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## Charles Friedel (1832-1899) and the Laboratory of Practical Chemistry in the Rue Michelet in Paris

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In France, the 1890s were marked by a number of important events in academic, economic, and –especially between 1894 and 1898, in the turbulent years of the Dreyfus affair– political life. The decade began with a fundamental reform of the educational system, especially at the secondary level. At the time, secondary education was divided between two parallel tracks: the ‘classical’ (*enseignement classique*), and the ‘special’ (*enseignement spécial*). The ‘special’ programme was intended to prepare for employment in agriculture, trade, and manufacturing. It embraced a substantial element of instruction in chemistry, including practical classes culminating in the techniques of analysis in the final year. But the programme failed to meet the needs of industry and was seen as lacking the status of its classical counterpart. In an attempt to achieve parity of esteem, the *enseignement spécial* was transformed into a new ‘modern’ programme (*enseignement moderne*) with a structure similar to that of the ‘classical’ programme in 1891. The *enseignement moderne* had its own ‘modern’ *baccalauréat* in what was intended as a move towards the unity of secondary education.<sup>1</sup> In addition to the provision in secondary education, chemistry was also taught in a number of vocational schools, though at a level that offered an inadequate coverage of the techniques used in the chemical industry.<sup>2</sup>

Higher education had been reformed in the previous decade, but the reforms had left unresolved the fundamental question of institutional titles. Should higher education be dispensed by individual faculties (as had been the case since the founding of the National University by Napoleon in 1808) or by Universities? The budget legislation of 1893 created groups of faculties (*corps de facultés*) in the major cities. These were hybrid bodies, somewhere between loose federations of individual faculties and true Universities. The reform of 1893 also introduced the PCN, a one-year programme of preparatory study in physics, chemistry and natural history, required for entry into a Faculty of Medicine: as part of this change, teaching of chemistry that had previously been conducted in Medical Faculties

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was transferred to the Faculties of Science. In 1896, the *corps de facultés* were redesignated as Universities,<sup>3</sup> and in a symbolic act signalling the change the new buildings of the Sorbonne were completed.

On the economic front, a visit to the international exhibition in Chicago in 1893 led Albin Haller, Professor at the Faculty of Science in Nancy, to sound the alarm with regard to chemistry. His report, which he submitted to the Minister of Commerce and Industry in the following year, reads as a solemn warning against the threats to the French chemical industry.<sup>4</sup> Haller insisted, for the industry to become competitive, in particular with its counterpart in Germany, it was essential to improve the teaching of chemistry, most notably in relation to industrial practice. The report, reinforced by other contributions by Haller, made a great impact in the press. When extensive extracts from the report were published in the *Revue générale des sciences* in 1894,<sup>5</sup> the journal's editor Louis Olivier described the enthusiastic response of his readers, both in the administration and among teachers.<sup>6</sup> In response to readers' demands for further discussion of the issues, Haller's articles were reissued as an independent volume in 1895.<sup>7</sup> The volume began with a discussion of the relations between higher education and industry in different countries, followed by a statistical comparison between output in the chemical industries of Britain, Germany, France, and the rest of the industrial world. Only one conclusion could be drawn. This was that France lagged far behind Britain and even more so Germany. The evidence did much to ensure renewed interest in the request for the creation of a school of practical<sup>8</sup> chemistry in Paris that the chemical manufacturer and Senator Alcide Poirrier had submitted to the Senate in 1893 (see below).

### **Practical chemistry in Paris during the 1890s**

In Paris, there were few institutions that prepared chemists for high-level industrial employment. The most prestigious of those that did so was the *École municipale de physique et de chimie industrielles* of the city of Paris (EMPCI). Opened in 1882, the school trained a limited number of pupils in accordance with a programme that gave prominence to laboratory classes (*travaux pratiques*). Candidates, all Parisian and aged between 14 and 18, were required to pass an entrance examination, after which three years of study led on to the diploma for the ablest pupils and for the rest, a leaving certificate. In this way, the school trained both chemists and foremen, i.e. in present French terminology 'ingénieurs' and 'techniciens'.<sup>9</sup>

