Elena Brambilla

Scientific and Professional Education in Lombardy, 1760-1803: Physics Between Medicine and Engineering

We shall examine here the influence exercised on the teaching of the sciences by the reforms that changed the pattern of education and recruitment into the medical and engineering professions in Lombardy during Volta's lifetime (1745-1827). We shall consider in particular the first and most fruitful years of his research and teaching activity in Como and Pavia, i.e., from the 1760s to his partial retirement in 1803-4, when the government allowed him to continue supervising the Physics Laboratory and to give a short series of lectures each spring, without obliging him to live in the small university city and shoulder the whole didactic burden of a full-time professor.[1]

To gain a general understanding of the significance of University reforms in this period, it may be useful to start from an external rather than an internal point of view. I shall first try to describe the system of guilds which had provided practical training for the scientific professions, requiring either a university degree or a practitioner licence; I shall then briefly examine the teaching of "philosophy" in the public schools of the regular Orders, where future members of the learned scientific professions acquired most of their formal education. It will thus be possible to consider the effects of the laicisation of Jesuit schools, and of the heightened scientific requirements imposed for gaining access to professional practice, on the disciplines taught or newly introduced into the university and on the formation of a scientific community.

ASM = Archivio di Stato di Milano; p.a.= parte antica (old section); p.m.= parte moderna (modern section).
ONB = Wien, Österreichische Nationalbibliothek; Ms.= Handschriftensammlung.
HHSA = Wien, Haus-Hof-und Staatsarchiv, Italienisch-Spanischer Rat; Lombardei Collectanea = Lomb. Coll. (microfilmed in ASM). I am grateful to prof. Carlo Capra for having generously put at my disposal his unique information on the Viennese sources concerning Lombardy.

[1] *VE*, IV, pp. 231-357 passim; see also the reports by the Commission for Public Education and the Ministry of Interior to Vice-President Melzi, 5.X.1804 and 29.XI.1805, on Volta's compliance to resume teaching from Lent to May, ASM, *Studi* p.m. 973.

1. Professional Monopolies

The liberal professions relevant in this regard are those of the medical sector – physicians, surgeons and apothecaries – and the technical ones – engineers, architects and land-surveyors. Of these only physicians, before the enlightened reforms, were required to attend university and get a doctoral title or degree.[2] All others were licensed by urban Guilds, Hospitals or the State Supervisor of medical private practice, the *Protofisico*.

In the prevailing system of trade monopolies or corporations, inherited from the Middle Ages and only partially modified during the period of Spanish rule (1535-1714), the free professions were organised into self-governing bodies called *Collegi*, a nobler variant of the trade guilds.[3] Since the same term, College, applied also to ecclesiastical public and boarding schools, we shall use the Italian term *Collegio/i* to define these "noble" guilds of lawyers, physicians and engineers-architects, which restricted entry to patrician or genteel members only. The *Collegi* were urban-based

[2] The Italian university system, deriving from the Bologna model and having at its top the Faculty of Civil and Canon Law, was different from the system common both to English and continental universities on the Parisian model, which had at its top the Theological Faculty: in particular, it did not confer the first and second level of general degrees, *baccellierato* and/or *magisterium* in the propaedeutic Faculty of Arts and Philosophy (Bachelor and Master of Arts). It conferred only an advanced doctoral degree or *doctoratus* in the professional Faculties of Law, Medicine and Theology (roughly corresponding to today's PhD). However, one could obtain a minor licence to practice after two or three years of study (instead of the statutory four) in these higher Faculties, confusingly called by the same name as the practitioner licences given by guilds.

