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*Science and industry in post world war II France
the first steps of a new national system
of research and innovation*

The relationships between science and industry appear as one of the most haunting questions which puzzle the historian of science and technology. It is also connected with very practical stakes: there are few weeks without an official statement dealing with an improvement of those relationships or with new incentives to cooperate. Finally, the question also raises numerous issues about national identities.

Hence, in the French case, a very pervasive discourse about the opposition between industrials who are unable to understand the importance of research and university professors or researchers who are said to be hostile to industry, has been one hallmark of the historiography.

The post world war II period appears naturally as one of profound change in the positions of both protagonists. The mutation which took place in the United States during and after the war, a period now very well documented, radically changed the context and created new industrial and scientific practices. One could almost say that an American model of how to handle science, research, innovation emerged and set the framework where other countries, especially in Europe, had to work.

The impact of the American example, but also of the French 1940 defeat brought about an awareness among some scientists, engineers and industrialists that France had to drastically reexamine the pre-war practices. It explains why this post-war period, let say approximately between 1945 and 1965, displays very interesting features showing an almost complete recomposition of the French research system, academic as well as industrial.

I will try to throw some new light on the French case using a detailed investigation I have carried on a French firm in the field of electronics, the Compagnie générale de télégraphie sans fil, or CSF.

Some qualifications are in order to point out the limits of the analysis. First, the choice of a firm implies that attention will be focused on the perception of science through the eyes of industrialists. Second, the position of the CSF does not correspond to the common attitude of the French industry. There are some similar cases of small or large firms promoting a very active strategy of research, but they are far from the majority. However, the action of the CSF can be seen as offering guideline for the reconstruction of the French system, and hence promoting new ways

of handling the scientific question which may have gained thereafter wide credence at the national level.

Lastly, it would be an error to extrapolate from a very specific technical case (electronics) to other industrial branches. Nevertheless, electronics appears at the core of the post-war mutation, one of the domain where the alliance between science and industry seemed the most fruitful.

This paper will explore three different aspects of the action of CSF trying to show how it reveals some general features of the French industrialists. The war has been an earth-quake for the leaders of the CSF. I intend to show how they tried to introduce the new practices of science in their firm. It will allow us to examine the perception they had from the role of science and from the way it should be organized. It will also show how the scientific mutation initiated by the war came in conflict with the structures of the firm. It often meant that adaptation was entrusted to small marginal parts of the firm which had a specific technological and scientific trajectory, such as the physico-chemical department. It also induced a reversal to traditional practices as soon as large scale projects were in order.

Second element, the paper will further the traditional opposition postulated between scientists and industrialists. It will show that there were important interactions but that each was constructing an image of the other that prevented efficient collaborations.

Last point, the relation between science and industry can not be understood without a reference to the role of the state and the complex game between industry, academic laboratories and technical services such as the military ones. Furthermore, science appears progressively as a kind of national value which goes beyond the question of innovation and industry. The leaders of the CSF in particular promoted a view of science (and its development) as one of the goals of their firm, sometimes in contradiction, in the short term, with their financial and capitalistic interests. Although they didn't succeed in carrying their view, they forged some of the aspects of a new practice which the Fifth Republic and General de Gaulle strongly advocated: control of advanced science and technology should be considered as a condition of national independence.

1. The CSF: a firm with a strong tradition, confronted with a new environment

Brief overview about CSF

The Compagnie générale de télégraphie sans fil developed in the aftermath of world war I. It was specialized in the production of radio wave equipment for telecommunication. For instance, it built among the first long distance links between France and Africa. Progressively, it developed

an important production of electronic tubes used both in CSF materials and as tubes sold to other firms. Progressively, through the twenties and thirties, the firm specialized itself in professional electronics, mostly dedicated to military uses and professional telecommunications. It sold its subsidiary company, La Radiotechnique, which was producing tubes for small applications such as radio sets.

In the thirties, CSF concentrated increasingly on very specialized applications, such as the detection of obstacles through centimetric waves. One of the first detector was installed on the liner *Normandie*. The CSF team subsequently worked on the fabrication of magnetrons which it thought being able of offering shorter wavelength and greater power. Those researches were partly stopped short by the outbreak of the world war II.

The thirties coincided with an important evolution of the CSF with the establishment of an important laboratory. The first steps of the firm corresponded to the traditional model of a small group of inventors and engineers using some of their ideas (such as the alternators of Joseph Bethenod) to set up a production and a firm.