Until 1891, another very popular school had been the one that Edme Fremy (1814-1894) ran in his practical chemistry laboratory at the *Muséum d'histoire naturelle*. A pupil of Gay-Lussac and Pelouze, Fremy was appointed to Chairs first at the *Muséum* and then at the *École polytechnique*. He was well connected on many fronts, including the Academy of science of the Institute of France (where he was elected in 1857) and Parisian high society. He also maintained strong links with manufacturers and was an administrator of the Saint-Gobain factory. Entry to Fremy's school, which he founded in 1863, was free of charge, and there were no formal entry requirements and no diploma. The programme of study lasted three years, but many students left after six months to work in a factory or laboratory. At the *Muséum*, they learned practical work 'à la paillasse', acquiring skills that employers greatly appreciated. Fremy was particularly well known for his dexterity as an experimenter, and he offered no theoretical instruction. Between 1863 and 1891, more than 1400 students were trained, including Henri Moissan. But on 13 December 1891, the laboratory closed, provoking strong reactions in the press and from the *Société chimique de Paris*, which asked for the reopening of the laboratory, without success.<sup>10</sup>

### A debate in the Senate

Industrialists themselves had raised the question of practical training in the *Société chimique de Paris*. Early in 1891, the chemicals manufacturer Louis-Alphonse Adrian, a member of the *Chambre syndicale des produits chimiques*, had presented the council of this Society with three different proposals for a school of practical and industrial chemistry.<sup>11</sup> The second of the proposals recommended that laboratories for applied chemistry, supported by grants from manufacturers, should be attached to certain Faculties of Science or to Higher Scientific Schools.<sup>12</sup> The resulting discussion was both fierce and confused.<sup>13</sup> Several members of the council were already committed to strengthening the relations between academic chemistry and the industrial world, and a number of attempts had been made to create an industrial section. Among the Presidents of the Society, who were particularly active in this respect were Charles Lauth (1883), Paul Schützenberger (1885), Philippe de Clermont (1886), Achille Le Bel (1892), Charles Friedel (1888) and Auguste Scheurer-Kestner (1894).<sup>14</sup> Among these, Charles Friedel (1832-1899), an Alsatian, crystallographer and chemist, was especially important. He had been a student of Wurtz, was a champion of the atomic theory, and succeeded Wurtz in the Chair of Organic Chemistry at the Sorbonne (1884). He was in regular correspondence with Scheurer-Kestner, whom he invit-

ed to accept the presidency in 1892: “I hope that in this way you will be willing to give a helping hand [...] in our efforts to establish an ever closer bond between industry and chemical science”.<sup>15</sup> Together, between 1894 and 1898, Friedel and Scheurer-Kestner worked to establish a Section of Industrial Chemistry in the Society, but with little success. Scientifically and economically, however, the general climate was favourable. This was a good moment, in fact, at which to ask the government to found a programme of advanced training in practical and industrial chemistry.

It was from this context that the Laboratory of Practical Chemistry in the *rue Michelet* (1896) emerged. The founding benefited from two other institutional opportunities: first, the closing of Fremy’s laboratory at the *Muséum* (13 December 1891) and, secondly, the installation of the Faculty of Science in the New Sorbonne, in the southern part of Henri-Paul Nénot’s building in the *rue Cujas*.

On 24 March 1893, Senator Alcide Poirrier said to the Minister of Public Instruction, in the debate about the *Muséum*’s budget for 1894: “There was a distinctive style of chemistry teaching in Mr. Fremy’s laboratory; it was the only laboratory where young men could acquire the knowledge necessary for work in the chemical industry. Now, the laboratory has been closed, and this has not improved the situation, far from it”.<sup>16</sup> At the time, Fremy’s name was familiar to everyone. His wife’s death had recently been announced in the press, and Fremy’s health was failing. Hence it was understandable that Poirrier should choose to cite Fremy in the debate, barely a year after the laboratory at the *Muséum* was closed.

Trained in business, Alcide Poirrier (1832-1917) became one of the heads of the *Société des matières colorantes de Saint-Denis*, in 1858. In 1870, he was a member of the *Chambre syndicale des produits chimiques* (subsequently its President), and in 1879 he became a member of the *Chambre de commerce de Paris* (later Secretary, Vice-president, then President for three years). In 1889, he was elected Senator (for 28 years), sitting on the political left, and Vice-president of the Senate from 1902 to 1905. As a close friend of Lauth, Scheurer-Kestner, and Friedel, and an active member of the *Société chimique de Paris*, he spoke about Friedel’s plan for a school of practical chemistry in the Faculty of Science.