[3] M.C. ZORZOLI, "Università di Pavia (1535-1796): L'organizzazione dello Studio", in SOCIETÀ PAVESE DI STORIA PATRIA and BANCA REGIONALE EUROPEA, eds., *Storia di Pavia*, 4 vols., (Pavia, 1984-95), IV:2 (1995), pp. 427-81; for an exhaustive analysis of mathematics and physics courses, from the Austrian to the Napoleonic eras, F. BEVILACQUA and A. FERRARESI, "Per una storia dello sviluppo della matematica e della fisica a Parigi e Pavia nell'età della Rivoluzione", in *Annali di storia pavese*, 20 (1991), pp. 199-249. As regards science and the professions, I have tried to give a more detailed analysis in a few articles, to which I refer for sources and bibliography: E. BRAMBILLA, "Il 'sistema letterario' di Milano. Professioni nobili e professioni borghesi dall'età spagnola alle riforme teresiane", in A. DE MADDALENA, E. ROTELLI and G. BARBARISI, eds., *Economia, istituzioni, cultura in Lombardia nell'età di Maria Teresa*, 3 vols., (Bologna, 1982), III, pp. 79-160; ID., "La medicina nel Settecento: Dal monopolio dogmatico alla professione scientifica", in F. DELLA PERUTA, ed., *Storia d'Italia, Annali 7: Malattia e medicina*, (Torino, 1983), pp. 5-147; ID., "Le professioni scientifico-tecniche a Milano e la riforma dei Collegi privilegiati (sec. XVII-1770)", in G. BARBARISI, ed., *Ideologia e scienza nell'opera di Paolo Frisi (1728-1784)*, 2 vols., (Milano, 1987), I, pp. 345-446; ID.,"Libertà filosofica e giuseppinismo: Tramonto delle corporazioni e ascesa degli studi scientifici in Lombardia, 1780-1796", in D. BARSANTI, V. BECAGLI and R. PASTA, eds., *La politica della scienza: Toscana e stati italiani nel tardo Settecento*, (Firenze, 1996), pp. 393-433; ID., "Dagli antidoti contro la peste alle farmacopee per i poveri: Farmacia, alchimia e chimica a Milano, 1600-1800", in M.L. BETRI and D. BIGAZZI, eds., *Studi in onore di Franco Della Peruta*, (Milano, 1996), II, pp. 303-52.

and existed as the self-governing bodies of each profession in most of the capitals of the provinces of which the State of Milan was the aggregate sum – Milan, Pavia, Lodi, Como, Cremona, Casalmaggiore and Mantua.[4]

The right of self-government enjoyed by professional *Collegi* meant, in the first place, that they had the monopoly of licensing, i.e. of admitting or rejecting applicants who wanted to practise in the city and the subordinate provincial territory. They also acted as tribunals against those practising without licence, pursuing them with fines, suspension or expulsion. To enforce this monopoly, the *Collegi* could publish by-laws, called Statutes, laying down the requirements applicants had to meet to be admitted to independent professional practice. These were subject to the approval of the Senate, the highest Court of Law and Magistracy of the State, who supervised both the University of Pavia and the professions in the whole State.[5] Under these Statutes, during the period of Spanish rule in the 16th and 17th centuries, the urban *Collegi* of physicians and engineers had restricted access to the profession, making it legally dependent on birth and status requirements.

The result was a complex, segmented system of local monopolies, whose first aim was to co-opt selected members of the higher branch of the legal profession (*giurisperiti*) into the patrician city governments. The same system operated to restrict access to practice in the medical and technical professions, on the basis of extra-scientific, legally discriminating criteria. First, there were restrictions as to the place of birth. Although the doctoral title acquired at Pavia University, as in the case of physicians and graduate surgeons, should have allowed them to practise anywhere in the State, they were restricted to one province at a time, subject to the licence of the urban *Collegio*. Secondly, in each province those born in the countryside might be excluded from practising in the city, where access to the profession was reserved for those born of urban parents. Thirdly, to gain access to the *Collegio* itself, and thus to the government of the profession and to the most profitable posts and clients, one had to prove that one was born of a family "untainted" by trade or mechanical arts. At the beginning of the 18th century this requirement varied from two generations for engineers to three for physicians.

Legal requirements segmented the professions according to criteria of birth and honour, discouraging or positively forbidding promotion by merit from lower to higher legal status. Honour in the professions was graded along a scale of growing respectability in direct relation to their theoretical or speculative character, and in

[4] For the medical professions, a general inspection in 1766 reported three *Collegi* of physicians, two of barber-surgeons and five of apothecaries, the most powerful being in Milan (G. Cicognini presenting the *Regolamento della Facoltà Medica* to the *Giunta degli Studi*, undated but 1767, ASM, *Sanità* p.a. 186).

