laws, though most of them insisted on supporting that the universe was created and governed by God's will.

Christomanos chose to finish his text repeating with emphasis an other classic thesis of the Greek enlighteners of the period before the War for Independence.

> "Let us permit the best pupils to enter the Physics Department (...) in order to perfect themselves and to be used later as teachers of natural sciences. And when their work will produce results, when their mission for the reformation of the society will penetrate in every class, then, but only then, will we able to speak about national awakening and power"[19].

In that case too, we may argue that Christomanos had been influenced by the spirit of late 19th century German nationalism and its educational and scientific policies, as he had lived and studied in countries of German culture for many years. These thoughts did not remain just "words without meaning" for Christomanos. As soon as he undertook duties in the University, he started

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[14] *Ibid.* (see note 12), p. 11.

[15] *Ibid.*, p. 12.

[16] *Ibid.*, p. 14.

[17] For the influence that principle had in the further development of applied physics see: Peter M. Harman, *Energy, Force and Matter: The Conceptual Development of Nineteenth-Century Physics*, Cambridge University Press, 1982.

[18] *Ibid.* (see note 12), p. 27.

[19] *Ibid.*, p. 32.

working for the establishment of a fully equipped and well-organized chemical laboratory. Christomanos vision for a chemical laboratory is described with his own words as follows:

> "I judge needless to speak for a long time in favor of the moral usefulness of our chemical laboratory because it is obvious to everybody. Besides the fact that the chemical laboratory in our country, which is full of minerals, could be a nursery of the industrial applications, incalculable will be the usefulness from the practical training of medicine and pharmacy students".

Let us note that Xaverios Landerer (1809-1885)[20], the former professor of Chemistry from Athens University had in his possession a cabinet-like collection of a few instruments. When he retired, he requested a rather large amount of money from the authorities of the University to leave these instruments in the possession of the University. This behavior, unsuitable for a professor, provoked the anger of the Head of that time.

Christomanos' efforts may be put in parallel with the transfer in Greece of the European model for teaching and research in laboratories, equipped properly with precision instruments of new technology and run, apart from the full professor, by experts assistants who were responsible for the maintenance of the laboratory and the instruction of the students.

It is evident, that during this transfer process, which undoubtedly faced many difficulties, sometimes foreseen, sometimes unexpected, Christomanos influenced, with the positive meaning of the term, the professors of Physics at the University of Athens. He did so to a lesser degree to Dimitrios Stroumbos and much more to his successor Timoleon Argyropoulos. To reconstruct the various stages of this process, we based our opinion mainly on the information included in the minutes of the Senate's meetings, that is the only available sources for information about what was happening at the University during that period. These texts, though written in an elegant style and filtered from any actually thorny expressions because of their public character, give us many details, qualitative as well as quantitative.

During 1864-65 when the Head of the University was Prof. of Mineralogy, Heraklis Mitsopoulos (1816-1892), the Senate decided to give financial support of 4 500 and 2 500 drachmas (dr.) respectively for increasing the collections of chemical and physical apparati. These 7 000 dr. represented about 2/3 of the money which had been granted to the Faculty of Philosophy for buying items for the library and the scientific collections of the University. According to the prices of the time, this was a relatively significant amount of money if one thinks that the salary of a full professor with many years of service was about 400-450 dr. per month. Thanks to that money, An. Christomanos, who had been appointed meanwhile as professor of experimental chemistry, succeeding Alexandros Venizelos who died unexpectedly at a very young age, bought from the well-

20 *Ibid.* (see note 8), pp. 7-8.

known instrument maker G. Zenoir in Vienna about 3000 dr. worth of instruments and chemical materials. At the same time he restored the room of the chemical laboratory, and bought shelves and tables for the experiments which cost no less than 730 dr.

As for Physics, D. Stroumbos ordered instruments of 2 250 dr. value from Paris, while the other half of the original amount was devoted to the supply of instruments from Vienna "where [instruments] are constructed in lower price though not worse in quality than those made in Paris". These first efforts seemed to bring results, even though moderate. During the academic year 1867-68 twenty two students of Medicine and twelve from the School of Pharmacy were trained in the chemical laboratory. The Head of the University during that year Theodore Orphanides (1817-1886), Professor of Botany and poet himself, concluded the following:

> "(...) we have a chemical laboratory ; if it is enriched every year, it will soon be perfect and probably will not be constrained to remain in the area which it occupied in the main University building, and a nearby separate building will be necessary to be built"[21].

This proposal may give us a hint, that Christomanos had already, though unofficially, pressed the authorities of the University for a new building for the laboratory of chemistry. We must not forget again that during the 1860's and the 1870's in Germany a great effort had been undertaken for the improvement of the facilities of the experimental sciences, especially Physics and Chemistry, and many buildings had been constructed for that purpose[22].

About the transfer of the chemical laboratory to a new building, we find more information in the Address of Pavlos Kalligas (1814-1896) when he served as Head of the University during the year 1869-70. At the beginning of his address, Kalligas gave the reasons that led the authorities of the University to accept the proposal for a new special building for the chemical laboratory:

> "As is today our chemical laboratory, located in a small room, it is responsible for damages both for itself and for the others. For itself, because there are kept all the chemical instruments, some of them really precious, which are endangered from the gases and need frequent maintenance or replacement. For the others, because these gases, transferred to the above floor, where the Natural History Museum and the Library are placed, threaten there also to cause very severe damages".

The same year, the Senate decided to buy a site of about 7 500 sq.'s and value of about 52 000 dr. in Solonos Street, near the University, to be used for the construction of a building, which would be used for the chemical laboratory, the

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[21] Λόγος εκφωνηθείς τη 24η Νοεμβρίου 1868 ημέρα της επισήμου εγκαθιδρύσεως των νέων αρχών του εθνικού Πανεπιστημίου υπό του Πρυτάνεως Θεοδώρου Γ. Ορφανίδου, (Address delivered on October 24, 1868 by the Head Theodoros G. Orphanides), Athens, 1868, p. 54.

[22] A very interesting article on that subject has been written by David Cahan, The institutional revolution in German physics, 1865-1914, *Historical studies in the physical sciences,* 15(2)/1985, pp. 1-65.

anatomical laboratory and the pharmaceutical school. The building's plans were drawn up by two famous architects, who have built very significant public buildings in Athens, Tsiller and Kaftanzoglou[23]. The cost of the building was estimated to be about 250 000 dr.

The interior of the Chemical Laboratory has been designed by Christomanos, who was influenced by German prototypes. He had submitted his plans to the architect of the Berlin Chemical Laboratory Zastrau and to the famous chemist Hofmann and received very favorable comments. He also collaborated with professor Kolbe of the University of Leipzig, who, according to Christomanos's opinion, had constructed the best chemical laboratory in Germany from a scientific point of view.

The high cost of the building seemed to frighten the Senate, which worried for the property of the University and postponed the decision of allocating a budget of about 50 000 dr. which had been proposed to start the construction process. Facing that unfortunate situation Christomanos in his annual report tried to prove "that mostly disastrous and especially from a financial point of view is the further delay for the starting of the building, whereas the construction of the chemical laboratory is a profitable enterprise".

His arguments seemed to convince Kalligas who finally adopted Christomanos' proposal, despite the decision of the members of the Senate:

> "Our Chemical Laboratory if it is established in such a building, will be the one and only in the East and will raise Greece as a pioneer country in that field of the sciences, which is so significant because of its applications in the industry. Therefore, do not hesitate, for any reason, to give Greek society all the means which can be used to learn the secrets of the natural world"[24].

In Kalligas's words is reflected the general spirit of the role he dreamed the University of Athens to be playing in Southeastern Europe as a junction point of knowledge's transfer from West to East. Actually it was the role of a regional center, the cradle of the new sciences for the Balkan people. Kalligas wanted to reproduce the situation prevailed during the period of the Neohellenic Revival, when Romanians and Bulgarians were studying at Greek schools. For example the most prominent Bulgarian introducer of the classical physics in Bulgaria Ivan Seliminski (1799-1867), born in Sliven, took lessons in the school of Kydoniai under the Greek teacher of natural sciences and philosophy Theophilos Kairis, between 1817 and 1821. He established a school in Sliven in 1825, and another one in Bucharest in 1831, where he used the Greek language exclusively. Greek was the language he used also for his written works which were translated in Bulgarian much later. Similar was the case of Emmanouil Vaskidovich (1795?-1875) who had as professors the enlightened Greek scholars Neophytos Vamvas and Konstantinos Vardalahos. Vaskidovich also taught Physics in Greek for

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23 *Ibid.* (see note 13), p. 14.
24 *Ibid.*, p. 17.

about 20 years (1824-1846). At the time when the Greek University tried to do its first steps, in Bulgaria appeared the first Bulgarian book of Physics. It was Nayden Guerov's *Survey of Physics*, 1849. In 1869 in Plovdiv was published the second Bulgarian textbook of Physics by J. Grouev ; it was a translation of A. Ganot's "Experimental Physics". Two other books of lower level appeared in 1872 and 1874. Therefore we might conclude that there were available opportunities for the Greek scientists to intervene in the development of physical sciences in Bulgaria and Romania. This was actually one of their aims. But finally they failed to have even the slightest influence on the development of scientific thought in the Balkans. That happened primarily because nationalism in both these neighboring countries had developed, so that Bulgarians and Romanians did not considered it right that Greeks, a nation, in similar financial and political situation to theirs, could rule over them scientifically. Another reason why Bulgarians and Romanians turned their back to Greek scientists was that the needs of their societies could not be satisfied with the expertise that Greeks were able to provide, a knowledge which was not original and remained "poor" in comparison with that supplied by the European centers.

On the other hand, if we take a glance at the situation of the scientific education in the Ottoman Empire we would see that there the situation was rather worse, although systematic and permanent efforts had already started, which gave fruitful results in the beginning of the 20th century. In an article entitled "L' Enseignement en Turquie" published in the *Revue des Deux Mondes* on October 15, 1876, Ernest de Salve described the ignorance of the Turkish people in many sciences and crafts. The first steps towards the improvement of this situation were based on efforts of the French governments. One of the results of this effort was the foundation of a high school in Istanbul (Mekteb-i-sultanisi) where a physics room, a chemical laboratory and a natural history classroom were established for the lectures of these sciences.

Furthermore, Christomanos took great care to supply high schools with instruments of chemistry having in mind to create the necessary conditions for teaching chemistry within secondary education. In Physics the same evolution, although not so fast, can be observed. Stroumbos bought new instruments from Paris whose value was about 4 000 dr., made by the well known firms Dubosq and Ruhmcorff[25]. In parallel, the University gave credit of 250 francs for the monthly salary of a French engineer expert who would undertake the maintenance and construction of physics instruments.

But all the efforts to find the appropriate person failed and the result was rather disastrous as "without such responsible assistant it was not possible to permit the assistant professors to use the instruments as the Senate has decided in many occasions". The University insisted on this practice from the beginning

25 *Ibid.*, p. 18

of the functioning of the Physics department. In his address as Head of the University, M.N. Kostis (1842) noted that:

> "the instruments are used only by the full professor of Physics. For reasons [the professor of Physics] has already explained to the Senate and have been approved, it is not permitted that the assistant professors and lecturers use these instrument, as the Professor is responsible for them"[26].

The positive attitude cultivated by P. Kalligas seemed to be reversed at the time the Head of the University was K. Vousakis (1819-1898):

> "While we are trying to find some space, such as four or six rooms for the practical works outside of the University, we are transferred suddenly, according to Christomanos plans, to real palaces of sciences, as if practical, anatomical or chemical exercises needed brilliant and luxurious buildings" [27].

Vousakis claimed that the cost of the new building for the chemical laboratory was too high, but this argument was proved rather a bad excuse, as another building was bought for 200 000 dr. Therefore, others must be the real reasons for the postponement of the new chemical laboratory building.

In 1873-74 the Head of the University G. Makkas (1818-1905) claimed that despite the efforts for modernizing the instruments, the instruments' collections remained very poor. Makkas considered the government responsible for that situation and argued that one of the results of its policy was that no well-trained scientists could be found in Greece, so scientists from foreign countries had to be invited. That year Stroumbos continued to enrich the "Cabinet of Physics" by buying from France new instruments, mainly for optics, galvanism acoustics and heat. These instruments were of his own choice and he traveled to Paris for that reason. Their value was of about 4 000 dr. These instruments were coming from the firms Dubosq, Ruhmcorff, Koenig, Alvergnat, Decretet, Rousseu etc., that is some of the most famous instruments makers in 19^{th} century Europe[28]. Meanwhile the engineer who was supposed to be responsible for the instruments of Physics and Chemistry at the University and the Pireaus High School finally had been found. The expenses for the functioning of the chemical laboratory were up to about 6 600 dr. Now in this laboratory, besides the students of Medicine and Pharmacy, some students of the Physics Department were doing practical exercise. The students of the first category were 29 and those of the second were 8.

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26 *Ibid.* (see note 6), p. 7.

27 *Λόγος, εκφωνηθείς τη 29 Νοεμβρίου 1871 ημέρα της επισήμου εγκαθιδρύσεως των νέων αρχών του Εθνικού Πανεπιστημίου υπό του πρώην Πρυτάνεως Κωνσταντίνου Βουσάκη*, (Address delivered on November 29, 1871 by the former Head Konstantinos Vousakis), Athens, 1872.

