THE ORGANIZATION OF FRENCH UNIVERSITY CHEMICAL EDUCATION

J.-E. DUBOIS

*Laboratoire de Chimie Organique Physique de la Faculté des Sciences de Paris**

At the beginning of the century, the French university system seemed extremely well adapted to the needs of society since it offered those students who had passed their Baccalaureat examination (marking the end of secondary school education) two educational paths according to their aptitude and temperament: the 'Grandes Ecoles' and the Science Faculties.

In this dualistic system, described in *Figure 1*:

(a) the 'Grandes Ecoles de Chimie' (E.N.S.I. or 'Ecoles Nationales Supérieures d'Ingénieurs') produced engineers oriented towards industry, while

(b) the Faculties produced graduates in the physical sciences (physics and chemistry) oriented for the most part towards secondary school teaching careers and for the brilliant ones to an academic career.

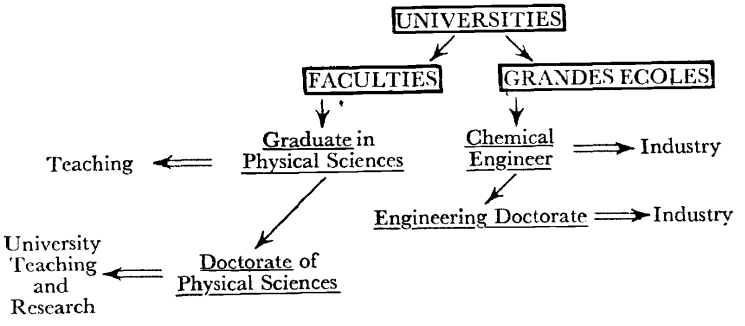

Figure 1. Organization of the universities before 1965–67*

This selective system (since only from one to eight per cent of a given age group received a higher education) worked relatively well for it dealt with small numbers.

However, the demographic increase in recent decades, the resulting rejuvenation of the country, and the increased population in higher education presented universities with problems of space, of staffing, in short, of pedagogy. Still more important was the problem of professional outlets. In fact, whereas the student of a 'Grande Ecole' was sure of obtaining a position, the Faculty student found himself unprepared for the requirements of the national economy, for the new necessities created by ever-increasing industrialization.

* Associé au C.N.R.S., 1 rue Guy de la Brosse, Paris V^e^.

In response to these pressures, the spirit of the university has progressively evolved, leading finally to the important reform whose foundations were established in 1964 and which concerns the structures, the programmes and the institutions of the university.

This evolution, which eases the alignment of French and foreign degrees and which markedly favours the orientation of the student, does not offer much to the chemistry schools (E.N.S.I.) but creates two parallel study cycles in what was, up to 1968, known as the university:

(1) the first leads to the creation of 'Instituts Universitaires de Technologie' (I.U.T. or University Technology Institutes) which offer a short, limited curriculum (two years) led by educators and professional chemists along original lines;
(2) reform of the previous university studies carried out in the Faculties, constitutes a long path whose steps are more clearly defined and whose studies are better integrated than formerly.

This second path is the one we shall discuss here, presenting the reforms which have affected degrees, titles and curricula. We shall also consider the institutional reforms.

I. STUDY STRUCTURES: DEGREES AND TITLES

The previous Faculty system has been replaced by a series of three levels of two years duration each: the first cycle or orientation, the second cycle or education, the third cycle or research training.
Figure 2 shows the organization of the Faculty system since 1965–67.

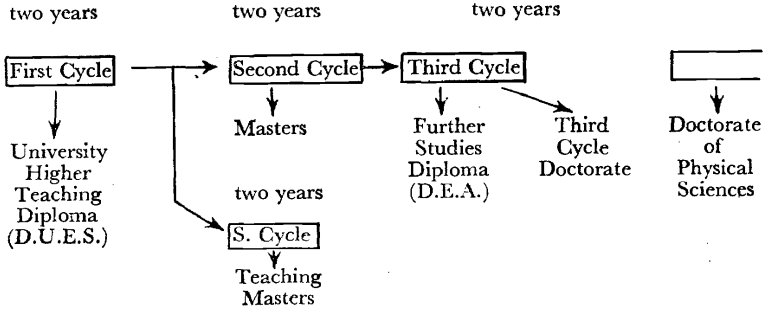

Figure 2. Organization of the Science Faculties since 1965–67.