[5] While the noble graduate professions, lawyers and physicians, were subject directly to the Senate, the minor or undergraduate ones, being part of the civic systems of guilds, depended in the first instance on municipal authorities (such as the *Vicario di Provvisione* in Milan), but their Statutes had to be approved by the Senate.

inverse relation to their proximity to the mechanical or manual arts. In medicine, physicians had set up *Collegi* in Milan, Cremona and Pavia; surgeons and apothecaries also had their corporate organisations in most provincial capitals, but these belonged to the distinctly urban and plebeian world of guilds; barber-surgeons were a mechanical art and apothecaries formed one of the most powerful trade guilds.

Physicians of the urban *Collegi*, by their strict birth requirements, were sharply divided from the inferior medical trades. They had gained access to the patrician Order thanks to a combination of factors: they underlined the theoretical foundations of their discipline in Aristotelian or general philosophy, and restricted their practice to internal illnesses, requiring observation of symptoms and a general theory of the causes of illness but no manual intervention on the body. The cure of wounds and fractures, the incision of abscesses and phlebotomy were left to the manual, inferior "art" of surgeons. This "philosophical" primacy was reflected in the strict conditions set by the *medical Collegi* for co-opting new members (who had to prove noble status), while retaining the right to licence those physicians who could not join the *Collegio* because of their non-noble birth.

As for engineers and architects, their status was semi-genteel or "civil". Their powerful *Collegio* in Milan required urban birth and excluded from membership the sons both of rural parents and of citizens employed in the mechanical arts and trades. The élite of the profession had thus drawn a legal barrier between the more specialised urban engineers and architects, consulted for land management, contracts and evaluation of property by the great landed gentry, and the inferior land-surveyors excluded from urban practice, often employed in the countryside, as stewards of ecclesiastical and patrician landlords.

It had always been the goal of the *Collegi* of physicians to enjoy a complete monopoly of recruitment and practice, to the exclusion of "charlatans", defined as such on corporate grounds of irregular birth and licence, rather than on the basis of education, experience and merit. Such a monopoly, however, had never been really enforceable, since various rival institutions existed, boasting parallel or encroaching rights of training and licensing. Patrician medical *Collegi* had managed to retain a partial control on their profession, since they had the monopoly of licensing; by this means they could also control the number of apprentices. But they had been compelled to open a register for those unfit for membership but subject to their approval, who made up what was then variously termed "Aula" or "Faculty": the non-noble, main body of the profession. In fact, the number of *Collegio* members had steadily declined since the end of the 17th century, while the size of the "Faculty" was steadily growing. An important source of employment for these graduates in "philosophy and medicine", who were excluded by birth from *Collegio* membership, came from the old and well-established system of the *condotte*, contracts by which towns and villages hired a physician or a surgeon, or both, paying them a salary out of communal income to ensure a partially or totally free health service for their inhabitants.

Another of the many rivals of the medical guilds was the *Protofisico*, who was responsible for the pricing and licensing of drugs and the inspection of apothecaries' shops in the whole State, and also had (often in bitter conflict with urban *Collegi*), the right of licensing surgeons and medical practitioners, and of admitting to practice graduates from foreign universities. Lastly there were the hospitals, which as pious foundations, managed under canon law by patrician boards, were exempt from any government supervision and inspection, and trained their own barber-surgeons, higher surgeons and apothecaries, mostly through practice in the hospital wards, and sometimes also through attending internal schools, such as those intermittently operating at the General Hospital in Milan.[6] Hospital surgeons were admitted to private practice by their hospital certificate, and often enjoyed, understandably, more credit than their colleagues trained by private guild-masters, who had not gone through hospital apprenticeship.