28 *Λόγος Γεωργίου Α. Μακκά παραδίδοντος την Πρυτανείαν εις τον Διάδοχον αυτού κον Παναγιώτην Ρομποτήν τη 17 οεμβρίου 1874*, (Address delivered by Georgios A. Makkas handing over the direction of the University to his successor Panagiotis Rombotis on November 17, 1874), Athens, 1875, pp. 70-71.

But Christomanos never stopped stressing the necessity of the construction of a new Chemical Laboratory which, in his opinion, would also be useful "for the introduction and establishment of the chemical industry in Greece, without which nobody can imagine today the development of trade and civilization to the point reached by the nations cultivating chemistry "[29].

Meanwhile, he did not leave the old chemical laboratory to its fate. Furnishing, supplies of instruments and materials, took so much of his time that, as he complained, he had no free time for original scientific research. Actually, Christomanos published some scientific papers, more than his other colleagues at the University of Athens, but, following the tradition in the 19th century Universities, he gave more importance to teaching than to research. During the following year, 6 students from the physics department and 25 others from the pharmaceutical school were trained in the chemical laboratory. Now Christomanos's disappointment about the case of the new chemical laboratory building is obvious:

> "I did not buy anything for the enrichment of the collections, which, though regularly maintained, are exposed to fatal destruction in the completely unfit room of the chemical laboratory"[30].

During academic year 1880-81, the Head of the University was V. Lacon (1838-1900). As Professor of Mathematics, he was friendly to the natural sciences. Seizing that opportunity, Christomanos submitted once more the plans for the new chemical laboratory building[31].

He spent about 2 500 dr. for buying instruments from Berlin (Schuchart) and Gerlitz (Wormbrunn). Among them was an equipment to prove the laws of Marriot and Gay-Lussac as well as an electrolytic device of his own construction whose production and representation in Europe had been undertaken by Wormbrunn.

Other smaller amounts of money were spent for repairing and maintaining the laboratory instruments, such as that of the Ruhmkorff device, which needed be sent abroad for repair.

Three physics and fourteen pharmaceutical school's students were trained that year (1880-81) in the chemical laboratory.

Prof. Stroumbos continued to enrich the collections of physical instruments, spending 2 000 dr. "to reach gradually the full perfection of the Cabinet of Physics". Stroumbos considered probably that one had to start by acquiring a full series of instruments before the students could be offered the opportunity to use them. During that period, in 1882-83, the building of a modern and according to

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[29] Christomanos *in ibid.*, p. 72.

[30] *Ibid.* (see note 7), p. 83.

[31] *Λόγος εκφωνηθείς, εν τω Εθνικώ Πανεπιστημίω τη ενδεκάτη Ιανουαρίου του έτους 1881 υπό Βασιλείου Λάκωνος*, (Address delivered at the University of Athens on January 11, 1881 by Vasilios Lakon), Athens, 1882.

the European standards chemical laboratory was attempted once again.

For that year, the University budget was 200 000 dr. but the Ministry of Education, based on bureaucratic excuses, did not permit their consumption. The University insisted. In the following year, the Head submitted a modified budget but the government refused once again the proper amount of money. This attitude disappointed Christomanos, who realized that his vision for a University education in Greece comparable to that of the European countries was running the risk of remaining in the sphere of Utopia. In his 1882-83 report about his activities Christomanos wrote:

> "This failure (regarding the building of the new chemical laboratory) disappointed [all people interested in the development of chemistry] and since then any hope to see better days for Chemistry in our country had vanished. So that we did nothing for the enrichment of the Chemical Laboratory".

And in the 1883-84 report he concluded:

> "On You [the Head] and on your paternal care for the Chemistry in Greece depends that these works be not the last ones"[32].

But Christomanos was one of the very few people who had the charisma to transform their utopias into reality. His continuing efforts finally had a happy end. In 1887 the new chemical laboratory was established. A building which was a real jewel for Greece during the last quarter of the 19th century, where the consciences of many generations of students have been formed.

Stroumbos died in 1890, the year when the new chemical laboratory building was given to Christomanos who started working there from the 18th January onwards and paying 40 000 dr. for the furnishing. In this building was also transferred the collection of instruments of Physics and with low expenses a genuine physical laboratory was established for the first time. As Prof. Argyropoulos mentioned himself, thanks to this transfer he was able to invent a new experiment, making visible "the several vibrations of sound generators chords". This experiment was presented at the Academy of Sciences in Paris by the French Academician Prof. Cornu. Argyropoulos seized the chance he had to use the modern facilities of the new Chemical Laboratory and it seems that he was active both in research and teaching. He constructed a dark room, both for his own scientific research and the experimental work done by his students in optics. Twenty-five students made such experiments that year (1890).

In 1890-91 Argyropoulos taught experimental physics for six hours per week and continued doing research. At that time he announced the construction of a device showing that denser bodies do not always have a greater refraction coefficient. Five years later Argyropoulos was in the zenith of his career. He was the first Greek scholar to use X-rays in research and medicine very soon after their invention by Roentgen. He worked also with mobile equipment donated by

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32 Address delivered by Venizelos in 1883-84, pp. 118-119.

the "Times", the well known English newspaper, outside of the laboratory, and did many radiographs for injured soldiers or patients in the hospitals.
The first inventory of the instruments of Physics is published that year, containing 560 instruments of mechanics, optics, heat, electricity and magnetism.

Conclusion

From what has been described in the previous pages it becomes obvious that the introduction of the teaching of the physical sciences at the University level in Greece during the 19^{th} century faced a series of difficulties, related mainly to the political and ideological framework prevailing during that period.

The fundamental ideology which characterized the Greek society during the 19th century was one that preached the creation of a state which could be considered the heir and the extension (continuation) of the ancient Greek civilization, after centuries of alteration from the influence of the Christian spirit of the Byzantine Empire. This ideology actually left the development of the physical sciences outside the scope of the central governmental policy, while the " theoretical" sciences (humanities), such as philosophy, archaeology, theology, developed within a favorable setting.

In this general climate, the development of Physics, Chemistry and Mathematics was based on personal efforts and isolated attempts, which nevertheless gradually achieved some positive results. Results which were far from being sufficient to support the native development of scientific research but which are also of some importance, and therefore must not be totally neglected.

Among the personalities whose action permitted the Physical sciences to gradually gain an autonomous presence in the cultural field in 19th Greece are the chemist An. Christomanos and the physicist Timoleon Argyropoulos.

The first one, working hard to develop chemistry as an applied experimental science, was strongly influenced by the relevant University pattern which he had experienced during his stay in Germany. His Mediterranean enthusiasm, in combination with his "German" sense of methodical work, permitted Christomanos to see his personal "scientific dream" fulfilled : a new chemical laboratory for the University of Athens. Thanks to this Laboratory, which was one of the best buildings of that kind in Europe, several generations of Greek students have been trained in chemistry.

Timoleon Argyropoulos, though a man of lower profile compared to An. Christomanos, also succeeded, though partially, in restoring Physics as a very important science in the conscience of Greek society. He understood that basic scientific research was considered by many people to be a luxury and that it was very difficult to find people willing to provide enough financial support for its promotion. Therefore, he tried to present physics' achievements as valuable and beneficial for society. For that reason he was one of the first physicists who used X-rays for diagnostic purposes in Medicine.

Argyropoulos has been mostly influenced by the French scientific tradition. Besides this fact, his collaboration with Christomanos was very good.

Both, Argyropoulos and Christomanos served their sciences with devotion and they are justifiably recognized as the levers for the development of scientific thought in modern Greece.

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THE CENTURY OF EDUCATION

ISABEL MALAQUIAS

THE INSTITUTIONALISATION OF SCIENCE IN 19th CENTURY PORTUGAL - AN OVERVIEW

The "low-need" of science labels the Portuguese culture till the second half of the 18th century when, in the sequence of Pombal's Enlightened and industrialising policy we assist to the first steps towards a new attitude that will affect the 19th century. In the middle we find a keyword – Progress.

Although we can find important marks of interest in what concerns the new cultural vision, since the reign of King João V, these marks are much more of practical level than of epistemological, philosophical or even educational domain.

The education was then firmly marked by the Jesuits that almost monopolised the secondary and some significant part of the university level too.

In 1755, the Lisbon earthquake, followed by a seaquake, was a most terrible event and the city become almost all destroyed. But this catastrophe enabled a decisive reform of its planning. The new city was conceived in an enlightened way and attention was paid to new technologies of construction. In the pictures that show the city before and after the earthquake, the net of streets is remarkably different and the buildings were rebuilt with some innovations regarding the prevention of earthquake phenomena, special walls against fire and systematic drainage systems were introduced. The Count of Oeiras, that after 1759 became Marquis of Pombal was the great Prime minister of King José I.

After the expulsion of the Jesuits, in 1759, we assist to the enlightened reforms he proposed. He intended to develop education in a new way of understanding the economic, social and political world, framed in the cultural parameters of European Enlightenment and Rationalism. The aim was to create the internal conditions for the development of a scientific elite, in order to surpass the situation of mere importation of foreign competencies. The central elements of the project became the creation of Colégio dos Nobres (College of Nobles) in Lisbon (1761-1837) and the reform of the University of Coimbra (1772).

The College of Nobles was intended to *"construct an educational structure, mostly directed by the State, in order to diminish the influence of the Jesuits"*. In this College were introduced for the first time in Portugal some scientific disciplines in the scholar curriculum: the Mathematics and the Experimental

Physics. The Military and Civil Architecture and Drawing were also considered scientific disciplines, but we will concentrate specially on the first two as we can find on them the foundations of a true pedagogy for a scientific education.

In Mathematics were taught both mathematics and aspects of theoretical physics. The Experimental Physics was based on the observation and elucidation of phenomena in the perspective of a Newtonian physical science, not a scholastic one. The experiment took a relevant place in this context and Pombal took as a special task to find abroad the best teacher for this new discipline. His teaching should be undertaken in a special physical cabinet that was supplied with a lot of instruments, many of them made by the Portuguese instrument-maker J.J. dos Reis. He became the machinist of the cabinet intended to perform the maintenance of the machines. The cabinet contained about 562 scientific-didactical instruments and many of them still exist today. Musschenbroek's course *Elementa Physica* was followed.

The aims of Pombal reform were not achieved immediately after this first attempt, in spite of the good teachers that came for the scientific disciplines – the Italians Brunelli for the Arithmetic, Giovanni Antonio Dalla Bella for the Experimental Physics and Miguel Franzini for Geometry. In 1772, the scientific education was extinguished in the College although it persisted with other disciplines till the second quarter of 19^{th} century. All the instruments and the teachers were sent to Coimbra to the now reformed university.

The spirit that was present to the creation of a scientific education in the College of Nobles is now clearly present in the reform of our oldest university. This one became divided in six Faculties: - Theology, Canonic Law, Civil Law, Medecine, Philosophy and Mathematics. And these last two were institutionalised for the first time. Attached to these new Faculties were created the Physical Cabinet, the Chemical Laboratory, the Natural History Cabinet, the Botanical Garden and the Astronomical Observatory.

The rising of these Faculties in the scientific area retook the orientation of Pombal's reforms: - to implement a new science eminently pragmatic, understood as a central element of a new cognitive system based on rationality and simultaneously, as a privileged way of access to a technological modernity as well as an economic one.

The Statutes of the Reformed University justified the importance of the study of Astronomy and Mathematics in Geography and Navigation; they focussed on the value of the observatories in the knowledge of Earth and they ordered the establishment of an observatory, not only for practical Astronomy, but also for the determination of geographical longitudes and the connection of fundamental elements of Astronomy. In April 1773, the construction of the Astronomical Observatory was started above the ruins of the ancient castle that existed in the town. But in 1775, the work was stopped as there were difficulties with the construction and the surroundings of the place (noisy streets with transit of persons and animals). A transitory observatory was then built in the "Terreiro dos Paços" (i.e., in the university courtyard) inside the old university. In that same year (1775) it was appointed a first director to this institution. The new building was ready in 1799 and the observatory remained there for 150 years.

The Natural History Cabinet was also created in 1772 under the direction of Domenico Vandelli. It became later (in 1885) a Museum of Natural History and was divided in the three sections corresponding to three big areas in these sciences. In the first quarter of 20th century (1911-1913) a new structure gave place to the Annexed Establishments of the University of Coimbra: - the Museum and Anthropological Laboratory, the Museum, Laboratory and Botanical Garden, the Museum and Mineralogical and Geological Laboratory and finally the Museum and Zoological Laboratory. The Anthropological Museum still contains very important ethnographic collections with more than 10 000 pieces, mostly from Portuguese colonies and among these, the best ones are the African and the Brazilian collections. Part of them have been exhibited over the world. The Museum also contains identified human osteologic collections, which have a great international scientific value. One of the aspects that gives particular relevance to these collections remains in the fact that they give basic tools to the identification of each individual.

The Botanical Museum was the heir of all the materials that belonged to the former Museum of Natural History. It contains a big collection of fruits, some of them dried, while others were conserved in alcohol and a considerable and diversified portion of vegetal products, such as resins, gums, fibres, peels, shells, etc. The woods from Brazil and others from ex-Portuguese colonies are also well represented.

The Mineralogical and Geological Museum had as its first director the Italian Domenico Vandelli (1772) and contains a very good mineralogical gallery too.

In the Zoological Museum there exist several important collections of different species and also some specimens that are now extinguished.

In the 19th century, precisely in 1864, it was created a Meteorological and Magnetic Observatory, now the Geophysics Institute. His first director undertook the job of equipping this new institution with observational and measurement instruments similar to those he found in other European countries he visited on purpose. We can testify that the first meteorological daily observations were made in that same year of 1864 and as far as 1866 there were made determinations of terrestrial magnetism in Coimbra.