The Minister, Charles Dupuy, replied: “[Our] laboratories prepare for the examinations and degrees of the University, but they do not train for specific employment as a laboratory or production chemist ... I believe that in the budget for 1894... I shall be able to satisfy Mr. Poirrier’s request”.<sup>17</sup> The discussions contin-

ued, and the plan came to fruition two years later. In 1894, Friedel and his colleagues moved to the New Sorbonne, so releasing the buildings in the *rue Michelet* for use by the future laboratory.

### The Laboratory of Practical Chemistry (1896)

On 1 November 1896,<sup>18</sup> the Laboratory of Industrial and Practical Chemistry opened, with Friedel as director and Camille Chabrié as his assistant. The programme lasted three years, with respectively 50, 40 and 30 students. Each student had to pay 500F per year, as a contribution to chemicals and other materials for experiments, and the budget for the three years was 118 800F.<sup>19</sup> There were no formal requirements for entry to the laboratory apart from a solid secondary education, but as there were many applicants it was necessary to be selective.<sup>20</sup> In this respect, the context was similar to that of Fremy's laboratory, the instruction was entirely practical, and it was open to anybody with the necessary intelligence and skill. The *Comité de patronage* included a number of representatives of the industrial or political world such as Scheurer-Kestner, Poirrier, and Lauth, but initially industry gave no financial support.<sup>21</sup>

The Laboratory's original mission was to train chemists for work in the chemical industry and in faculty laboratories or other institutional laboratories such as the *Laboratoire municipal*. The standing of students at the end of the course was similar to that of superior technicians in our own day. Each year, a student was expected to take one certificate, and after the three years, the most successful students received a diploma as a chemist, awarded by the Faculty.<sup>22</sup> During the first two years, students learnt qualitative and quantitative analysis and performed laboratory exercises in inorganic and organic chemistry. The third year was devoted exclusively to the chemical analysis of manufactured products, both organic and inorganic. Along the way, students were introduced to manufacturing processes and to the handling of apparatus they might be expected to use later in industrial laboratories. Theoretical teaching was not neglected: in addition to lectures in the faculty, students attended lectures on industrial chemistry and applied physics, as well as ones by the laboratory staff.<sup>23</sup> The additional training in theory means that the similarity to Fremy's laboratory breaks down. The practical instruction consisted of a large number of laboratory classes intended to inculcate not only a high level of manual dexterity but also (because of a large measure of freedom in the teaching, here as in Fremy's laboratory<sup>24</sup>) a spirit of initiative. As for the syllabus, Friedel's laboratory of practical chemistry had much in common with the *École municipale de physique et de chimie industrielles*.

This is hardly surprising, given the shared aspirations of the chemists who founded the two institutions.

### **Friedel's succession (1899)**

Friedel had been very active in Dreyfus's cause. His engagement in support of justice drained much of his energy, and in April 1899 he died. He left two posts to fill in the Faculty of Science: the Chair of Organic Chemistry, in the *rue Cujas*, and the position of Director of the Laboratory of Practical Chemistry, in the *rue Michelet*. In the Council of the Professors of the Faculty, there was discussion of whether the two Chairs should be transformed into a single Chair of Applied Chemistry, or whether the distinction between the two posts should be maintained. Haller was invited to accept both posts. But he accepted only the Chair of Organic Chemistry,<sup>25</sup> while the Laboratory of Practical Chemistry was entrusted to Henri Moissan.<sup>26</sup> One year later (1900), at the Faculty of science in Paris, the Chair of Chemistry (Troost's) fell vacant, and Moissan was appointed to the post, which he held in addition to the directorship of the Laboratory.<sup>27</sup>

### **Moissan's long-term task**

Moissan was faced with two urgent tasks. The first was to resolve the question of the dilapidation of the building, which was in danger of collapse. On 26 June 1900, for example, students had their feet in water because of leaks, rust was falling from the chimneys into the crucibles, gas-mains were leaking, the work-surfaces were burnt and marked, the roof was beyond repair and letting in rain, etc.<sup>28</sup>

The second task was to raise the standard of the students, improving their theoretical instruction and their general command of the subject. The view that Moissan expressed to the Council of the Faculty on 10 November 1900 was unequivocal: "Some of them [students] are impeded in their analytical work because they don't know the rule of three! An examination for entry to the laboratory should be introduced".<sup>29</sup> He asked too that the students should be required to follow the lectures for the licence.