As for architects, engineers and surveyors – of whom neither university attendance nor a degree was required – the *Collegio* of Milan had its rivals in some of the civil agencies of the central government. A technical service, the *Ufficio del Censo*, came into being for the execution and up-dating of the great land-survey (1718-60), on which the reform of direct taxation was based; another, classical field for engineers was the maintenance of the complex and highly advanced network of canals for the irrigation of the lower Lombard plain. A fiscal and judicial board, called *Magistrato Camerale*, was responsible, among its many duties, for the supervision of rivers, canals and waterways. This was financed through the levying of tolls at river stations, and the exaction of fees from landed proprietors, in proportion to the volume of water they used to irrigate their farms: measurement of flowing water and hydraulics were thus among the subjects on which the *Collegio* examined would-be engineers.[7] The *Magistrato* employed private, *Collegi* engineers, paying them as consultants on a day-to-day basis; but from mid-century onwards a new generation of skilled Cameral or fiscal engineers and surveyors, trained in the direct service of the State, began to challenge urban monopolies of recruitment.[8]

It must be remembered, however, that while civil engineers had a long-standing

[6] D.A. VERGA, *Intorno all'Ospitale Maggiore di Milano nel secolo XVIII, e specialmente alle sue scuole d'anatomia e chirurgia*, (Milano, 1871); G. COSMACINI, *Barbieri e norcini smettono di fare i chirurghi*, in *L'Europa riconosciuta: Anche Milano accende i suoi lumi (1706-1796)*, (Milano, 1987), pp. 257-85.

[7] For a sample of such exams, Milan, Archivio Storico Civico, Materie, 551.

[8] On the fiscal system and its reform, C. CAPRA, "Il Settecento", in D. SELLA and C. CAPRA, *Il Ducato di Milano dal 1535 al 1796*, (Torino, 1984), esp. on pp. 214-29; on its technical and mathematical aspects S. ZANINELLI, *Il nuovo censo dello Stato di Milano dall'editto del 1718 al 1733*, (Milano, 1963), pp. 40-8. On canals and engineers, the essays by M. SIGNORI, M. SAVOIA and G. LIVA, in L. GAMBI, ed., *L'immagine interessata: Territorio e cartografia in Lombardia tra 500 e 800*, Archivio di Stato di Milano-Como, New Press, 1984; G. BIGATTI, *La provincia delle acque. Ambiente, istituzioni e tecnici in Lombardia tra Sette e Ottocento*, (Milano, 1995).

and influential role in the economic and social fabric of Lombard agriculture, no such tradition existed for military engineering, whose beginnings at the Sforzas' Court in the Renaissance had been interrupted by the Spanish conquest, and had not been revived under Austrian rule. In the absence both of an independent dynasty and of an autochthonous military aristocracy, of the kind existing in the neighbouring reign of Sardinia, technical services for the foreign regiments stationed throughout the State had been provided mostly by foreign architects and engineers.[9] Military surgeons too, under Austrian rule, depended directly from the *Generalkriegskommissariat* in Vienna, and were cut off from the Lombard civil profession, although in their recruitment the local element may have played a wider role, as shown by the appointment of the Pavia surgeon Giovanni Alessandro Brambilla at the head of the military medical services in Vienna in 1779.[10]

The civil professions, on the contrary, were deeply rooted in the Lombard corporate tradition; but since birth prevailed on merit, no premium was put on advanced studies. This does not mean, of course, that ignorance reigned, but rather that the system favoured the transmission of knowledge along empirical channels, through family dynasties, private learning, and imitation. While the system as a whole was rooted in tradition and resistant to change, it could always leave room for gifted members, interested in improving themselves through voluntary study, and cultivating science to advance in their profession:[11] as is typical of a "connoisseur",