Vandelli began his classes on Natural History and on Chemistry in 1773 and the building of the Chemical Laboratory was ready by 1778.

Returning back to 1772 we can witness the creation of the first Academy of Sciences in Rio de Janeiro, Brazil, a few years before the creation of the Royal Academy of Sciences in Lisbon. This one was created later in 1779 after King José's death and the dismiss of Pombal. The new Academy was founded under the auspices of Queen Maria I. (The despotism of Pombal marked him negatively and he left his Prime Ministry after the Queen began to reign).

The Lisbon Academy took great relevance in the kingdom as a vehicle of scientific progress founded on utility and applications of modern science. Many members of Rio Academy became now members of Lisbon Academy of Sciences. In there it was created a chemical laboratory, a physical cabinet and special classes for the public. The settling of the Academy was not simple and only in 1833 it took definitively its place. The Academy promoted philosophical tours in the country and colonies, sent abroad many students for special technical and scientific training, published several memoirs, created scientific prizes (to develop agriculture, for instance) and so on.

Other relevant institutions were created in Lisbon in the last quarter of the 18^{th} century – the Botanical Garden to where the most different specimens were sent, the Mineralogical Museum and also a Physical cabinet – all these in Ajuda Palace (the Queen's palace). In the colonies, specially in the biggest one that was Brazil, it was also created a Botanical Garden in Belém, in 1796, and a few years later another one in Rio de Janeiro.

Around 1790, the Portuguese Government was very much interested in the geodesic triangulation of the kingdom following what was going on in France and England. For that purpose many instruments came from those countries to Portugal in order to perform those aims. We were then prepared to accept the new metric system although its systematic introduction was put forward in schools and town halls only in the second quarter of 19^{th} century.

The period comprised between 1807 and 1811 was a difficult one. Portugal was invaded for three times by Napoleon troops, and although they were defeated, the Royal family moved to Brazil. This episode marks the end of Brazil as a colony as now the capital of the Empire was there. In 1816 the designation used by the King was *"The United Kingdom of Portugal, Brazil and Algarves"*, and this measure legalised for practical purposes the end of a colonial tradition.

With the moving of the Court many things were sent with it to Brazil, including some scientific instruments, mineralogical collections, books, collections of natural specimens, and so on. During this same period the French troops took also with them, among other things, many instruments and collections that belonged to the University of Coimbra, for instance, with a particular characteristic: - frequently they led a note registering what they were taking with them.

The settling of the King in Brazil (in 1807) developed the foundation of new institutions, some of them with scientific purposes. When in 1808 the King moved from Bahia to Rio de Janeiro, the city became the capital of an empire of world proportions. And in 1810, the King ordered that all the material that came from Lisbon should be placed in two new institutions – the Royal Library and the Cabinet of Mathematical and Physical Instruments, both in Rio de Janeiro. The

Royal Library was opened to the public (in 1814) daily with the only exceptions of Sundays and holidays.

After the Liberal Revolution, in 1820, the King returned to Portugal and in the same year his eldest son Peter took the Regency of the Kingdom of Brazil. In 1821 Peter proclaimed the independence of Brazil and became his first Emperor. Meanwhile he gave the Throne of Portugal to his daughter Maria, who was still a child. In Portugal there succeed a period of civil war between the adepts of Peter (the Liberals) and his brother Miguel (the Absolutists). Peace arrived after the Constitutional Letter (1822) and we entered the Regeneration Period. From now on we assist to the development of several projects of reform of the country in order to attain modernity and of course education was there. After the revolutionary period we get a more interesting perspective of the reform of education and institutionalisation of science.

Then, in 1823 Mouzinho de Albuquerque introduced his project for a *"General Reform of Education"*. At the time he was president of the Royal Mint where he taught a modern course on Physics and Chemistry. This course was attended by many students, not only those directly interested in the certification of precious metals for the Mint. Some years later, someone wrote the following considerations concerning the political Portuguese affairs: - *"since the political events of 1820 till 1828 we can only find a remarkable event: Mouzinho de Albuquerque's classes"*.

Mouzinho's educational project had some influence from the French scholar system. He also proclaimed some revolutionary intentions such as *"public instruction must be a sacred debt of governments"* and *"people has an undeniable right to demand it"*. In it, he established four kinds of schools:

- the primary schools, then

-the secondary schools[1]

-the Liceums (in a total of nine in the country)[2]

As a final type of school we should have

-the Academies, more precisely three Academies – one in Lisbon, another in Oporto and still another in Coimbra. Each one should be divided in five Faculties, namely the Exact Sciences, the Natural Sciences, Medicine, Law and Arts.

Mouzinho's thoughts were against the existing University of Coimbra and he suggested firmly that the Government should destroy it - *"that vicious institution"*. But his project had no future and his ideas were not representative of the liberal thought as we can register other important statements that were recommending the abolishment of all the ancient institutions namely the Royal Academy of Sciences as people need only to know how to read and count!

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[1] There students should learn Portuguese and Latin, Arithmetics and Elements of Algebra, Descriptive Geometry and Linear Drawing, Elementary Mechanics and Agriculture.

[2] Here the students should learn Greek, French, English, Logic and Retorics, Laws, Natural Sciences, Physics and Chemistry, Geography and History, and this last specially Portuguese History).

Meanwhile during this period there occurred the creation of two new Schools – the Royal Schools of Surgery, one in Lisbon and the other in Oporto, both with a five years course.

Around 1835 there also existed in Portugal many public institutions devoted to the professional preparation of some activities of technical character but, as a Governmental report said – none gave the profit they should do! With this in mind the then minister Rodrigo da Fonseca tried their replacement by a more economic and profitable single institution – the so called Institute of Mathematical and Physical Sciences in Lisbon. Then he proceeded to the extinction of several public institutions as were the Navy Academy, the Academy of Sea Guards, the Academy of Fortification, the one of Artillery and that of Drawing. Also the courses of Physics, Chemistry and Docimasy that were followed at the Royal Mint as well as those on Agriculture and Botanics given at the Botanical Garden of Ajuda and the course on Commerce (Trade) were extinguished. All these studies should now be undertaken at the new Institute of Mathematical and Physical Sciences that was organised as a Modern University in five special schools that were similar to faculties. These were: - the Civil Engineering School – with a five years course; the Military Engineering School – also with a five years course; the Navy School – with a three years course; the Pilotage School – with a two years course and the School of Commerce – with a three years course.

The Institute had 24 disciplines and some of them were common to the different courses.

In the same Governmental decree it was intended the creation of Liceums that should make the transition between the primary schools and the higher education to which the above mentioned Institute belonged. But soon Rodrigo da Fonseca had to abandon the Government as many susceptibilities were hurt in Coimbra.

The above mentioned Mouzinho de Albuquerque replaced Rodrigo da Fonseca in the Government and took the suspension of all the decrees related with the reform of primary education and the creation of the Institute of Mathematical and Physical Sciences. We must remember that Mouzinho's course on Chemistry at the Royal Mint was suspended too!

We were able again to assume our incapacity of making the progress of the country !

When Rodrigo da Fonseca was proposing his reform project (in 1835), there was also a public presentation of another one called *"Law Project of Organisation of the University in Portugal".* This later was signed by Dias Pegado, a Mathematical professor in the Navy that had been exiled in France where he taught Mathematics in Brest. He was well acquainted with the pedagogical reforms of Napoleon. His project had many resemblance with the one Mouzinho presented twelve years before (in 1823). But taking into account the title of Pegado's project we are left to suppose that the University was only his main focus, which in fact was not true. It referred also to the other institutions that were included in the public instruction system. In his project there were six main groups (while that of Mouzinho's contained only four). In these we can find: - primary schools; secondary schools; Liceums[3] (when the student ended the Liceum he got a Bachelor Degree in Arts that was the main condition to enter a higher education); Seminars (training schools for priesthood); Faculties[4] and then the Special Schools. In these last ones were inserted Fortification and Artillery that took the way of Engineering, the Naval School and the Pilotage School, Pharmacy, Commerce, the School of Arts, the School of Arts and Crafts and the Military and Regimental Schools.

This was a well-conceived large project. We can probably assign some influence of this project in the big reform that the minister Passos Manuel undertook (1836 and on).

Another Mathematician, but this one from the Royal Navy Academy, conceived a project to reform the Public Instruction in the same period (1836). In there he conceived a new and modern University to be settled in Lisbon, the capital. In this University there should exist the teaching of Sciences, of Arts and Liberal Arts. This was a big attack to the hegemony of the University of Coimbra. He also was a radical and wanted to move all the higher education from Coimbra and concentrate it in Lisbon. He only admitted the existence of the Medical faculty in Oporto.

During the 19^{th} century some attention was paid to technical education, namely in the north of the country where some institutions were created in Oporto. They had their origin in the proposals of Oporto Industrial Association. Then we can find the Industrial School of Oporto (Escola Industrial Portuense), whose orientation was to combine harmoniously practical and theoretical knowledge. It was a secondary level school and its model was the British one. It was organised around the idea of workshop as a place of apprenticeship – it integrated the idea of "shop-culture" and this will be the main model of our intermediate technical level. The importance of hands and eyes, the importance of doing, emphasised by a vision of the relationship between scientific knowledge and practical application, which is close to Bacon's theories, are paradigmatic elements in the definition of the objectives and internal structures of technical courses, after the second half of 19^{th} century till the middle of 20^{th} century.

In this school there existed a library, a chemical laboratory and three cabinets: - one for Natural History applied to the Arts; another for industrial

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[3] with the same disciplines that were taught in the secondary ones plus Greek, English, Logic, Retoric, Elementary Physics and Chemistry.

[4] In these we will have Arts, Theology, Jurisprudence, Exact Sciences, Physical Sciences plus Medecine and Surgery.

physics and mechanics and still another for models intended useful for drawing, stereotyping and building. There also existed six workshops intended for – carpentry of moulds and constructions, turners (persons who worked with the lathe), forgers, the art of casting metals, the work of metals, dyeing and stamping.

By 1854, regular courses were opened at Oporto Industrial School and those of the Industrial Institution in Lisbon too. In both cases they maintained the didactical project formerly established by the Oporto Industrial Association.

In 1855, there existed 333 students in Oporto and from these, 294 were connected with industry. In the same year, there were 402 students in Lisbon and 6 of them were intended to follow mechanical engineering.

As many difficulties were displayed against the creation of scientific high level courses in Lisbon, difficulties that arose from those that were connected with the civil higher education, we assist to the creation of the Polytechnical School, in 1837, under the support of the Ministries of War and Navy. This Polytechnical School was an institution intended for the preparation of military staff that needed a scientific base. Then, there were found four courses with that purpose and also a fifth one – a General Course – where all the subjects that were given in the School were present. This last course was explicitly devoted to the preparation of technico-scientific professionals for the civil society.

After 1855, the Polytechnical School became reformed and got free from its military component and directed itself to the practice of scientific courses. This was a modification at a pedagogical and epistemological level towards a much bigger interrelation between theory and practice. The Polytechnical School was settled in the same place of the extinguished College of Nobles. The new mentalities that emerged from the liberal revolution tried to put Portugal in the 19^{th} century modernity. The scientific activities of the Polytechnical School were completed with the following cabinets and Annexed Institutions: - Physical cabinet, Natural History cabinet, Chemical Laboratory as well as a Meteorological Observatory (created in 1853 by the King and whose first director was Dias Pegado who teached Experimental Physics and Mathematics), an Astronomical Observatory (created in 1875) and a Botanical Garden.

The Botanical Garden and the Natural History Cabinet of the Polytechnic had its former origin in the Royal Museum and Botanical Garden of Ajuda Palace that had been created in 1792. Lately, these two institutions integrated the Nacional Natural History Museum.

In 1836, the remaining collections of the ancient Ajuda Museum were incorporated in the Museum of the Royal Academy of Sciences in Lisbon. After the creation of the Polytechnical School, a year later, they entered this last institution.

In what concerns Oporto, there flourished the Polytechnical Academy that maintained a course similar to the one from the Lisbon school. The list of disciplines as well as the curricula were similar, although taught with less development. Progressively it will assume a clear direction towards the specific sense of engineering, differing then from the Polytechnical School of Lisbon. This last one would be connected with the scientific courses mainly.

We can also try to visualise the institutionalisation of science in Portugal, in the second half of 19th century, through distinct families of scientific and cultural periodicals: medical and pharmaceutical ones; those devoted to agriculture and agronomy; those concerned with physical, mathematical and natural sciences (including biology); those of a cultural and scientific purpose connected with institutions. We will consider only to the last two categories in order to visualise some level of scientific communicability. Then we can try to establish a direct connection between the existing institutions – the place of a scientific born community – and the scientific and cultural journals that adapt, (re)product what the *"big European science"* tells and spreads. When establishing a connection between persons and collectivities we obtain different domains of legitimacy of the knowledge through the language, the discourses and real and artificial images of Science, in both internalist and externalistic levels.

When looking to the localisation and mobility of the members of our Portuguese scientific community we can find some processes of discourse in the following institutions: - the Academy of Sciences in Lisbon; the Polytechnical School in Lisbon; the Geography Society in Lisbon; the University of Coimbra; the Polytechnical Academy in Oporto and the Municipal Museum in Oporto.