(1) The first cycle

This leads to a D.U.E.S. ('Diplôme Universitaire d'Etudes Supérieures'). The choice among five orientations is not binding at this stage. Each orientation leads to about three potential Master's degrees. In chemistry, three combinations are possible: M.P., P.C. and B.G. (that is, Mathematics and Physics, Physics and Chemistry, Biology and Geology). These abbreviations point, of course, to the subjects most emphasized in these studies.

* A. *Figure 1* is valid for the *chemistry schools* where curriculum begins at the level of the second cycle; before entering these schools, students usually work for two years in 'preparatory classes' outside the university.
B. Several 'Grandes Ecoles' are not attached to any university, and deliver Engineering Degrees, but no Doctorate.

(2) The second cycle

In the second cycle, three Master's degrees have been created: two Master's degrees (four years of study: first cycle plus second cycle), one in chemistry and the other in physical chemistry, have functioned in the universities since 1967. A third Master's degree in physics and chemistry was created in 1968. Theoretically, this latter will be oriented towards high school teaching careers, while the other two should prepare for posts in industry and for research careers. In fact there are many signs that the physics and chemistry Masters degree will also prepare for industry and for research and might even, in the long run, be the most valuable one!

(3) The third cycle

This consists of research and course work and leads either to a D.E.A. ('Diplôme d'Etudes Approfondies') or to a Third Cycle Doctorate. The third cycle is very flexible and forms an easy entry for foreign students. With this grounding, the research worker may go on to a Physical Science Doctorate, the period for which is not specified but is generally from three to five years.

II. STUDY PROGRAMMES FOR FIRST, SECOND AND THIRD CYCLES

We shall now examine in detail the syllabuses of the three cycles.

(1) First cycle

The first cycle, which lasts two years, is divided into four sections. The specialization chosen in the first cycle determines what sort of chemistry Master's degrees can be taken in the second cycle (*Figure 3*):

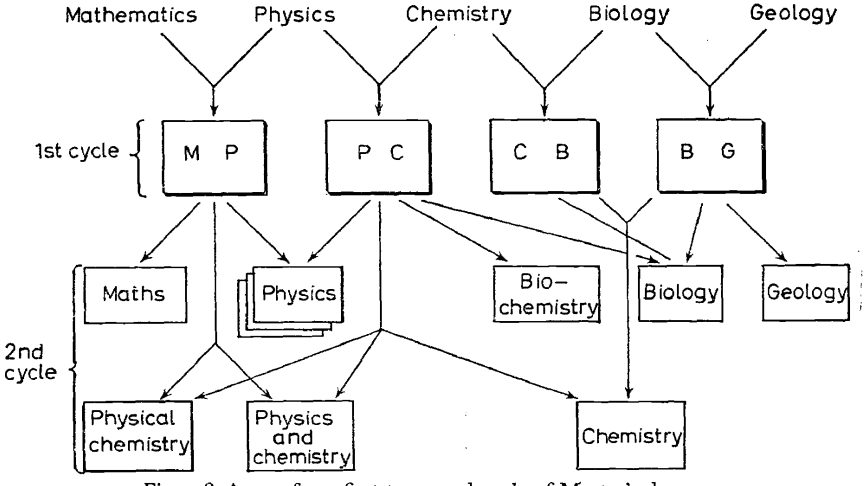

Figure 3. Access from first to second cycle of Master's degree.

(a) PC 1 + PC 2 give access to all three Masters;
(b) CB – BG + CB 2 give access only to the chemistry Masters;
(c) MP 1 + MP 2 tend to lead in other directions, mainly physics. It is, however, still possible to prepare the Physical Chemistry Masters and the Physics and Chemistry Masters and this is indeed advisable for future theoreticians.

(2) Second cycle

These programmes are very different for the Chemistry and Physical Chemistry Master's degree in the subjects chosen, the order of subjects and, above all, the average level of the students. The layout of the Master's degree is shown in *Figure 4.*

Degree	Duration	Certificate	
Chemistry	1st year	C1 C2	General Physical Chemistry Organic Chemistry
	2nd year	C3 C4	Inorganic Chemistry Option
Physical Chemistry	1st year	C1 C2	Chemical Bond and Spectroscopy Thermodynamics and Chemical Kinetics
	2nd year	C3 C4	Systematic Chemistry Option
Physics and Chemistry	1st year	C1	General Physical Chemistry Physics
	2nd year	C2	Inorganic and Organic Chemistry—Physics

Figure 4. Structure of Master's degree (2nd cycle).