[9] Some data on military engineers in Lombardy in the 1740s and 1750s in ASM, *Militare*, 16; for an up-to-date review of the weight of the military sector in the Italian States, C. DONATI, "Il "militare" nella storia dell'Italia moderna dal Rinascimento all'età napoleonica", introduction to C. DONATI, ed., *Eserciti e carriere militari nell'Italia moderna*, (Milano, 1998), pp. 7-38. On the Piedmontese military schools, V. FERRONE, "L'apparato militare sabaudo tra l'antico regime e l'età napoleonica", in *La nuova Atlantide e i lumi: Scienza e politica nel Piemonte di Vittorio Amedeo III*, (Torino, 1988), pp. 176-93; ID., "I meccanismi di formazione delle élites sabaude. Reclutamento e selezione nelle scuole militari del Piemonte nel Settecento", in P. ALATRI, ed., *L'Europa tra Illuminismo e Restaurazione*, (Roma, 1993), pp. 157-200; ID., "Paradigmi scientifici e politica della scienza: La Reale Accademia di Torino e le scienze della vita nel Settecento", in *La politica della scienza*, cit. 3, pp. 307-18; on the Verona military school and the Venetian mathematical tradition, C. FARINELLA, *L'accademia repubblicana. La Società dei Quaranta e Anton Mario Lorgna*, (Milano, 1993).

[10] L. BELLONI, "Giovanni Alessandro Brambilla e l'equiparazione della chirurgia alla medicina", in *Giovanni Alessandro Brambilla nella cultura medica del Settecento europeo*, (Milano, 1980), p. 16; for the development of military medical services during the Napoleonic era, A. FORTI MESSINA, *Il soldato in ospedale: I servizi di sanità dell'esercito italico (1796-1814*), (Milano, 1991).

[11] For this voluntary, irregular and often haphazard course of advanced studies, mostly depending on the help of some rich relative and on access to noble libraries and patronage, see the case of G.B. Venturi (son of a land-surveyor of Parma and mathematician), W. SPAGGIARI, ed., *Giambattista Venturi. Autobiografia. Carteggi del periodo elvetico (1801-1813)*, (Parma, 1984), pp. 43-56; from the 1770s, however, the government began to replace this private study and patronage with post-graduate scholarships (the so-called *stipendi letterari*, ASM, *Studi* p.a. 350), sending the best student-apprentices to famous foreign schools and financing tours abroad, to update their education and then employ them as teachers: compare the studies of botany and

pre-institutionalised scientific culture, advanced studies were an individual exception to the rule, an optional qualification that could but need not to be added to the average, more limited requirements to enter the profession.

This is well reflected in the subordinate role of formal education. For the average surgeon, engineer or apothecary, schooling was usually limited to two to four years in the "humanities": the course of Latin grammar and rhetoric, taught in the high schools run by one of the teaching Orders, mostly Jesuits but also Barnabites, Piarists (Scolopi) and Somaschi; these were followed by four to six years of apprenticeship, at the end of which a practitioner licence was bought for a fee from the respective guild or *Collegio*. The professions of higher noble and theoretical status, lawyers and physicians, were supposed to undergo one or two more years of formal schooling, attending philosophy courses in the religious schools, and had then to acquire a university degree to be admitted to practice; but in fact, after they had learnt their Latin and philosophy, the specialised or professional part of their education consisted for them too in learning through observation, repetition and imitation, as private pupils of practising professionals.

The so-called *Istituzioni* or "first elements" of professional education – meaning the abridged introductory principles for beginners, rather than the theoretical foundations of the discipline – could be learnt by private voluntary study during the course of apprenticeship; if they were taught at all, this was mostly done through private lessons or "academies", given for a fee by senior members of the *Collegi* to their pupils-apprentices. Sometimes, short series of public lectures were given by junior *Collegi* members, such as the introductory courses of Law given by the patrician *Collegio* of *giurisperiti* in their palace in Milan, the so-called Palatine schools. Occasionally, lectures of *Instituta* were also given by *Collegi* in other provincial capitals, such as Cremona and Mantua; the schools of Pavia themselves had declined to this more modest role, providing lessons of *Instituta* for local would-be professionals. No more than a few weeks or months of desultory university attendance were necessary to get a degree, thanks to a system of legal fiction and illegal corruption, by which both attendance certificates and the title of doctor could be bought, without undergoing any serious examination;[12] furthermore, some *Collegi* could also graduate members fit for co-optation, thanks to privileges acquired by the pope or the emperor some time in the past (*jus doctorandi*). In sum, to qualify for a scientific profession, formal schooling was limited to a general course of Latin and philosophy, which was provided by clerical schools, according to the standard curriculum of the Jesuit *ratio studiorum*; no further period of formal scientific

chemistry by the Milanese apothecaries Ambrogio and Paolo Sangiorgio, father and son, the first an example of the old private system, the latter sent to Vienna and later employed as assistant to Pietro Moscati in the pharmaceutical school newly opened in the General Hospital in Milan, BRAMBILLA, "Dagli antidoti", cit. 3, pp. 336-8. On the growing recourse to scholarships to finance advanced studies, especially on funds of the Ghislieri College, ASM, *Studi* p.a. 212, 350.