To have a general view of what was going on in the second half of 19th century we refer to a scientific periodical that was conceived and done as a complement to the sociability of the University of Coimbra – its name was "O Instituto" (1852). In 1857-1858, we have the "Annaes das Sciencias e Letras"[5], published in Lisbon under the permission of the Royal Academy of Sciences. During 1816-1918, the same Academy published the "Jornal das Sciencias Mathematicas, F_sicas e Naturaes". The beginning of the sixties in 19th century gave us a novelty – the desire of showing Chemistry as a autonomous science. And by 1861, born the "Boletim de Chimica Applicada à fabricaç_o de productos chimicos, às artes; à agricultura; à hygiene e medicina; à pharmacia; à economia doméstica" [6]. It was published under the protection of the Industrial Institute of Lisbon.

Although there were big efforts in the sense of sedimentation of a technological and industrial culture, the true results were still far away from the desirable by all the different reforms. It is very clear the low level of instruction of the working classes and that reflects on the capability of an evolution of the technological structure itself.

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5 Annals of Sciences and Arts.

6 Bulletin of Chemistry applied to the production of chemicals, to the arts; to agriculture; to hygienics and medicine; to pharmacy; to domestic economy.

In what concerns the scientific and technological education Portugal is in a non-continuous way of accumulation of knowledge, but we can find some conjectural developments that are conditioned on political attitudes or economic necessities:

in 18^{th} century – the Enlightened despotism of Pombal gives permission to a first outbreak of scientifically structured activity;

in 19^{th} century – the Liberalism and Regeneration periods when trying to develop the Portuguese industry, produced the bases of a scientific and technical education that will serve as a model to Republican period and to the thirties and fourties of Estado Novo in this century, even with different epistemological attitudes.

GEORGE N. VLAHAKIS

SCIENCE AND SOCIETY IN 19th CENTURY GREECE: THE JOURNALS

During the second half of the 19th century, at a time when in Europe the popularization of science had been acknowledged as a serious enterprise by almost everybody, and journals devoted exclusively to that aim, such as *The Popular Science Review, The Quarterly Journal of Science,* and naturally, T.H. Huxley's *Nature,* had already appeared with great success, a similar spirit governed those engaged with sciences in late 19th century Greece. This spirit was very vividly described by Huxley as a great spiritual stream having railways, telegraphs and printing presses instead of ripples and bubbles.

Compared with European countries we may claim that in Greece we had a reservoir-like science where almost all the new scientific theories were instantaneously received and accepted, but the appearance of original scientific products (ideas, theories, experiments, instruments) was restricted to a minimum. Greeks showed always a preference to be engaged with history and philosophy of science rather than science itself, though for the Greeks, be they from the high or the middle class, science was a respectable practice. A practice closely associated with other social activities and having the following particular characteristic: that science's results could improve, materialistically or spiritually, the life of the new state's citizens, who, in return should recognize publicly the benefits of science. Therefore, it is not a surprise that many relevant articles appeared in several Greek journals during the period under consideration.

As the situation was not yet mature enough, with the exception of medicine and agriculture for which special journals were published, the main effort for the popularization of science in Greece took place through journals of wider interest, that is journals addressed mostly to educated but not specifically knowledgeable readers.

In this brief survey we will concentrate our study on three of the most prestigious journals of that period, namely *Estia, Pandora and Parnassos.* Other ephemeral series, such as *Eptalophos, Athinaion etc.* are omitted in this short analysis, although it may be interesting to compare the contents appeared in journals that failed to have a long-lasting existence with those of the journals that finally succeeded in having a relatively long period of publication.

Estia was a weekly magazine published every Sunday from 1876 to 1895. Among editors were several Greek scholars, such as Pavlos Diomidis (1876-82), Georgios Kasdonis (1883-88), N.G. Politis and Georgios Drosinis (1889-90), Georgios Drosinis (1891-94), G. Xenopoulos (1895). After 1895, *Estia* altered to a daily newspaper which is still published.

Pandora was a fortnight publication self-characterized as "historical and literary", published by A.R. Ragavis, Konstantinos Paparigopoulos, N. Dragoumis, from April 1850 to April 1872.

Finally, *Parnassos* was a monthly journal published from 1877-1895 as an organ of the homonymous philological society.

To consider a journal as "organ" was a common practice in 19^{th} century Greece, reflecting probably a similar European tendency. It is known for example that in Victorian England and elsewere in Europe, many popularizing scientific journals were caracterized as "organs".

Though a superficial overview of the three journals does not reveal remarkable differences regarding the criteria and the standards of the articles relating to science, we may proceed to the following remarks.

The first one has to do with the fact that all three journals had a continuous publication for about twenty years, something very unusual given the social and economic circumstances of the 1850s to 1900s, not only in Greece but in Europe as well.

Secondly we would like to deal with the professional identity of the editors. None of them can be considered to be a scientist even in the wider sense of the word. G. Drosinis and Gr. Xenopoulos were well-known men of letters, Al. Ragavis was archaeologist and diplomat, K. Paparigopoulos the most important Greek historian of the 19^{th} century, Nik. Dragoumis was historian and journalist, Nik. Politis a famous researcher working on Greek popular songs, Pavlos Diomidis and Georgios Kasdonis were journalists.

This fact shows once again on the one hand that the editors were open-minded, on the other hand that science had become a really important and difficult to ignore factor in Greeks' intellectual community life.

A third observation is that all these journals emphasized mechanical inventions and industrial processes as science was supposed to be useful to industry and the state.

As during the second half of that century Greek engineers were not enough to fulfill the needs of the country it was not difficult for scientists through their articles to promote a definition of science establishing clear barriers between science and technology while, at the same time, they argued that science was the foundation of technological progress. Through this view, scientists and especially university professors tried to form the public opinion in favor of their efforts for more governmental financial support in order to develop teaching and research facilities. A typical example was the Chemical Laboratory at the University of

Athens, which despite the many difficulties arson by certain intellectual circles was finally built on plans based on German standards. On the other hand, most of the scientists, having in mind very unfavorable experiences of the recent past, did not want to confront with the official church. Therefore, they tried, using very elegant expressions, to make clear that science was essentially different from religion. As at the time of the *Origin of the Species* the implications of science for religious belief became a maim point of public interest, several Greek scientists preached the "incommensurability" thesis, putting science and religion in two entirely distinct realms.

Another particular characteristic of the Greek journals was that with few exceptions, they were not used by the members of the scientific community as means of their communication. The Greek journals were used by the scientists mainly as a tool to achieve social distinction.

We should note also another difference from the situation that was prevailing in Europe. There flourished the amateurs' contributions in writing interesting articles on several subjects, especially on Botany and Astronomy. That did not happen in Greece, probably because the University professors created a climate of scientific orthodoxy, a climate that considered science a too serious matter to be undertaken by amateurs.

The majority of the contributions were signed, even when they were translations of foreign-language articles or reports on new inventions. Usually the only unsigned pieces were the short news that were appearing in the regular columns.

This situation proves once again that contributors used their publications in these journals not only to popularize science but to make themselves popular too.

Pandora

In *Pandora*, the earliest of the three journals, we mostly find articles related to education, natural history and medicine.

Articles regarding natural history could be divided into those referred to Botany and those dealing with Geology. In the first group belong the articles, which described several plants, used for gardening, in the second one articles on earthquakes, volcanoes and mineral waters' springs.

Of particular interest is a series of articles written by Joseph de Kigallas (1812-1886), a medically trained contributor to natural history topics (Kigallas was also a regular correspondent of French and Italian journals on natural history topics), particularly articles about children who were born with serious defects. We keep in mind the following titles:

On Monsters, vol. 5, 1854, p. 269.
About a twin monster, vol. 5, 1854, p. 355
On a mishapenned baby, vol. 5, 1854, p. 490.
Giants and dwarfs, 1858, p. 474.
On Siamaean children, p. 185.
The Wolfman, 1866, p. 115.

There were also some articles concerning astronomy written mostly by the Director of Athens Observatory, the German astronomer Julius Smith, or his assistant Dimitrios Kokkidis.

Very few were the articles concerning Physics and Chemistry, as they demanded both more serious contributors and more advanced readers. That happened only during the last quarter of the century, since the teaching of physics and chemistry entered seriously the secondary education not earlier than the 1860s.

One of the articles about Physics described the principles and the significance of spectral analysis. The author referred to the efforts of Norrman Lockyer and Janssen to find the spectrum of the solar corona, as well as to the spectroscopes constructed by Huggins and Secchi (Pandora, 1871, p. 470-475).

From the first period of the journal, in 1854, we read a short notice on a new microscope constructed by a German professor at the University of Koeln, Assert, which could magnify an object up to 4000 times.

We conclude this short survey on the articles of Pandora, which had a scientific attitude by mentioning an article having the peculiar title: "Chemistry heals arrogance". This is actually a description of an event concerning a baron in Germany who sent his blood and the blood of one of his servants to Klaproth to analyze them and find out if the first one was of better quality. As Klaproth answered that there was no difference in both samples, the baron was convinced that there is not any natural superiority of the nobles compared to the working class people. Though from a scientific point of view the article could not be considered significant, its publication in a journal of that kind proves that according to the Greeks science could not be used for claiming social hierarchy. It proved that science should belong to everybody and not just to few people having the power of money or the nobility.

Parnassos

We will start the short presentation of *Parnassos*' scientific articles by presenting a piece of similar attitude, entitled " Morality is improved by physical sciences". Through the historical account of facts, such as the prohibition of teaching Aristotelian natural philosophy at the University of Paris by Pope Innocent the third in 1215, the author condemns Church's practice to intervene in science. He concludes that:

> "In the study of physical sciences there is the basic principle that the progress in Nature is governed by a universal law", or "Nothing ever moralized humanity so much as the study of the physical sciences".

Comparing with *Pandora*, we met in *Parnassos* significantly more articles concerning sciences. Though natural history and astronomy articles continued to appear, they were no longer the majority. This detectable shift to physical sciences reflected also a similar trend in the academic community and the public interest. In *Parnassos* there were standard columns where interesting news were published concerning Geography and Travels, Technology and Science, Meteorological observations.

In the columns of Geography information was given about the expedition of the famous travelers of the 19th centuries towards the North Pole or the African interior, information that naturally provoked the imagination of the readers.

In the column "Technology and Science" the emphasis was put on the new inventions which had practical usefulness such as the telephone, as well as on publications of Greeks in foreign scientific journals.

In the column of the "Meteorological observations" appeared regularly statistical data for parameters like atmospheric pressure, temperature, rain and wind, given by the National Observatory of Athens which had already established a network of meteorological stations. The Director of the Observatory seized the opportunity to prove that at his institution not only pure astronomical research was taking place but also a number of activities with direct usefulness to the public were engaged.

Let us now look at two of the articles in detail. These articles presented in extenso important scientific discoveries of the 19th century.

The first one deals with the liquefaction of the gases, which constitute the atmospheric air, by Cailletet in Paris and Pictet in Geneva. The relevant experiments were described by the most prominent physicist of the 19th century in Greece, Timoleon Argyropoulos. The epilogue of the article reflects perfectly the ideological framework concerning the scientific development in the new Greek state, a framework which was undoubtedly Baconian. We read:

> "These marvelous discoveries should be considered for the moment of exceptional significance from purely scientific view and not from practical or industrial consideration. It is probable that in the future they will have their applications".

The second article is about the kinetic theory of gases. In the first paragraph, is given in a very definitive way the general spirit of physics and chemistry in the 19th century, a spirit formed by the German naturphilosophie and the mechanistic "image" of the world:

> "According to all recent research it seems that not only chemistry but all the sciences are governed by a simple mechanical law".

In this article one can read the contributions of Vant Hoff and Van der Waals to the final form of the theory. The conclusion confirms the prologue:

"From the above research, and the discoveries of the French physicist Rohault, it seems that chemistry and physics constitute a single science".

Other articles of particular importance were those concerning the formation of the earth and the Darwinian theory of evolution. Darwin's theory became a subject of deep interest not only within the small Greek scientific community but also within the society as a whole, as the critical question was: is theory compatible with the Christian dogmas?

In *Parnassos* we find also extensive descriptions of the scientific inventions (or were they technological innovations?) of the era: the Bell's telephone, the Edison's phonograph, the Hughes microphone for which it was noted that it will be used in acoustics as the microscope was used in optics, and the electric lamp.

Estia

Estia had a parallel evolution with *Parnassos*. Therefore, it is natural that the articles about science are on similar topics.

The telephone, the phonograph, telegraphy, electrical applications on the one side, earthquakes and volcanoes on the other are the "classic" contents of *Estia*.

Charles Darwin is also present through the articles of one of his supporters in Greece, the professor of Botany in the University of Athens, Spyros Miliarakis.

One of the novelties that introduced Estia was a series of biographical sketches of famous scientists under the title "the Martyrs of Sciences", written originally by the famous French popularizer of science Gaston Tissandier and translated by one of the most brilliant Greek women in the late 19th century Greece, Eliza Soutzou (We jump at the chance to open a parenthesis containing a short comment on the place of women in 19th Greek University. Let us note that just before the end of the century, the first female students entered the University, one of them in the Physics Department. Most of them after their graduation worked as teachers in high schools). Is it a coincidence that during that time the national Greek poet Kostis Palamas published under the same title "Martyrs of science" -in *Parnassos*- a poem praising the role of scientists to the social development ?

Conclusion

We have avoided giving quantitative data, which sometimes create distorted pictures, if they are not analyzed properly.

We considered convenient to restrict ourselves to a brief sketch of the scientific subjects, which were published in the three most influential Greek journals of the 19th century in order to form an opinion of the way popularization of science was made.

Knowing the general role of these journals in the intellectual life of that period we may argue that finally their influence in the acceptance of science as a considerable social component was not negligible.