The organization of the Research Master's degree is based on four units, called certificates, of which three are 'core' courses and one an option which is taken in the second year. This option allows the student to choose from a variety of more specialized courses according to his preferences. In the Teaching Masters there is no optional course. Details of the 'core' courses are given in *Figures 5* and *6*†.

Chemistry	Physical Chemistry
C1—*General Physical Chemistry* Atomic Structure Structure of Matter Spectroscopy Thermodynamic Principles Basic Electrochemistry Kinetics	C1—*Chemical Bond and Spectroscopy* Quantum Mechanics Spectroscopy
	C2—*Thermodynamics and Chemical Kinetics* Thermodynamics Electrochemistry Kinetics Physical Chemistry of Solid State
C2 + C3 + C4 (option) (See *Figure 6*)	C3 + C4 (option) (See *Figure 6*)

Figure 5. Comparison of the two Masters physical chemistry programmes.

† Parallel to this analysis, it is interesting to consider the usual programmes of the chemistry schools. The entry examination for these schools necessitates two or three years of study ('Mathématiques supérieures' and 'Mathématiques spéciales') which correspond roughly to the first cycle. The course work of the schools deals with much the same material as in the second cycle but with a greater emphasis on laboratory work and applied chemistry.

Chemistry	Physical Chemistry
C2—*Organic Chemistry* Simple and Mixed Functions Natural Substances Structure. Stereochemistry Reaction Mechanisms Physical Methods of Analysis	C3—*Systematic Chemistry* Physical Inorganic Chemistry Physical Organic Chemistry Functional Properties Structure Mechanisms
C3—*Inorganic Chemistry* Comparison of the Elements Inorganic Analytical Chemistry in solution in solid state	
+ C4 (option)	+ C4(option)

Figure 6. Comparison of the two Masters' organic and inorganic chemistry programmes.

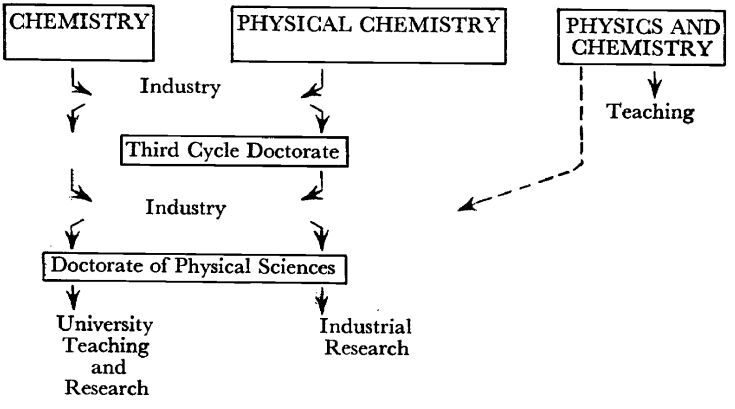

Figure 7. Outlets for chemistry Masters.

Having reached the end of the second cycle, let us now consider the possibilities open to the Masters graduate. *Figure 7* provides us with an answer to this vital question concerning the student's future: industry, teaching, or Third Cycle Doctorate.

After the Third Cycle Doctorate, two choices are possible: a post with industry, or research leading to a Physical Science Doctorate. The latter qualifies the student for a career in university teaching and research or in industrial research.

(3) Third cycle

(a) The third cycle (*Figure 8*) has no programme laid down at the national level. Its organization is based on broad delegations to groups of three or four professors who have the right to prepare students for a diploma of

advanced studies (D.E.A.) in a specific field covered by a general title (e.g. analytical chemistry, chemical kinetics, physical organic chemistry, chemical engineering, etc.). The course work leads to a certificate known as the A.E.A. ('Aptitude des Etudes Approfondies'). To this is added the student's report on the research he has carried out during this first year. The whole 'A.E.A. + Research' makes up the D.E.A.

Year	Programme	Diploma
First	Teaching and Research	Teaching: AEA AEA + Research = DEA
Second	Research	Doctor of Third Cycle

Figure 8. Organization of third cycle.

The second year of this third cycle consists entirely of research presented in the form of a thesis in order to obtain the 'Third Cycle Doctorate'.

(b) For a view of subject distribution of the various D.E.A.s in France, we shall refer to *Figure 9* which gives their breakdown under subject headings. The height of each column indicates the number of universities offering a particular diploma.