The creator of the firm, Emile Girardeau, decided however in the thirties that, if CSF wanted to preserve its rank, it should possess an advanced laboratory able to introduce new technical ideas, but also to bring about a better mastery of the physical processes used in the electronic tubes and their fabrication. It was of course in line with the orientation of the firm toward specialized products often dedicated to the militaries which required technical characteristics difficult to obtain through traditional artisanal means.

To fulfill those new needs, Girardeau recruited a young physicist, former student of the *Ecole Normale Supérieure*, trained at the laboratory of the Duke de Broglie and expert in the electronic emission of metals, Maurice Ponte. One of its first tasks was to improve the cathodes of the tubes which were very capricious and flimsy. To do so he had to mobilize his fundamental knowledge of metals and to conduct a detailed study of the parameters influencing the behaviour of the cathodes. In Ponte's own words: the electronical technique to give the desired results had to use new qualities of materials: classical analyses are not sufficient"¹.

Another example of this scientific orientation of CSF could be given with the case of the physicist Yves Rocard, future director of the physics laboratory of the *Ecole Normale* and who also worked at CSF during those years.

Three remarks are in order to appreciate this trend. First, the interest for scientific research does not imply any permanent links with the academic world. CSF imports scientists in its laboratory and develops

¹ M.Ponte, *Titres et travaux*, p.13.

research on its own. Second, the case of CSF is relatively singular in France at that time; there were very few important industrial laboratories, at best ten in all French firms. Thirdly, one should not exaggerate the importance of CSF laboratory. It is still very strongly connected with an almost artisanal fabrication of tubes: the researchers designed the tubes, but the small number of tubes produced allowed to maintain laboratory and workshop close together. Production was artisanal, specialized and could react immediately to the wishes of the researchers.

- Post-war CSF

The war constituted a shock for CSF. It impeded the work of the laboratory and the factories. Hence, the first post-war years are dedicated to reconstruction. CSF found mighty allies in this enterprise among the military technical services which were interested to acquire rapidly new systems such as radars and telecommunications devices. Therefore, CSF tended to concentrate its activities on the military side where numerous orders and funds were available. It means that the two most important departments of the CSF around 1950 were the professional tubes department of R. Warnecke producing magnetrons, klystrons and so on and the general physics department in charge of radar and aërial detection of H. Gutton.

At the same time, the former director of the laboratories, Maurice Ponte, became deputy director of the all firm. In order to give some indications, one may note that CSF represented in 1950 around 9000 persons among which seven or eight hundredes in the different laboratories. The firm had a very splitted structure with numerous small activities and subsidiaries, most of them working at an artisanal scale.

The strong imbrication between CSF and military purchases soon raised important difficulties. First, a large part of the income of the firm depended on military contract leaving almost no place for autonomous research development. Indeed, CSF had a very weak capitalistic structure and very small financial means. It had very few possibilities to establish new activities without a previous incentive of some customers.

There was a further problem. The French military technique services were not favouring research of innovative solutions. They tended to reproduce former models with some incremental modifications. Also, they continuously asked for modifications so that the firms could not produce any materials in series. It meant that the financial charges of each projet were always higher for CSF with contracts which brought few benefices.

- The marginal role of the RPC department

The awareness of this phenomena pushed M. Ponte to search after new sources of income which might be independant of military professional

markets. The researches conducted in the physico-chemical department of the firm appeared to offer a very good opportunity to do so. The department was first conceived as an auxiliary for tubes production. It had to improve the materials and to examine the technical problems such as those raised by the quality of glass of the tubes which might deteriorate the electronic properties.

Therefore it was an almost marginal unit in the firm with a very specific culture which concentrated on materials, their elaboration, the understanding of their properties, questions of purity and preparation. Following its own scientific dynamic, this group became increasingly interested in new materials such as ceramic and implemented a production of ceramic condensators which found a wide market for large scale application.

- Germanium: work on semiconductors and conception of science

The introduction and subsequent fate of semiconductor research at CSF constitutes a good case to decipher the perception of science by the leaders of the firm. The Bell Laboratories had announced the realization of a new device called transistor in 1948. It is not before 1953 that CSF set up a laboratory dedicated to the study of germanium. The importance of semiconductors is now an evidence for the historian, but it should not mislead in the interpretation of CSF's attitude. Before the beginning of the fifties, the firm had no access to scientific and technical data on the question. It began to be interested when it could establish link with the physics laboratory of the Ecole Normale headed by Yves Rocard.