[12] Kaunitz to Firmian 9.V.1769, ASM, *Studi* p.a. 158.

instruction was required, since the *Instituta* for each profession were learnt during, rather than before apprenticeship.

2. The Jesuit University of Brera

In the corporate organisation of the professions, then, education was roughly divided into two parts: formal schooling was limited to general education, either in Latin only or in Latin and philosophy; the specialised, professional part of training was essentially practical. The philosophical courses, therefore, were the crucial element that could make a difference, providing theoretical principles and general foundations for the scientific professions. Since the Counter-Reformation, the new teaching Orders, first among them the Company of Jesus, had acquired a virtual monopoly of philosophical lectures and courses: from the late 16th to the 18th century, in the whole of Italy their role had been central in the teaching of sciences.[13] As is well known, mathematics and general physics were included, together with logic and metaphysics, under the broad label of philosophy as the second level of the *ratio studiorum*. This was an intermediate level between that of high-school, for Latin and humanities, and the professional Faculty of Theology: in the State of Milan, the physical and mathematical sciences – within the limits then allowed by censorship – were learnt, taught and studied in the Philosophical Faculties of religious monasteries and Colleges, and especially in the so-called "complete" College (*Collegio di Pieno Esercizio*) of the Company of Jesus in the Brera Palace in Milan, built by the Senate and the city to host their public schools.

This institute of higher education, before the dissolution of the Order in 1773, corresponded much more closely than the modest and decayed schools of Pavia to the model of Austrian and German Catholic universities: the Jesuit schools in Brera were in fact a university, of the type classified by German scholars as composed of two Faculties, philosophy and theology, and endowed by the Pope with the right of graduating in theology.[14] The main difference between this type of pontifical universities outside the Papal State, and their equivalents beyond the Alps, was that in Italy they were neither subject to the supervision of secular governments, nor included in the State system of university Faculties, but depended only from the provincial and central authorities of the Order, the Roman Curia and the Pope

[13] G. BARONCINI, "L'insegnamento della filosofia naturale nei Collegi italiani dei Gesuiti (1610-1670): Un esempio di nuovo aristotelismo", in G.P. BRIZZI, ed., *La "Ratio studiorum": Modelli culturali e pratiche educative dei Gesuiti in Italia tra Cinque e Seicento*, (Roma, 1981), pp. 163-215; U. BALDINI, *Legem impone subactis: Studi su filosofia e scienza dei Gesuiti in Italia*, (Roma, 1992); R. GATTO, *Tra scienza e immaginazione. Le matematiche presso il Collegio gesuitico napoletano (1552-1670 ca.)*, (Firenze, 1994).

[14] K. HENGST, *Jesuiten an Universitäten und Jesuitenuniversitäten*, (Padernborn, 1981); R.A. MÜLLER, "*Universitas et Societas Jesu:* The Catholic Universities in Early Modern Germany", in A. ROMANO, ed., *Università in Europa: Le istituzioni universitarie dal Medioevo ai giorni nostri*, (Messina, 1995), pp. 395-403.

himself.