Diplomas in the more traditional disciplines (organic: 14 physical: 13, structural: 12) are the most readily available, followed by biochemistry, inorganic and physical organic chemistry. One is struck by the

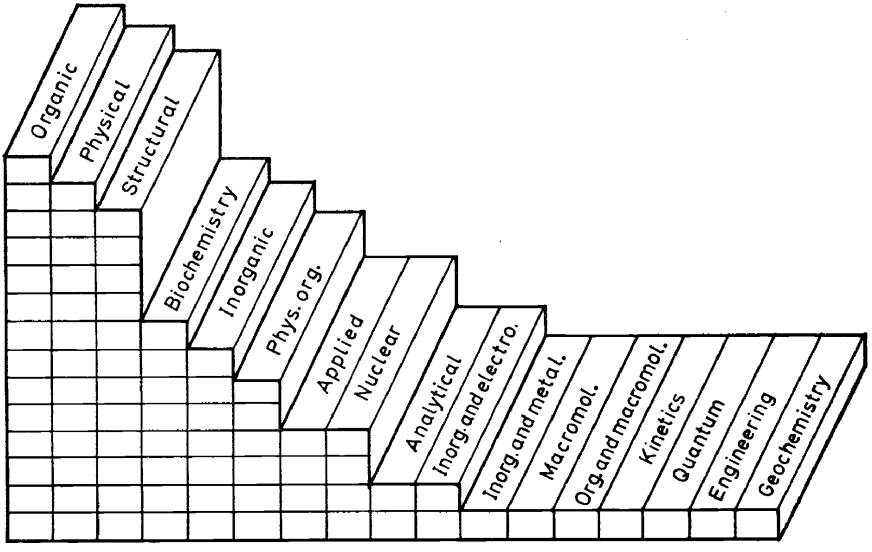

Figure 9. Breakdown of chemistry D.E.A. by subjects.

number of important subjects such as chemical kinetics, macromolecular chemistry, quantum chemistry, etc. . . . which can only be pursued in one university.

(c) With a view to the decentralization of advanced studies, several universities offer D.E.A. courses. The next three figures show the geographical distribution of those places where a student, after two years of study, can take a Third Cycle Doctorate (*Figures 10*, *11* and *12*).

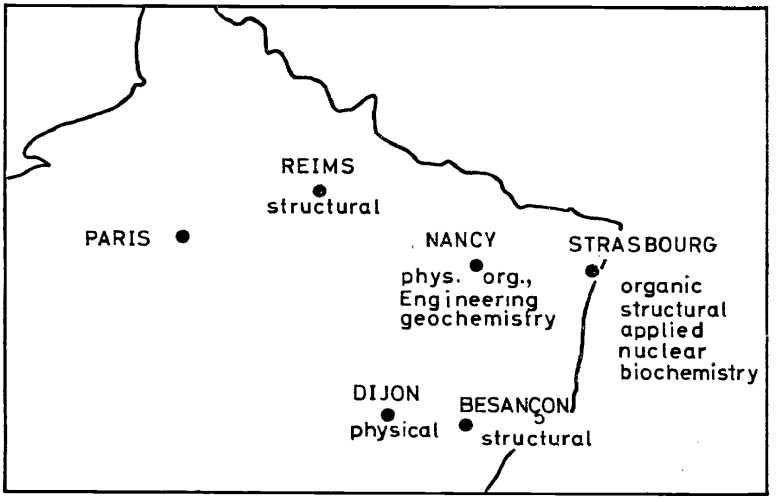

Figure 10. Geographical distribution of facilities for chemistry D.E.A.

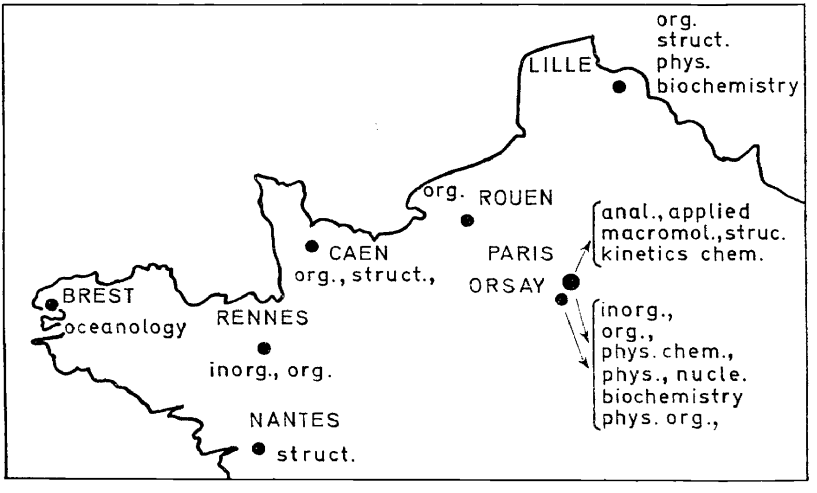

Figure 11. Geographical distribution of facilities for chemistry D.E.A.