As there were not specialized scientific journals in Greece, sometimes the publications we have referred to were the only channels of dialogue on subjects which even in Europe were at that time at the peak of the scientific interest, such as the theory of evolution.

A common characteristic of all the publications was that they referred to recent facts. Despite their low "productivity"l once they came back to Greece after having studied abroad, Greek scientists were knowledgeable, in a good extent, of the topics of their field of interest.

The absence of mathematical analysis, which could be expected from articles aiming at the popularization of science, does not reduce the scientific accuracy of the writings. But in connection with a relevant persistence to the "qualitative" (non mathematical) approach of science which was also to be found in more serious essays or books in Greece during 19th century, Greek scientists gave credits to those scientists in Europe who, influenced by the Romantic movement, continued being committed themselves to a non "mathematized" science. In opposition with the prevailed current in Europe, that of full mathematization, the Greek conception of science was that of a science of the philosophical argument.

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I would like to mention gratefully Ruth Barton of the University of Auckland, whose ideas and discussion on 19th century popularizing journals in Victorian England were truly inspirational.

YANNIS KARAS

LES CRITIQUES DE PAVLOS KALLIGAS CONTRE THÉOPHILE KAÏRIS ÉTAIENT - ELLES UN MALENTENDU ?

Je vais me concentrer, et forcément vous aussi avec moi, sur une critique de Pavlos Kalligas, une " analyse ", de surplus " impartiale ", comme il le dit lui-même, qui fut initialement publiée en 1851 dans la revue *Pandore*, et, par la suite, en 1899, dans le second tome de ses *Études* ; C'est là que, en moins de sept pages il essaie de remanier, de critiquer, ou, plus exactement, de vilipender deux œuvres, sans arriver à persuader qu'il les a lues, du moins en profondeur. Ces œuvres, parmi les plus importantes de la Renaissance Néohellénique, sont la *Gnostique ou bref exposé des connaissances humaines* (*Γνωστική ή των του ανθρώπου γνώσεων σύντομος έκθεσις*), publiée à Athènes en 1849, et les *Éléments de Philosophie* (*Στοιχεία Φιλοσοφίας, ή των περί τα όντα γενικώτερον θεωρουμένων τα στοιχειοδέστερα*), Athènes, 1851 ; elles totalisent 220 pages, et leur auteur est Théophile Kaïris, savant, combattant, celui qui a marqué la pensée scientifique et philosophique néohellénique, " la figure la plus universelle de la nouvelle Grèce ", d'après le Professeur Vassilis Tatakis.

Dans un passage de cette critique, Pavlos Kalligas se demande s'il est juste de s'occuper de la philosophie de Kaïris et même, de la considérer comme un " cheval de Troie. "

En renversant les termes et paraphrasant le texte, nous pouvons de même nous demander s'il est juste que cette critique de Kalligas soit matière à controverses. Mais la période sous laquelle cette critique a vu le jour, le contexte culturel et surtout politique dans lequel elle est placée, et aussi l'effort déployé dans ce Colloque pour l'étude et la discussion de certains pans de la pensée politique et philosophique du 19ème siècle, font que nous devons nous pencher avec attention *aussi* sur ce texte. Il constitue la contribution de l'auteur, contribution publique, active, avec des extensions politiques, à l'intense débat qui avait éclaté dans le milieu de ce siècle, à propos de Théophile Kaïris.

Soulignons le symbolisme : sur la place centrale d'Hermoupolis à Syros, où se déroule notre Colloque, veille le buste de Théophile Kaïris !

Chaque chose en son temps. Tout d'abord, posons les questions en attendant des réponses brèves : Qui est la personne jugée, quelle est son œuvre ?

Théophile Kaïris est né à Andros en 1784. Au début du siècle suivant, il se trouve à Pise. En 1807, il est à Paris, où, comme le note son biographe, avec

" passion d'esprit insatiable ", il complète en quatre ans ses études et entre en même temps en contact avec les idées des Lumières, françaises et plus généralement européennes, mais aussi avec celles de la Révolution française. Il rentre en Grèce en 1810. D'après Alexandre Soutsos, " il se signalait par ses qualités rares et ses vastes connaissances. " En 1881, K. Bleziotis ajoute qu'il " était considéré comme le plus éduqué jeune homme de la nation en Orient. " Il enseigne aux collèges de Kydoniès, de Smyrne, puis encore à Kydoniès, où il se concentre sur la vulgarisation des nouvelles connaissances scientifiques. C'est pendant son séjour que son collège (l'Hellènomousseion) atteint l'apogée de sa gloire, avec une imprimerie, une bibliothèque de 700 à 800 volumes, des instruments astronomiques et scientifiques. Quand sonne le tocsin de la révolution grecque, il se trouve à l'avant-garde du combat ; il est blessé lors de la révolte de l'Olympe. Il est élu député à la première Assemblée Nationale, et quand Capodistrias débarque à Égine, en Janvier 1828, Kaïris s'adresse à lui et lui demande de gouverner " afin que la Patrie ressente, que nous autres comprenons, que l'Histoire impartiale répète, que tous les siècles résonnent le fait que ni Toi, ni Ton fils, ni un ami à Toi, ni l'esprit de clan, mais en vérité la loi de Dieu elle-même, cet droit, les institutions de la Grèce gouvernent le pays à travers Toi. "

Avec des mots simples, il donne à Capodistrias une leçon de gestion démocratique, de la même façon que, plus tard, en 1835, il rappellera à Othon, dans la lettre où il refusait la croix d'Or du Sauveur, que son devoir était de gouverner constitutionnellement. Là, il écrit que " ...la nation hellénique a trouvé en Toi, Souverain, celui qui veut et peut garantir son indépendance et son bien-être, avec ses institutions constitutionnelles [...] que personne ne peut outrepasser sans sanction. "

Retenons ces deux prises de position, ces deux expressions d'un esprit intensément libéral, car c'est à elles que nous reviendrons quand nous chercherons les raisons, les véritables et profondes causes de la persécution de Théophile Kaïris. Persécution sans pitié, où tous les moyens furent utilisés, avouables ou non, et à laquelle Pavlos Kalligas a contribué.

Mais continuons un peu à dérouler le fil de l'histoire.

Il y a dans la vie de Théophile Kaïris des lignes droites, mais aussi des articulations. Une de celles-ci est l'année 1835, pendant laquelle il fonda à Andros, l'île dont il est originaire, l'orphelinat qui fut inauguré quelques mois plus tard, en janvier 1836, et ferma ses portes fin mars 1839.

L'orphelinat, dans lequel il rassemble des enfants de combattants, est une institution moderne avec des salles d'enseignement spacieuses, une riche bibliothèque avec plus de 1340 œuvres, en 2348 tomes de différents langages européens, et des laboratoires de physique et de chimie, bien fournis en instruments scientifiques spécialement amenés d'Europe. D'après *Pandore*, c'est là que l'on rencontre la " première collection d'instruments constituée en

Grèce. " De même, le premier télescope venu en Grèce. Quant à Théophile Kaïris, selon un témoignage de Firmin Didot, il lisait avec sa sœur Evanthia, pendant ses heures d'oisiveté, les équations transcendantales et les sections coniques de Newton.

Othon avait envoyé à Andros son conseiller Christian August Brandis, philosophe allemand et professeur à l'université de Bonn, pour observer l'enseignement à l'orphelinat, resta " bouche-bée ", selon l'expression du journal *Clairon Évangélique* (*Ευαγγελική Σάλπιγξ*), devant l'éloquence, mais aussi l'esprit libéral et novateur de Kaïris, lequel, dit-il, " honore toute la nation hellénique et doit être respecté par toute l'humanité. " Il avait même émit l'opinion que " si Kaïris enseigne encore pendant trois ans, le roi Othon devra quitter la Grèce. "

Retenons aussi cette déclaration, en association avec le moment où elle est faite, 1839, l'année de la fermeture de l'école. Elle nous sera utile rechercher les raisons de la persécution de Théophile Kaïris.

L'instant où Othon envoie son conseiller à Andros n'est pas une coïncidence. La guerre contre Kaïris a commencé, encouragée par certains entourages du Palais, mais aussi ecclésiastiques. Le Saint-synode, selon son propre Secrétaire Théoclète Farmakidis, était constitué de personnes " pour la plupart ignares et totalement incultes et donc méprisant l'éducation ", de personnes " grossières, incultes et rustres, de naissance et d'éducation ", qui ne doivent ce qu'ils ont obtenu " qu'uniquement aux circonstances, et à aucune autre vertu ", qui " ont peur de l'éducation " ; ce Saint-synode ne pouvait rester insensible à l'esprit novateur du maître et à l'abondant contenu philosophique et scientifique de son enseignement. Ces personnes ne peuvent pas oublier que Kaïris, qui était un fidèle chrétien orthodoxe, leur impute que leurs actions ne concordent pas avec leurs paroles, et c'est pour cela qu'il prône le contact direct entre l'homme et Dieu, sans intermédiaires, avec la théorie de l'amour de Dieu.

La guerre contre Kaïris, connivence entre le Palais et l'église, revêt des formes de plus en plus intenses. Les conservateurs se battent fanatiquement contre les idées novatrices de Théophile Kaïris. Il est accusé d'être " hypocrite, menteur, dépravé, antéchrist, matérialiste, athée, panthéiste, déiste, luthérien, calviniste ", de prôner l'existence d'êtres doués de pensée dans certains corps célestes, opinion que Kaïris lui-même ne désavoue pas, sans qu'il ait été le premier à la formuler. Avant lui, Rigas Feraios, Constantin Vardalachos, Benjamin Lesvios, Dimitrios N. Darvaris, Panagiotis Kodrikas, Iosipos Moisiodax et autres.

Adamante Coray écrivait à Dorithéos Proios, en se référant au contexte social de la condamnation, du côté de l'Église mais aussi de la théorie héliocentrique : " Ce qui les échauffe contre la théorie du mouvement de la terre n'est pas leur zèle chrétien, mais ils ont peur que la révolution de la sphère n'émeuve et ne renverse la considération qu'ils ont acquise sans mérite. "

Selon Spyridon Komninos, président de la cour de Cassation d'Athènes, l'Église essayera " de dompter l'esprit novateur dans la science, la politique et l'Église elle-même, et, ayant échoué, réagira terriblement contre l'esprit, en organisant la police des consciences. "

Quelle vérité est recelée dans les paroles du Maître, d'Adamante Coray : " Avant de conseiller la correction d'œuvres faussées, il faut prévoir la guerre inévitable que mèneront ceux dont l'honneur et le bonheur dépendent de la fausseté. " Kaïris n'avait pas compté sur cette guerre ; il ne pouvait prévoir ni l'intensité qu'elle prendrait ni les moyens qui seraient utilisés pour le discréditer.

On exige de lui une déclaration de foi, il est expulsé du sein de l'Église, voué à l'anathème éternel, et le Palais, lequel n'a pas oublié l'altière position de Kaïris contre Othon, ordonne Canaris, amiral de la flotte royale de l'Égée, de l'arrêter et de le transporter à l'île d'Égine pour l'enfermer, après une procédure sommaire, dans un monastère. La décision produit une mauvaise impression et de graves réactions de la part de la société grecque. Théoclète Farmakidis écrit qu' " il y eut moult fracas et bruit, les gens furent divisés. " Des incidents sont probables. Canaris est de nouveau ordonné à escorter Kaïris, comme un vulgaire prisonnier, dans un monastère de l'île de Skiathos, où il est remis " contre reçu " ; de là, il ira en déportation. Vassilis Tatakis écrit que " le gouvernement et le Saint-synode, qui n'avaient soupçonné ni la grandeur morale du personnage, ni la leçon supérieure qu'il leur donnait, raisonnèrent comme les pachas turcs. Kaïris, après tout ce qu'il avait enduré, avait le droit de se renier, de céder une déclaration de foi ; en d'autres termes, de se transformer de pur en corrompu, d'ami de la vérité en traître de celle-ci. En tant que tel, il pouvait rester en Grèce, mais non en tant que Kaïris. "

C'est dans cette ambiance que nous venons de décrire très sommairement, et, plus généralement, pendant une époque où, par dépit, la population de la Grèce qui est libérée des Turcs, désigne l'époque pré-révolutionnaire comme " le bon temps ", que Pavlos Kalligas publie sa critique des deux importants ouvrages de Théophile Kaïris. Il veut évidemment se poser comme l'homme de lettres qui " anéantit " Kaïris, non seulement en tant que meneur de secte, comme l'Église l'avait accusé, mais aussi en tant que philosophe.

D'ailleurs, nous savons qu'il avait été licencié de l'Université, après deux ans en tant que professeur honoraire, et qu'ainsi, après la mort de Colettis en 1847 et la constitution du nouveau gouvernement, il est confronté au problème de son statut social. Ce n'est pas un hasard si, pendant cette même année, il est nommé vice-procureur à la Cour Suprême, position qu'il conservera pendant quatre ans, de 1851 à 1854. En ce qui concerne ses ambitions philosophiques plus générales, nous retenons le fait que peu après sa critique de Kaïris, il publie, toujours dans la revue *Pandore*, une critique de l'ouvrage du philosophe Petros Vrailas Armenis *L'essai sur les idées et principes premiers* (*Δοκίμιον περί των πρώτων ιδεών και αρχών)* ; là, bien qu'il admette que cette œuvre constitue " un grand acquis et un nouveau monument de la pensée grecque renaissante ", il la critique, mais avec de nombreuses confusions en ce qui concerne des notions philosophiques comme le temps, le lieu, la causalité, l'intuition, et ceci, malgré que, de son aveu, il ne connaisse pas tout le système de l'auteur. Un peu plus tard, dans cette même revue, on pourra lire une autre critique, positive cette fois-ci, de l'ouvrage *Mémoires pour servir à l'histoire de mon temps*, de François Guizot, historien et politique, ennemi de toute réforme, où est répandu un esprit conservateur et contre-révolutionnaire. Là, la Révolution Française est traitée de la pire tempête qui ait secoué toute l'Europe, ébranlé des convictions et étranglé la liberté. Les révolutions, celle de 1789 et celle de 1848, sont considérées comme des actions violentes, qui ont amené l'anomalie ; Guizot parle des interdictions et des mors dont a besoin l'humanité afin que les bonnes tendances surpassent les mauvaises.