Rocard had sent two of his students, Pierre Aigrain and Claude Dugas, to the United States in 1947 in order for them to become acquainted with the new domain of solid state physics. Returning from F.Seitz' laboratory, both men established a small research group. During the first year, Ponte only manifested a mild interest. He had good relationships with Rocard, which was his fellow worker at the Ecole Normale and at CSF before the war. In fact, Ponte was not convinced that germanium was not a pure fancy. Moreover, he did not think of germanium transistors as something really different from tubes: it had the same function and could be handled the same way.

Finally, as Ponte himself expressed it: "CSF has watched over the germanium during some years. But, at their beginning, researches from this nature cost a lot for very random results and we have waited that the domain became clarified in order to know in what direction to carry on with greater probability of rentability"².

². M.Ponte, Note sur l'état actuel et le programme de développement des semi-conducteurs à CSF, 20.2.1953, AAD, CA1, F10.

This prudent choice already reveals a peculiar conception of science and research. In fact, a clear separation appeared between the realm of science and the realm of industrial research as conceived by Ponte. Although Ponte was convinced of the importance of high scientific competences inside of a firme, he wanted to distinguish mature research which gave an opportunity of industrial development and uncertain domain which often revealed as pure waste of time. The procedure he used to begin research on germanium exemplifies very well this conception. He asked Y.Rocard for a scientist of his laboratory to set up a new research group at CSF. In fact, he imported the stock of scientific knowledge he considered necessary to begin the work. In July 1952, Claude Dugas became head of the germanium laboratory at CSF.

Another significant feature denoted the place given to germanium. The task of developing this domain was givent to the department of physico-chemical research. It had to produce germanium diodes and transistors. The relatively marginal position of the department inside CSF shows clearly that germanium was perceived as an object wich had to be accomodated, like science, before it could transform in a standard scientifico-industrial subject.

The unfolding of events will allow us to bring further insight in the conception of science of the CSF leaders, partly in opposition to the heads of the laboratory, André Danzin and Claude Dugas.

Three main problems mobilized the attention of the group in charge of germanium. Those difficulties are in no way original. Some of them, for instance as regards replication and transfer ok knowledge, are now well documented by historians of technology. But, they confronted the firm with a ne framework which strongly contrasted with the universe of the tubes.

First of all, Dugas and its team had to mastered the production of raw germanium. It revealed to be very hazardous. As Dugas put it in one report: "we are not ablo to produce germanium with in advance strictly determinated characteristics. The diodes or triodes manufactured with our germanium will therefore present a great dispersion of characteristic incompatible with mass production"³.

A good illustration of this point came a year and a half later, in september 1954, when suddenly, without evident explanations, the laboratoiry became unable to produce any germanium proper to transistors production. It took two months before surmonting this crisis and the team was only suspecting possible reasons. It implied to reexamine the complet

³. C.Dugas, Développement des activités du laboratoire germanium, 12.11.1952, AAD, CA1, F.

process and to adopt drastic purity conditions. The purification by the melting zone method, ported from the Bell laboratories, had to be pushed until “electrical methods of measurement themselves do not allow to disclose any impurities”⁴.

Far from being transparent, industrial actors and technical experts played a dominant part. Let us begin with the case of the company CSF, and its leader Maurice Ponte. CSF developed since 1952 research on semi-conductors in close collaboration with the laboratory of Y.Rocard and his student P.Aigrain. Since 1955, the company launched an impressive campaign in favour of a scientific and technical programme for electronics around transistor as a key element, but linked with many other components (resistance, condensator, ferrite). The strategy of CSF around 1955-1958 was to develop advanced technologies which could be used for mass-market products such as radio-sets, hence to combine fundamental research and large markets.

Through this argumentation CSF began to transform electronics in a major stake for national science, economy and independence. As soon as 1956, it almost succeeded in getting large subsidy (1,4 billion francs for 1957-8) from the French administration. The suggested programme was intended to develop an all-range of fundamental and applied research around miniaturization. In 1960, Ponte was called head of the CCRST, the governmental advisory body. He was a forceful advocate of a special action in favour of electronics in the frame of the concerted actions of the DGRST. This enterprise succeeded in september 1961 when a programme for fifteen millions of francs was approved⁵. Hence, the creation of the concerted action on electronics was largely industrially-driven.

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⁴. Rapport d'ensemble sur les recherches effectuée à Puteaux, janvier 1955, p.97, AAD, Ca12.

⁵. On all those aspects, see F.Jacq, *Bâtir une électronique française ...* There is in particular a note of M.Ponte to his second A.Danzin, in September 1961, where he explicitly stated that A.Danzin and his collaborators should elaborate a complete research program for an amount of fifteen millions of francs because he had obtained the approval of a fifteen millions francs programme.