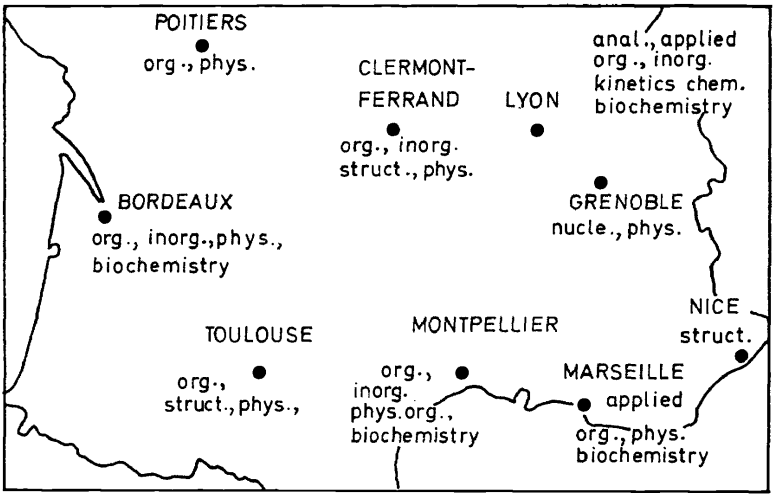

Figure 12. Geographical distribution of facilities for chemistry D.E.A.

(d) The nature of the final Physical Science Doctorate is still a matter for discussion. Five titles are now distinguished in France: Doctor in Physical Science, Doctor in Applied Science, Engineering Doctor, Specialized Doctor, University Doctor. Surely, some further simplification would be desirable here.

III. NATURE OF THE INSTITUTIONS

Between 1960 and 1968, in order to satisfy the large influx of students, France created four new Academies and numerous C.S.U.s ('Collège Scientifique Universitaire') and C.L.U.s ('Collège Littéraire Universitaire'). These latter are fairly small units, covering only the first two university years, which enable the student to begin his studies in a more human environment and one which is often closer to his home. Subsequently, however, the 1969 higher education law ('loi cadre') put an end to the entire centralized university system and, in its place, established a multitude of potential universities. University independence is thus fostered, and numerous local revisions in work and teaching methods have already been introduced, based on more active student participation (dialogue and discussions on laboratory work). Thus, both the Faculties and the C.S.U.s have been replaced by basic units called Teaching and Research Units ('U.E.R.'—Unités d'Enseignement et de Recherche).

At present, 630 U.E.R.s have been able to regroup themselves, usually in interdisciplinary university groups. (For example, the Medical Faculty in Paris has split into ten University Medical Centres). It should be noted that Chemistry U.E.R.s of various types have sprung up from the former Department of Chemistry of the Science Faculties. Some of these are traditional, such as 'Organic Chemistry', 'Inorganic Chemistry' and 'Physical Chemistry' (Paris), while others are more original, such as 'Applications of Chemistry' (Orsay) or 'Material Sciences' (Grenoble) and could lead to interesting developments.

Approximately 30 universities and multidisciplinary university centres have been established by this reform, where formerly only 18 universities controlled higher education, and it is already possible to envisage the creation of some 60 to 80 universities or university centres in the-not-too distant future.

CONCLUSION

Ten years of planning and research went into the elaboration of this reform. It encompasses a body of measures which will have transformed the structures of degrees and titles, created new curricula and modified the aims of education in the Science Faculties by preparing students for the chemical professions instead of preparing them to be professors of chemistry. It has also changed student–teacher relationships, enabling the former to participate directly in the diverse problems of the universities.

The creation of Teaching and Research Units has transformed a highly centralized system into a decentralized one, better adapted to satisfy the demographic and economic requirements of the world today.

While these institutions continue to evolve towards an ever increasing democratization of higher education, it should be noted that the question of the E.N.S.I. (schools of chemistry) has scarcely been touched upon. Only the recent trend towards research in these schools brings them closer in spirit to the universities.

This evolution of higher education in France should create conditions comparable to international trends and thereby facilitate real and fruitful exchanges of opinion on essential problems of chemistry.