Nous avons abordé de manière concise les étapes principales de celui qui est jugé, de Théophile Kaïris, en essayant de les placer dans leur contexte temporel. De la même manière, nous avons vu les persécutions dont il a été victime.

Nous sommes en 1851, année de publication de la critique de Pavlos Kalligas. C'est la période pendant laquelle tous les censeurs de Kaïris " le voyant pieds et poings liés, la bouche scellée, l'attaquent sans pitié et le torturent de mille façons ". Cette phrase apparaît, la même année, dans une réponse à la critique de Kalligas, où l'auteur (S. Glafkopidis) reste, pour des raisons évidentes, anonyme, et où il est dit que " les ironies et moqueries de Kalligas " contre Théophile Kaïris " ne sont pas dignes d'un grand homme.

Mais voyons le texte de la critique de Pavlos Kalligas. Nous avons déjà dit qu'il s'agit d'un texte de sept pages, mais où les références aux œuvres jugées ne dépassent pas les quatre pages. Le reste du texte n'est que références vagues à la personne de Kaïris. Kalligas est agressif dès les premières lignes : " Si seule la mention du nom de ce nouveau chef de secte est capable d'inquiéter, combien sera secoué celui qui doit lire une analyse impartiale de ses ouvrages. " Faut-il comprendre que la critique ne sera pas impartiale pour ne pas " secouer " le lecteur ? Je ne souhaiterais pas traduire ainsi les dires de Kalligas, bien que son texte aille dans cette direction.

Kaïris est accusé ici " d'introduire dans les âmes tendre des jeunes privés de jugement des principes contraires à la religion de leurs pères ", de " embrasser et d'enseigner ce que l'Église n'accepte pas ", d'être incapable " d'amener de nouvelles lumières à la société ", mais seulement " d'éteindre celles qui existent déjà ", etc.

En fait, Kalligas paraphrase ici les textes du Saint-synode, mais ce qui étonnera le lecteur du texte est une phrase non dénuée de sens : " Nous n'étudions pas maintenant, après la destitution, de quel droit [Kaïris] est placé en restriction, transféré ici ou là. " Pourquoi le légiste Kalligas ne répond-il pas à cette question si épineuse posée par le scientifique Kalligas mais non répondue par Kalligas le politique? Pourquoi ne reste-t-il pas sur la position tout à fait juste qu'il avait énoncée en 1840 dans sa préface au livre de Friedrich August Biener : " l'Église se corrompt quand elle se mêle des affaires du siècle car elle oublie son but absolu et surgissent les passions dont elle doit purifier l'homme. "

Je ne m'attarderai pas sur des critiques accessoires, comme son opposition à la classification des sciences par Kaïris, car ces critiques proviennent, d'après l'auteur de la réponse anonyme citée auparavant, " d'inattention et d'ignorance ", et conduisent Kalligas " à une illusion à proprement parler paradoxale. " Je passe également sur la déclaration de Kalligas d'après laquelle " si nos prêtres remplissaient leur devoir " selon Kaïris, c'est à dire " fidèlement et avec raison ", nous aurions autant de religions que de prêtres. " Nous pouvons donc nous demander si les prêtres doivent enseigner " sans raison " pour ne pas aboutir à tant de religions ? Je pose simplement la question, sans autres commentaires.

Suivent d'autres aphorismes : les textes de Kaïris " sur l'histoire de la philosophie n'ont aucune valeur ", trop peu de choses sont mentionnées sur " la nouvelle philosophie de l'Europe " et sur " les nouveaux philosophes grecs ". Cependant, tout ceci est mentionné dans l'introduction des *Éléments de Philosophie* (*Στοιχεία Φιλοσοφίας ή των περί τα όντα γενικώτερον θεωρουμένων τα στοιχειοδέστερα)*, et Kalligas ne le mentionne pas malgré le fait que c'est un des deux ouvrages qui subissent sa critique. Voyons tout de même l'unique problème philosophique posé par Kalligas, le problème de la connaissance, qui d'ailleurs est sa seule remarque qui vaille que l'on s'arrête dessus.

Kalligas dit que, selon Kaïris, " nous ne connaissons absolument aucune substance, mais seulement, par rapport à nous, des renseignements des êtres qui nous entourent. C'est à dire que nous ne connaissons pas la nature en elle même, mais les changements que les substances provoquent en nous". Toujours selon Kaïris, " les idées naissent soit par les sens, soit par l'abstraction ", tandis que " quand plusieurs choses excitent les organes sensoriels, par la répétition d'une de celles-ci est activé le reste des nerfs, rappelant le reste des idées, et d'où la réminiscence. "

Nous ne voyons aucune raison de contredire Kalligas sur ce point. C'est un fait que Kaïris, qui a particulièrement approfondi les questions de la connaissance, affirme qu'il n'y a pas de vérité absolue, car nous ne pouvons pas connaître absolument " la nature des choses, mais ce qui se rapporte à elles. "

Il est évident qu'avec une lecture de Kaïris qui, comme Kalligas, ne retiendrait que cette idée, et ne l'étudierait pas dans son contexte, conduirait à taxer Kaïris d'agnosticisme et de relativisme, de disciple de Berkeley et de la philosophie écossaise. Mais une lecture assidue du texte de Kaïris conduit à des conclusions différentes, montrant que la relativité de nos connaissances n'est pas conçue en tant que négation de la vérité objective, mais comme une limite de notre aptitude à atteindre la vérité absolue et objective. Il conçoit la connaissance comme un processus continu pendant lequel l'homme " dans la mesure où il avance dans la connaissance des êtres, voit augmenter le désir de connaître. Et rien de ce qui sur la terre est grand et brillant ne sera plus tard petit et terni " La connaissance avance, se perfectionne " grâce à l'expérience acquise, l'observation " ; l'expérience, la pratique, constitue le départ de la connaissance.

Aussi, il n'accepte aucune autre source de connaissance autre que les sens. Tous les sens sont pour lui le résultat de l'action des objets extérieurs sur les organes sensoriels de l'homme. Ainsi, la création des sens, ainsi que des notions et des idées, n'est pas possible si les objets qui sont reflétés n'existent pas. Les excitations des organes sensoriels sont transmises aux centres respectifs du cerveau grâce aux nerfs, lesquels se subdivisent sur la surface du corps, et assurent la communication directe entre les organes sensoriels et le cerveau, la création des connaissances. La création d'une ou de plusieurs sensations conduit à la création d'une ou de plusieurs notions ou idées, à la création de la connaissance. Et, dit Kaïris, à partir des notions simples " sont créées les idées complexes de l'homme ", la mention de plusieurs idées pourvoit les jugements, les idées scientifiques.

Ces pensées traduisent les multiples facettes de la philosophie de Kaïris. Malheureusement, Kalligas n'a pas voulu les distinguer, mais, au contraire, essaya de les condamner sans jugement.

Je ne m'attarderai pas sur ce sujet. Mais je ferai une dernière remarque, toujours en suivant le fil de la critique de Kalligas, qui épilogue : " notre philosophe est très éloigné du progrès actuel de la science [...] nous ne voyons ni système, ni principes, ni rigueur logique, ni dialectique, ni recherche approfondie. "

La meilleure réponse à cette dernière remarque est donnée non seulement par les textes philosophiques imprimés de Kaïris, mais aussi par ceux qui sont purement scientifiques, et qui malheureusement ne subsistent que sous la forme de manuscrits dans différentes bibliothèques, grecques ou autres [il s'agit de notes de Kaïris ou de ses élèves, prises pendant son enseignement à Andros, voir Y. Karas, *Les sciences sous la domination ottomane* (*Οι Επιστήμες στην Τουρκοκρατία)*, 2e Vol., Athènes, 1992, pp. 136-145] ; c'est la que nous rencontrons plus analytiquement sa théorie sur l'*Enylon.* Il s'agit d'une théorie originale, du moins pour l'espace hellénique, avec les caractéristiques suivantes : elle exprime une forme supérieure d'organisation de la matière ; établit la proposition de la non-existence du vide ; rassemble les propriétés du photogène, du thermogène, de l'*echogène* (théorie du son), du fluide électrique et magnétique ; explique les causes de la transformation des états de la matière ; montre l'unité du microcosme et de l'univers ; édifie la cohérence du monde matériel ; comble le fossé entre le monde réel et le surnaturel en unifiant dans un ordre naturel les corps inanimés et les êtres vivants ; enfin, il fournit un outil important pour l'étude de la valeur de la connaissance.

En se référant à la théorie de Kaïris sur l'*Enylon*, Nikos Sotirakis écrit dans une étude au sous-titre caractéristique, *Théophile Kaïris précurseur de la science contemporaine* (*Ο Θεόφιλος Καΐρης πρόδρομος της νεώτερης επιστήμης*) : " Kaïris croit pleinement en la fertilité et la sécurité de la raison humaine. Il recherche avec passion religieuse les routes de la science et de la philosophie, il assimile aisément les connaissances scientifiques de son époque. Il se meut librement dans les zones, interdites aux esprits communs, de la Mathématique, la Physique et la mécanique céleste. Il décrit avec rigueur scientifique les phénomènes physiques et astronomiques, exprime et examine leurs lois avec des formules mathématiques et, finalement, insatisfait des réponses de la science, s'élève au niveau de philosophe pour donner sa propre réponse aux problèmes éternels de la philosophie : les problèmes de la connaissance, du principe et de la cause des êtres. "

Il n'y aurait rien à ajouter à tout ce qu'écrit Nikos Sotirakis, et qui démontent toutes les critiques de Pavlos Kalligas, sinon répéter qu'il ne nous convainc pas d'avoir lu, du moins en profondeur et impartialement, les œuvres par lui jugées.

Nous ne partageons pas entièrement l'opinion exprimée dans la réponse anonyme de 1851, selon laquelle " ignare et escroc, Kalligas devient illogique et aboutit à des non-sens ", mais nous sommes en accord avec une seconde opinion de ce même texte : " Beaucoup de lecteurs saisissent que Kalligas, dans son analyse, avait un autre but. "

La critique de Pavlos Kalligas contre Théophile Kaïris n'était pas un malentendu, mais un choix délibéré.

Nous pouvons lire dans le texte que Kalligas lui-même a préfacé en 1840, " qu'il n'est pas difficile de montrer que non seulement en une, mais dans plusieurs pages de l'histoire, combien désastreux fut le sacrifice de la justice à l'opportunité, que ce soit par noble zèle ou pour des raisons douteuses " Voilà de très justes paroles, que le Kalligas de 1851 semble avoir oubliées. C'est ainsi que dans ce cas nous observons un scientifique, un légiste de qualité, ne pas suivre la voix de sa conscience scientifique, ne pas suivre ses collègues reconnus, comme Nikolaos Saripolos, Markos Renieris, Spyridon Komnos et autres, mais suivre une propre voie qui ne lui sera pas reconnue par l'histoire de la Grèce contemporaine. Les bustes de Théophile Kaïris qui décorent la place centrale d'Andros, mais aussi ici à Hermoupolis, son nom sur les plaques de diverses rues grecques, les articles, les études et les livres où est loué son apport à la pensée scientifique et philosophique de la Grèce moderne, les vers immortels que lui dédie Kostis Palamas, et tant d'autres choses, constituent la meilleure réponse de la Grèce contemporaine à l'un de ses créateurs, et aussi à ses censeurs de tout poil.

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MARIA TERDIMOU

CONSTANTINE KARATHEODORIS: A CONTRIBUTION TO THE REORGANIZATION OF THE GREEK UNIVERSITY

In 1955, short before his death, Albert Einstein gave an interview to American reporters. After having answered accurately to many questions, the reporters were ready to go. Then, Einstein took a serious look and told them: "I am sorry that you leave without posing the most important question: who my teacher was, who showed to me the way to higher mathematical thinking and scientific research. In order not to tire you, I tell you simply, without many details, that my important teacher was the insurmountable Greek Constantine Karatheodoris, to whom, I, Mathematics, Physics, the wisdom of our century owe a lot". This is the point of Einstein for Karatheodoris, the great mathematician, who had died five years earlier, on the second of February of 1950.

The name of Karatheodoris did not become famous because of Constantine. His family tree starts in the middle of the 18th century, at the village Bosna, south-east of Andrianoupolis, from the young Theodoris, who, because of his brunet face got a first compound at his name, Kara (which means black) and became Kara-Theodoris. Greengrocer at the beginning, prosperous merchant later, he was happy to leave descendants who shined in politics, as well as in sciences. Constantine is one of great-great grandsons, of one of Theodoris' sons, Antonios (1765-1815).

The most eminent person of Karatheodoris family was undoubtedly Alexander Pacha (1883-1906), grand son of Theodoris, from his second son, Stephan (1789-1867), doctor and important scholar of his time.