The name *Institut de chimie appliquée* (given to the Laboratory in 1901) was changed to *École nationale supérieure de chimie de Paris* (ENSCP) in 1948. Now, the entrance examination is difficult, and the chemical engineers who graduate from the ENSPC are generalists with excellent career prospects. As successor to Friedel, whose ideas he followed, Moissan (Nobel Prize, 1906) brought great fame

to the Institute. In particular, he was sensitive to the evolving nature of instrumentation in chemical laboratories, which increasingly drew certain techniques from physics. He also recognised that as electrochemistry and physical chemistry had emerged as major areas of chemical enquiry, and that the teaching offered to students had to constantly evolve.

## Conclusion

This case study has brought out the complexity of the structures and procedures for teaching and training in practical chemistry in Paris at the end of the XIX<sup>th</sup> century. The shifting requirements of manufacturers, the limited number of posts, and the cost of the training all conditioned what could be done. But, in conclusion, let me insist on the remarks that Chabrié (who succeeded Moissan as director in 1906) made at the banquet of the *Association des élèves de M. Fremy* in 1908: “[my] Institute would never have been founded if the *Muséum*’s laboratory had continued to exist... Friedel had often expressed to [me] the indignation he had felt at the closure”.<sup>30</sup> In that speech Chabrié was expressing an essential and important truth.

## Notes

<sup>1</sup> Danielle Fauque, “L’enseignement de la chimie et les exercices pratiques dans le cadre de la réforme de 1902”, in *Études sur l’enseignement des sciences physiques et naturelles*, ed. Nicole Hulin (Lyon: ENS Éditions, SFHST, 2001), 154-80, on 157-58.

<sup>2</sup> For more information, see Charles R. Day, “Education for the industrial world: technical and modern instruction in France under the Third Republic, 1870-1914” in eds Robert Fox and George Weisz, *The Organization of science and technology in France 1808-1914* (Cambridge: Cambridge University Press, 1980), 127-153.

<sup>3</sup> Alain Prost, *L’enseignement en France, 1800-1967* (Paris: Armand Colin, 1968), 252-254. See also Robert Fox, “Science, the University, and the State in Nineteenth-Century France”, in *Science, Industry, and the Social Order in Post-Revolutionary France*, ed. Robert Fox (Aldershot UK, Brookfield Vermont USA: Variorum, Ashgate, 1995), VIII, 66-145, on 110-118.

<sup>4</sup> Albin Haller, *L’Industrie chimique, les Produits chimiques et pharmaceutiques, à l’Exposition de Chicago. Rapport à M. le Ministre du Commerce et de l’Industrie, et à M. le Ministre de l’Instruction publique* (Paris: Imprimerie nationale, 1894). Review by Henri Moissan in *Revue générale des Sciences pures et appliquées (RGS)*, V (1894): n° 21, 829-32 (15 novembre).

<sup>5</sup> Albin Haller, “La lutte des nations sur le terrain de l’industrie chimique”, *RGS*, V (1894): 473-87 (15 juillet); “Sur quelques récents perfectionnements de la grande industrie chimique”, *RGS*, V (1894): 563-78 (15 août); “L’enseignement chimique à l’étranger. Laboratoires nouveaux”, *RGS*, VI (1895): 201-204 (15 mars).