Alexander was born and grew up in Constantinople. After the end of his law and mathematical studies in London and Paris, he was appointed initially in the Turkish Ministry of Foreign Affairs and escorted the vizier Aali Pacha in Crete (1867-68), during the negotiations with Cretan revolutionaries. A capable diplomat, he served as ambassador in Italy, Deputy Minister of Foreign Affairs, later Minister of Public Works (1878) and at the same year Minister of Foreign Affairs in the government of Hayredin Pacha, for a short time.

In 1885 Alexander was appointed commander of Samos, a position that he kept until 1894 and in 1896 he undertook, for one year, the general administration of Crete. He came to Crete in August, accompanied by the 24 years old Constantine, who met there, for his first time, the great Greek politician, Eleftherios Venizelos.

Apart from international and diplomatic service, Alexander was an author as well. He published research-papers on the eastern languages, on the *meteorologicals* of Aristotle, on the Homeric issue, on letters and sciences during the reign of August, and translated Persian and Arab poets. Moreover, Alexander worked on mathematics and many of his mathematical dissertations are extant today. One complete distinguished work is a manuscript containing the translation from Arabic of the *Tadhkira* ", of Nasir-al-Tussi, the Persian mathematician and astronomer of the 13th century. It was published as "Traité du quadrilatère attribué à Nassirudin-el Toussy, traduit par Alexander Pacha Caratheodory". Many of his researches and exercises on different branches of mathematics are to be found in his archives. And it was probably the common interest for mathematics that united him with Constantine and made him support the decision of the young mathematician to abandon, as we will see later, a serious career as an engineer.

Constantine Karatheodoris was born in Berlin on 13th of September 1873. His father, Stephan, ambassador of Turkey in Berlin, was also a lawyer and a diplomat and had represented Turkey in many international conferences. His mother, Despina Petrokokinou, with origin from Chio, died when Constantine was six years old. Euthalia, grandmother from his mother's side, took care of his bringing up. He grew up in Brussels, with his sister Julia, in a scientific, and cosmopolitan environment.

In 1866, he attended the high school "Athenée Royale" of Brussels, showing a unique interest for the lectures in mathematics of professor Angenotte. During that period, and for two continuous years, he took the first prize in the mathematical competition "Concours Generaux".

In 1891, he subscribed at the famous military school, "Ecole militaire" of Belgium. In his autobiographical notes for this school, one can easily distinguish his interest for mathematics, thermodynamics and engineering.

In August 1895, year of his graduation from school, Constantine came to Crete with Alexander Karatheodoris. There he met E.Venizelos, nine years older than him and a deep relationship between the two men started. Alexander Pacha made an effort to convince them to join the service of the Ottoman Empire. This effort was not only unsuccessful, but gradually both of them became serious enemies of the empire. After his trip to Crete, Constantine tenderly will be differentiated from Karatheodoris family and many times from then, he will help Venizelos at difficult situations.

Alexander left Crete in 1896, taking the position of Great Translator at the palace. He died in 1906 and two years later, Constantine got married with Alexander's little daughter, Euphrosini.

Constantine's first job was in 1896 at the island of Lesbos (then under

Ottoman control), where he worked as a civil engineer, at works of road constructions.

In 1897, he was in Athens, watching from a distance the Greek-Turkish war.

After a short visit to London during the winter 1897-98, he went to Egypt, as an employee of the British government and precisely as assistant-engineer at the dams of Assouan and Assiout. It is during that period that he became witness of the discovery of Royal Tombs at the Royal Valley. In his autobiographical notes, Constantine, thrilled, describes his experience. Apart from that, in those notes, we are informed that during his first stay in Egypt, he used to study Jordan's "Cours d' Analyse" and the Analytical Geometry of Salmon-Fiedler. It is also during this period that the thought of abandoning the engineering and devoting himself in mathematics. In April 1900, having taken his final decision, he goes back to Europe, where, of course, he meets the opposition of his family and friends.

"My family and my Greek friends, Dimitrios Vikelas and Markos Dragoumis found my plan to abandon a guaranteed position with many perspectives in order to fulfill a romantic tendency, something more than comical. I was persuaded that my plan was fruitful. I couldn't resist to the thought that only my unconditional occupation with mathematics will give to my life its meaning...". The only one who supported him to his decision was Alexander Karatheodoris Pacha.

In 1900, he was enrolled in the University of Berlin. There, he met the great mathematicians L. Fuchs, H.Schwarzand and G.Fobenius, who's the courses he attended. He also attended the lectures of Carl Stumf in Mathematical Logic and of Max Plank in Physics. At that time, he wrote his first book, whose subject was Egypt. It was published by the Greek "Association on the spreading of useful books", which was directed by Dimitrios Vikelas.

In 1903, at Göttingen, he attended the classes of F.Klein, D.Hilbert and Minkowski. And, as he mentioned, "after the meal, we used to go for a walk, discussing about all mathematical problems we could think of".

In July 1904, he took his PhD from Göttingen, with the dissertation "about the inconsecutive solutions of calculus of alterations". This work was much appreciated by the mathematicians of his time, who, from that time on, considered him as one of the most important researchers in mathematics.

After an unsuccessful effort, in 1905, to find a good job in Greece, he went back to Germany, where he published his work with the title "About the general law of alterations".

He was awarded the title of Venia Legendi of the School of Philosophy and was nominated lecturer at Göttingen, where he taught theory of functions. In1908, he taught at the University of Bonn and in 1909 he was elected full professor at the technical University of Breslau. It is there that, for the first time, Venizelos will look for him, asking for help.

Venizelos' government tried, by voting a new decree, to change the procedure of filling of the Chairs devoid at the University of Athens, which, until then, were occupied in a spoilt way. A committee was set up and for the Faculty of Sciences, Venizelos proposed the participation of Karatheodoris.

Accepting the invitation, Constantine came to Greece and indeed the election process took place in an exemplary way.

Karatheodoris continued his mathematical career, by publishing works on Picard's theorem, on Study's dams and on linear meter in sets of points. In 1913, he was elected as full professor at Göttingen, and Plank accepted him with a great speech in the Academy of Prussia.

In September of 1919, Venizelos was in Paris for the Peace Meeting. He invited Karatheodoris who was at the University of Berlin, for a discussion on political matters. We don't know everything they discussed. The only thing of their discussion for which we know, is educational matters. It is well known that the lack of educational programmes of the Liberal Party was replaced by the presence of personalities, who were assigned to apply new measures. Some of them are G. Papandreou, M. Triandafillidis, A. Delmousos, D. Glinos, and C.Karatheodoris.

At that time, Venizelos was strongly occupied by the idea of a second Greek university in one of the unfettered cities. "We will establish one university in Constantinople and one in Smirna. We will give total equality to Turks, something we have promised".

Karatheodoris proved to be the hotter supporter of this plan and undertook to write the relevant proposals. On 20th of October 1919, he submitted to the Greek Government a memorandum with the plan of foundation of a new Greek university in Smirna, a place which was considered to be the most suitable. He undertook himself the organization and so, in June 1920, having already being recognized as one of the most important mathematicians of the whole world, he abandoned his seat at the University of Göttingen, and came to Greece.

Georgios Ioakimoglou, professor at the University of Berlin, was also invited to help the organization of the new university.

In an optimistic climate, the two men with Alexander Zachariou, came to Smirna. At their arrival, they had the first episodic contact with the high commissioner of Smirna, A. Stergiadis. "We are waiting in the hall. After a while, Stergiadis entered and his first saying was sir, are you so young? You are very very young. My answer: Mr Stergiadis, you are right, this is a disadvantage. Unfortunately, it is decreasing day after day".

That month, Stergiadis signed the decision of the foundation of the university.

Karatheodoris designed the university functional and structural plan, according to the English universities. This plan comprised human and applied sciences with the following departments: Department of literature, eastern cultures and languages (Turkish, Arabian, Armenian, Persian, Hebrew) for the preparation of teachers for the higher educational institutions. Department of civil servants with courses of civil law, department of social sciences and economics, higher Muslim seminary, institute of hygiene.

In the area of applied sciences, there was a department of "physics and geoponics studies", for the education of architects, civil engineers, chemists, geologists, mechanical engineers and agronomists. The department also undertook the organization of classes of farmers, for the efficient cultivation of fields and the fighting of diseases in animals and plants.

The plan would establish laboratories, experimental fields in Smirna, and a big farm at Tebeki, all of them attached at the University. The establishment of a library with books of special as well as of general interest was also in the plan.

Every one who had the right qualifications, besides his nationality, could be acceptable as a student. Language of teaching was Greek and whenever it was possible the Turkish, without excluding the possibility of using other languages as well. For the housing of the new University, a group of buildings at the hill of Bahri Baba, situated on ancient Byzantine ruins, has been created: an amphitheater, independent lodgings for the professors and the auxiliary buildings for the staff.

During the period of his governing, Venizelos had taken care of the financing of the buildings and equipment. Karatheodoris undertook the providing of equipment of the labs. The Ministry of Foreign Affairs disposed for this purpose 500.000 marks and the Administration of Smirna 200.000 marks.

Karatheodoris took care of the creation of a rich library. His dream was the establishment of a real "Universitat Literarum", with a unique library in the whole East. He went himself to Germany, in July 1921, to buy books. Thirty-six boxes were then sent to Smirna and into those a great number of important books about Minor Asia, gathered by the Austrian archaeologists in Effesus, was added.

Expecting the new University to become the most important intellectual establishment of the East, Karatheodoris choose as an emblem, the expression "light from the East". The Chairs were occupied by professors having his complete acceptance and finally, in spite of the difficulties that came up after the change of the Government in November of 1920 and the serious reactions from the Turkish part, the University, a creation of Venizelos, Karatheodoris and Chrisostomos, archbishop of Smirna, was ready and his operation was expected to start in September 1922.

But then came the military disaster of August. Karatheodoris, until the last day of the catastrophe tried to save whatever was possible. The books and a part of lab equipment were loaded at the last war-ship, named Naxos, by which he left also himself. Most of these books are kept now in the Athens University.

Karatheodoris was deeply affected by the catastrophe of Smirna and the lost University. For one more time he found shelter in mathematics. Soon he will publish some inventive works in disciplines like multiple integrals, theory of fields, punctual transformations, postulate of the theory of relativity, etc. At that time, he stayed for one year in Athens, teaching at the University and the National Technical University.

In 1924, he was invited at the University of Munich, to succeed Professor F. Liendmann. Later, he received the medieval title of Geheinmat and became member of the Munich Academy.

In 1928, he taught for one semester at Harvard and later at Berkley, California. He gave also lectures at many American universities.

All that time, he never stopped being interested in Greek matters. In his correspondence with Penelope Delta, he refers always to Greece, saying: "Instead of loosing my time there (he means Greece), I can, from here, benefit to Greece much more, with the propaganda that I do for Greece".

From Seattle, he is watching with much interest the elections of August 1928, hoping to the reelection of Venizelos. The last four years period of Venizelo's governing starts. The serious speculation of the government for educational matters creates a hopeful climate. Venizelos invites again Karatheodoris to undertake the educational reform at the high level education, considering the experience that Constantine had obtained from relevant cases in European universities, among them the one of Göttingen. Although the climate that exists in Greek education is very conservative, Karatheodoris accepts the invitation, hoping as he writes, "to persuade the government to take measures connected one with others".

Very soon, he will memorialize the reorganization of the University of Athens. His proposals are concerning financial matters, library, the new buildings, the system of the examinations and the procedure of election of professors. Many of these proposals were considered very daring for the time and others applicable. Some were applied, others encountered the wall of bureaucracy and others were rejected.

At the elections of 1933, Venizelos falls and Karatheodoris is resigned from the task he had until then. Later, Tsaldaris will ask him to take a similar effort for the National Technical University and the relevant report will be submitted from Karatheodoris in August 1935.

During these years, it seems that he had correspondence with Einstein. In a letter from Munich to Penelope Delta, dated 5-21-1930, he writes: "Dear Penelope, I send for your collection an autograph of Virginia and a letter of Einstein which arrived this morning", satisfying Penelope's wish to acquire a letter of the great scientist.

In 1936 he was again in U.S.A., teaching at the University of Madison. In 1937, when he came to Athens, Venizelos had already died.

During the second world war, Constantine tried to come to Greece, but without success. When, towards the end, his friend, Ioannis Kalitsounakis visited

Einstein at Princeton, the second one wondered about the staying of Karatheodoris at Munich and decided to ask American government to allow his return to Greece. "Er ist ein feiner Mench", he observed.

Karatheodory died at the age of 77, in February 1950.

He left a huge and original scientific work with 132 dissertations, which opened new paths in Mathematics and Physics. This work refers, mostly, to:

1. Calculus of alterations
2. Functions of one complex variable and more complex variables
3. Functions of real variables
4. Conformal functions
5. Differential geometry
6. Mathematical Physics
7. Optics

According to Karatheodoris, Mathematics is the accountancy of inevitable conclusions, and time, consisting of infinitesimal moments, composes a liquidity, which follows cruel rates of alteration.

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SCIENCE AND NATION FORMATION IN 19th c. GREECE REMARKS ON THE ESTABLISHMENT OF HIGHER EDUCATION

In this work we will discuss the foundation of the institutions of higher learning in Greece during the 1830's and their early functioning. This paper is a summary of an article under preparation in greek and draws a lot of its pragmatological material from the master theses of Ilias Karkanis and Dimitris Tangalakis.

In recent historiography on the 19th century science there are established many general topics of study like, national styles of science, the Humboltian science, the science of the liberal gentlemen and the science within le grandes ecoles systeme, problems around the notion of exactness and scientific measurement, studies on the establishment of scientific and technological laboratories, on the moral economy of 19th century science and on the notion of objectivity, on the rise of statistical thinking, on evolutionary thinking and its consequences, on science as a component of imperialist expansion, on scientific popularisation etc. David Knight calls the big 19th century, the period from the French Revolution to the first world war as the age of science, where science formed the paradigm for other forms of intellectual activity and where the separation between the two cultures was not as deep as during the 20th century. The same period is a period of social transformation for the European societies, om agriculture to industry.

In the case of Greece we think that most of the above mentioned types of study are very difficult to be pursued due to the existing level of literature ,some are irrelevant and in any case the core of the issue of the 19th century greek science according to our opinion is its role towards the creation of the state. Anthropological topics on the development of the notion of exactness and certitude, on space and time or even on the notion of trust, in the peasant greek society under the influence of the development of the educational system in general, and higher education in particular, are also of great importance.

The main existing special works are two book length studies by general historians on the National Technical University ,established as a Sunday school at 1837, by K.Biris of 1957 and an unpublished 1997 Ph. D. thesis by K. Lappas on Athens University.

In 19th c. Greece there existed 3000 scholars, including scientists, according to a 1852 note by Alexander Soutsos, while in the whole the period of the so called greek Enlightenment we observe the steady formation of scholars from the commercial greek communities of the Greek mainland and the broader Balkans. There were also the phanariotes, the greek highly educated aristocratic community, based in Konstantinople and serving the ottoman rule since early 18th century. During the 19th c. the newly independent state created its own scholars through a system of scholarships to European Universities, some of them beeing raised to the level of a European scholar, Till 1843 we had about two decades of German professors in Athens University ,while some of them remained in Greece after the constitutional events of that year, when the majority of the foreign specialists were expelled from the country. Most recent studies agree on the point that the 1843 events represent no turning point for the educational matters of the country which happened only at 1985.

These people constitute the personnel of 19th c. greek science, but in the greek community of historians and philosophers of science there is a strong thesis claiming that we can talk about greek science in the proper sense of the word, only after the 1970-80's, although there were certainly important scholars in Greece during the 20th century. Professor D. Chondros, an A. Sommerfield Ph. D. student, worked very respectfully in the Physics department of Athens University but Quantum Physics were first taught many years after his death in 1968. His case personifies the whole situation, while the other great greek physicist of the 30-50's A. Papapetrou had to immigrate to East Berlin and Paris, in order to start scientific contacts with A. Einstein.

In the general sociological literature there is an important thesis about the overeducation of the Greeks, established by the work of K. Tsoukalas during the 1970-80's, which alhough has come under some criticism later, to our understanding is still valid. It is also closely related to the notion that the Greek higher education system had always a very strong utilitarian component and served heavily till the 1980's as the most important factor of social mobility.

The first discussions about the creation of institutions of higher learning appeared already at 1822 within the framework of the Pelloponesian Senate, under the influence of Korais, while at 1824 was submitted to the National Assembly a project for the creation of an institution modelled on the basis of the Institut de France of Paris, without further elaboration. Under governor Kapodistrias at 1827 the main efforts were driven towards the middle level and technical education and principal adviser on educational matters was governor's friend Alexander Stourza, who also served in russian diplomacy. To what extent the conservative framework of the tsar Nicolai I was his source of inspiration in juxtaposition to the enlightenment policies of the tsar Alexander I under which Kapodistrias served, is open to further research. In any case there are evidences that Stourza thought that the function of the education system as a whole must contribute towards piety, state security, immediate needs of the new state leaving by the side the luxury of erudition.

In this period a school for teachers, another for priests, and the central war school were created. Also we have an agricultural technical school under the direction of George Palaiologos who studied at the Patriarchical Academy in Konstantinople and also in Paris and London. The problem of secondary technical education in Greece is always difficult to trace and for this period can be described by the lengthy essay of 1892 by Th. Zigouras, presented to the prime minister Charilaos Tricoupis. There the emphasis on higher non technical learning, law, medicine and philology is underlined and information is given about the creation of three technical agricultural schools at 1887, as the only state effort towards technical education since the Kapodistrian period. The creation of the School of Arts by king Othon does not belong to the middle level vocational training. The author expresses his sorrow for the total abandonment of the technical professional schools and attempts a sociological conclusion. The bad pedagogical education is reflected also to the technical life of the Greeks. If they were educated in the professional schools we propose, they should know the work discipline. The issue of the middle level technical education in Greece during the 19^{th}c. has not been studied, while recent researches, Ch. Agriantoni, show an important manufacture development in late 19^{th} c. Greece. In any case it seems clear that in 19^{th} c. Greece at least till the 1880's, there was minimal technical education. The main efforts were in other areas.

Under King Othon founded the Athens University at 1837. The technical School also of 1837 seems to be purely a result of the initiatives of the bavarian regency, while the Athens University had a long preparation in various ministerial and political circles. There are plenty of studies on the matter and we can summarise that king Othon tried to adapt to the realities of the day various projects elaborated by german scholars and politicians like Thiers, Mauer, Brandis. Al. Ragavis at 1834 proposed a combination of the French and German educational systems of higher learning, but he was simply ignored. Athens University was modelled on the German University system where the idea of the unity of science was dominant, and so physics and mathematics were taught in the Faculty of Philosophy till 1904. The students were given initially lectures on the method of science, while the seminar system was established, but functioned till the 1880's only for philological studies. The laboratories for physics in the proper sense of the term, were established only by the 1880's according to Th. Kritikos.

During the discussions for the creation of the University the member of king's Othon Regency Georg Ludwig Mauer at 1835 puts for the first time to our knowledge the function of the University in relation to the "megali idea" ,the dominant political idea in Greece from 1843 to 1922, the expression of greek irredentism, according to which destination of Greece is to transmit one day the light of European civilisation to the East. P. Kitromilidis in a study of 1997 puts it aptly the theoretical compromise on which greek nationalism was based was an ideological achievement by Athens University. During the 1870's in front of the main building of Athens University were erected two pairs of statues representing the most important national figures of early 19th century Greece, pairs which represented totally opposing views.

The trends which provided the poles to be compromised ,were the needs of modern state. If the governments had a minimum dose of patriotism they would have suffered seeing us been taxed by foreign engineers and officers and they would be creating the soonest possible the university we read in the newspaper Athina 6.6.1836, by Konstantin Negris, who was appointed professor of Mathematics at the University at its creation. The other pole was the dominant romanticism, which at that time was expressed by the admiration of the great past of ancient Greece .

The basis of the compromise was the creation at the University of an important body of greek modern professionals doctors, lawyers, school teachers who originated from and worked at the greek communities of the ottoman empire.

There is some importance on the fundingof the University. The Regency passed a degree to confiscate the lands of the small greek monasteries in order to finance the education system, although Thiers, the professor from Bavaria who drafted the rules of the University declared his opposition to it, Th. Christou. In the Athenian press of this period we have plenty of references to the case. In the conservative Aion at 1841 we read the greek criticises and complains for the situation of the public education and nothing else could console his sorrow (about the confiscation of the lands) but the idea that these incomes will be used for the upbringing of his children. In the relevant literature there are different opinions about the symbolic or even the purely economic role of the confiscation of the monastery lands for education and this important issue requires further research.

The origins of the first group of the appointed professors at Athens University are also important. The first generation of professors were divided into two groups according to the country of their studies. Germany represented the most important group and secondly was France. Their social cultural origins were mainly from the phanariotes, while the scholars who were emerged from other greek strata and had studied in Europe during the so called greek Enlightenment were secondary in number and role. Important is the appearance of German scholars at the institutions of higher learning, who served mainly till 1843. There are some who stayed in Greece for example Landerer, who worked as a professor, court pharmacist, chemist, mineral collector, member of the committee for the encouragement of the greek industry, science popularizer till 1885. In any case our researches on the first generation of the professors at

Athens University are in agreement with the conclusion made by Efth. Nikolaïdis that the Greeks were in all cases the driving forces at the University. It is illuminating the out come of the elections for the member of parliament representative of the University at 1844. The appointed professors, educated only in Germany and France rejected pressures from the rector and the government and elected Alexander Mavrocordatos, ex prime minister, leader of the pro England party.

This brings us to the issue of the state university relations. The state kept the privilege to appoint professors out of a list handed by the university till the Tricoupis period of 1880`s. The first rector of the University king appointee, the phanariot K. Schinas in the University opening speech clearly talked about the university being created by the king and thus have Greece does not have to pass from the slow and painful stage the barbarous years during which the western universities were formed.

We now give some points about the other two institutions, the military academy and the school of arts. The military academy, which changed directorship from french to german during Othon's reign, had the most advanced syllabuses for mathematics and the sciences, further more the students were tough two foreign languages and were given social education. For sure it was the most prestigious institution. Othon's administration applied a regulation, under which fifty children, participants of the liberation war were accepted into the academy every year with full scholarship. This regulation proved to be important for the creation of a national elit, since graduates of the school and their immediate descendants had important public roles even in the 20th century, while about twenty professors of the newly established School of Arts were graduates of the Academy. From 1860's fees were applied for its students .The newly born elit tried to keep the social mobility to a minimum.

The School of Arts, term which meant the cruel arts according to Aristotle's classification, was created from the efforts of the Bavarian officer of the corps of engineers Zentner who stayed as its director till 1844. During the last period of his directorship he tried to reform this popular but educationally unclassified school into an institution of higher learning. Research into the library of the National Technical University of Athens, the present title of the institution, showed that during the late 1830's early 40's the holdings of the library were enriched with the latest scientific and technical literature, whereas for the next twenty year period, there is a total lack of all relevant works. A speach by the well known historian G. Papadopoulos at 1845, showed that the students of the school preferred to take practical courses like drawing etc., instead of the basics of the physical science and mechanics. The chart of the school wrote that its graduates should be worked as foremen for important state buildings and the historians say is in full agreement. When Zentner left, the school was essentially transformed into a school of architecture and applied arts and only in the 1870's started to create its technical laboratories.

The next issue concerns the studies in the university of Athens. From rectors speeches in early 1840's we gather the information that all attempts to impose fees for the students were undermined by the rectors themselves. Studies in law and medicine were the most popular in terms of students enrolled, followed by the faculty of philosophy, that is the school teachers. The faculty of theology, which from the very beginning of the university had to defend itself form accusations about promoting a state subordinated religion, had in all cases minimal numbers of students. The students were attracted obviously by the needs of the new state and the social needs of the important greek communities.

Language represented also a serious problem for the new state. E.Skopetea comments that during the liberation war there was no problem of communication, but the needs of the state created a situation that forces K. Th. Dimaras to write that during the 1880's the archaism of the language passed even the most mad hopes of the proarchaists. In the liberal newspaper Athena of 12.6.1840 we read. How the written language can receive uniform character according to the sense of beauty and of the national language. How can the people gradually be used to it (the new language), so that they can replace the amorphous unarticulated language which is in use now. The philological seminar was the only one functioning at the university since the 1840's and the teachers seem to be very successful to the creation of the new state language. The main teaching and research efforts during the first fifty years of the university were towards the language, the archaeological past, country's flora and fauna. Since the 1880's folklore studies started, as a reaction to the purism and the romanticism of the classicist, but represented another option of this same romanticism, according to Beaton.

Closing it is important to refer to A. Ragavis, one of the most important intellectual public figures of the century. His liberal ideas about higher education are expressed in an article of 1854, where he puts forward the issues of academic liberties for professors and students, academic tenure, proposes a combined system of student fees and scholarships and talks about the university as a research institution. Most of the above ideas had small acceptance during the 19^{th} century. Its important to note that Ragavis does not talk about the contribution of the university for the economical development, and to our knowledge at this early stage the rare references to this issue are only oblique ones.

Our final conclusion is that the system of higher learning in 19^{th} century Greece, can be considered as an exemplar case for the function of education towards the formation of the nation. The national historian K. Paparigopoulos, Professor at Athens University, was clear. The nations create history not history the nations, and the greek nationalism according to P. Kitromilidis was really successful, since within a century it increased the national territory to an unimagined degree. Greek nationalism based on the idea of irredentism, easily transformed the early romanticism of the 1830's, asit was expressed for example by. I. Rizos Neroulos who included a total condemnation of Byzantium ala Givon and the total foundation of the national consciousness on the ancient greek ideal, to a solid new idea of national continuity which included Byzantium at the 1870's. Paparigopoulos gave the national body what was needed writes Dimaras and A. Liakos comments in a syntagmatic way. In the 1880's, when the curbing of the early enlitenghment framework was completed, as Dimaras aptly put it, the country being able to accept again western ideas, wold soon create its full national space and would start to discuss new social ideas.

Contemporary theories of nationalism by Gellner, Anderson and Hobbsbawm provide the framework for a small test of our main thesis .

Nationalism, which some times takes pre-existing cultures and turns them into nations, some times invents them says Gellner, while the social engineering is also clearly entered into the nation making. The common language just because it is not naturally evolved but constructed, and especially when forced into print, acquired a new fixity which made it appear more permanent and came to be the actual language of modern states via public education and other administrative mechanisms writes Hobbsbawm approving of Anderson, noting also that the schools and Universities are most consciousness allies of nationalism.

Athens University with its lawyers, teachers and doctors, the School of Arts with the foremen for the new state buildings and the military officers from the School of Evelpidon are the most important factors from the early 19th century greek higher educational system. Pure science had to wait its turn.

SCIENCE, TECHNOLOGY
AND THE 19th CENTURY STATE

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