- <sup>6</sup> Haller, "L'enseignement chimique", *RGS VI* (1895): 201, n. 2. Danielle Fauque & Georges Bram, "La chimie française à l'orée du XX<sup>e</sup> siècle", *Pour La Science* 189 (1993): 44-50, on 48.
- <sup>7</sup> Albin Haller, *L'Industrie chimique* (Paris: Librairie J.-B. Baillière et fils, 1895).
- <sup>8</sup> 'Practical': This word means that the pupil was trained in laboratory practices relevant to both pure and industrial chemistry. The time devoted to laboratory instruction was greater than that allocated to theoretical lectures.
- <sup>9</sup> Hippolyte Copaux (dir.), *École municipale de physique et chimie industrielles. Cinquante années de science appliquée à l'industrie* (Paris: EMPCI, 1932).
- <sup>10</sup> Danielle Fauque, "Organisation des laboratoires de chimie à Paris sous le ministère Duruy (1863-1869): Cas des laboratoires de Fremy et de Wurtz", *Annals of Science*, 62 (2005): n°4, 501-31.
- <sup>11</sup> I am grateful to Alan Rocke for drawing my attention to his point in correspondence in the spring 2007. Ulrike Fell and Alan Rocke, "The Chemical Society of France in its Formative Years, 1857-1914: Disciplinary Identity and the Struggle for Unity", in *Creating Networks in Chemistry: The Founding and Early History of Chemical Societies in Europe*, eds A. Kildeboek Nielsen and S. ěrbánová (London: Royal Society of Chemistry, 2008), 92-113. Marika Blondel-Mégrelis, "Esquisse pour une histoire de la Société chimique, 1857-2007", *L'Actualité chimique*, 310 (juillet 2007): I-XIX, on XII. Archives of the Société française de chimie (SFC), Procès-verbaux de la Société chimique de Paris (SCP), 20 juin 1891, 91-100.
- <sup>12</sup> SFC, procès-verbaux des séances du conseil de la SCP, 20 juin 1891, 91-93.
- <sup>13</sup> SFC, procès-verbaux des séances du conseil de la SCP, 20 juin 1891, 91-93; 7 décembre 1891, 95-96; 25 janvier 1892, 99-100.
- <sup>14</sup> Laurence Lestel (ed.), *Itinéraires de chimistes, 1857-2007. 150 ans de chimie en France avec les présidents de la SFC* (Les Ullis, France: EDP Sciences, SFC, 2008).
- <sup>15</sup> Charles Friedel to A. Scheurer Kestner, 29 novembre 1892, Bibliothèque nationale universitaire de Strasbourg, Mss 5982-83, p. 245 V°.
- <sup>16</sup> *Journal officiel de la République française (J.O.)*, Débats parlementaires, Sénat. Séance ordinaire du vendredi 24 mars 1893, 394.
- <sup>17</sup> *J.O.* (1893): 394. Also, Fauque, "Organisation des laboratoires", 530-31.
- <sup>18</sup> Archives nationales de France, Centre des archives contemporaines (CAC), Fontainebleau, ENSCP, 20010498, 131/1, Arrêté du 29 avril 1896.
- <sup>19</sup> CAC, 20010498, 131/1, Delpeuch's report, extract, 1895.
- <sup>20</sup> CAC, 20010498, 131/2, the *Doyen* G. Darboux to the *Recteur*, 29 novembre 1897.
- <sup>21</sup> CAC, 20010498, 131/1 V°, handwritten extract of the projected budget for 1896-1899.
- <sup>22</sup> CAC, 20010498, 131/1. It is clearly announced in the school rules that the diploma is a diploma of "ingénieur-chimiste" in 1896.
- <sup>23</sup> Paul Freundler, "Charles Friedel et l'enseignement pratique de la chimie appliquée à la Faculté des sciences de Paris", *Revue générale de chimie pure et appliquée* I (1899): 209-10.
- <sup>24</sup> Fauque, "Organisation des laboratoires", 503.
- <sup>25</sup> Archives nationales de France, Centre d'accueil et de recherche des Archives nationales (CARAN), Paris, AJ/16/5122, Registre des procès-verbaux des séances du Conseil de la Faculté des sciences, 4 juillet 1899, 249.
- <sup>26</sup> CARAN, AJ/16/5122, 28 octobre 1899, 256.
- <sup>27</sup> CARAN, AJ/16/5122, 18 juillet 1900, 283; 5 novembre 1900, 286.
- <sup>28</sup> CAC, 20010498, 131/2, Moissan to the *Recteur*, 26 juin 1900.
- <sup>29</sup> CARAN, AJ/16/5122, 10 novembre 1900, Moissan at the Faculty Council.
- <sup>30</sup> *Bulletin de l'Association des Anciens Élèves de M. Fremy* (1908): nouvelle série, n° 4, 173.