The public schools of the University of Brera were attended by the patrician inmates of their exclusive boarding College (*Collegio dei Nobili*), by hundreds of out-pupils from city families and by senior clerical students boarding in the major episcopal seminaries, who until the middle of the 18th century went to hear the Fathers' lessons for their advanced studies and grades in theology and canon law. The Jesuit high schools in Pavia, Monza and Cremona were subordinate to the head-schools in the capital. They were limited to the lower and middle levels of the *ratio*, from humanities to philosophy. The Company had opened another "complete" University-College in Mantua, when this city was still the capital of an independent minor State. In addition to this most influential school system, one must mention the high schools or *gymnasia* of episcopal seminaries, attended by several hundred students, not only clerical but lay, and the many regular Orders who also had their own schools of humanities, philosophy and theology. Some were limited to the "private" or internal education of members, as the various Benedictine congregations; others kept public schools, such as the Barnabites, Piarists and Somaschi, who were especially dedicated to teaching by their Counter-Reformation calling or *Beruf*.[15]

In the University of Pavia itself, professorships in the philosophical and theological disciplines were handed over to religious monasteries and Colleges: the Dominicans of San Tommaso had pride of place for dogmatic theology, the residential College of the Jesuits with its public schools (*Scuole del Gesù*), built just in front of the two Courts (*portici*)[16] of the University, taught moral theology in addition to the complete Latin and philosophical courses.[17] In 1767 the last *Tabulae*

[15] (G. CICOGNINI), "Del sistema letterario di Milano. Discorso", ONB, Ms. 12971, gives a list of the major religious Colleges and endowed foundations in the State; in Milan, the most important ones besides the Jesuits were the Barnabites, who also had a boarding College, and taught in their palace in S. Alessandro. According to M. BERNUZZI, *La Facoltà teologica dell'Università di Pavia nel periodo delle riforme (1767-1797)*, (Milano, 1982), pp. 30-1, in Milan seventeen regular "families" (monasteries) had schools of philosophy and theology; the archbishopric had three seminaries (*Maggiore* for students graduating in theology, *Canonica* for parish clergy, *Elvetico* for the Swiss protestant territories), with a total of 587 students in 1767. The archbishop Pozzobonelli suggested that teachers of physics and other *Oblati* attend Brera for experimental physics, letter to Kaunitz, 24.VII.1774, ASM, *Studi* p.a. 333.

[16] CICOGNINI, Report on the reform of the medical Faculty, 1767, annex D, ONB, Ms. 13992: the University was then organized in two *Portici*, one for Canon and Civil Law (with 6 professors), and the other for Theology and Arts, including also the philosophical and professional lectures for medicine – a telling sign of the subordination of philosophy to theology.

[17] Public schools in humanities and philosophy were also kept in Pavia by Somaschi and Barnabites (in Canepanova), who taught also dogmatic and moral theology; the teaching staff of the Theological Faculty was traditionally composed of five Dominican friars of the monastery of San Tommaso (BERNUZZI, cit. 15, pp. 37-8); among them were traditionally chosen the local judges of the Inquisition. In 1767, Pecci of the *Giunta degli Studi* attributed the decline of the University especially to the Jesuit schools (ASM, *Studi* p.a. 375): "sono popolate in quella città le

lectorum reflecting the policy of appointment by the Senate (who since 1757 had started a first, reluctant attempt at reform), listed 17 professorships altogether, only four of whom had some scientific relevance, botany, experimental physics, "philosophy with Euclid", and mathematics. Botany (then unoccupied) was in fact pharmacy limited to drugs from herbs (chemical remedies having been banned from "classical" university lecturing by papal censorship since 1584), and was thus part of the Medical Faculty, with theoretical and practical medicine and anatomy. In the propaedeutic Philosophical Faculty, physics and philosophy – on whom we shall return later – were then taught by two friars, one a Franciscan and the other a Somasco; only for mathematics the Senate had taken the pains to find a truly brilliant professor, and characteristically had looked for him in the headquarters of all Jesuit Universities, the Roman College. But the Dalmatian Jesuit Ruggero Boscovich (at Pavia 1764-68) complained at once about the sad lack of even minimal research facilities, such as a library, and soon obtained to be moved from the College of Pavia to Brera, with the task of providing it with an Astronomical Observatory.[18] The only schools really active in the University were the great boarding Colleges of papal and archiepiscopal foundation, Ghislieri and Borromeo, reserved for patrician fellows to be trained in theology and canon law. In 1767, a report reckoned that out of a total of only 153 students in Pavia, at least a hundred were supported by fellowships and scholarships intended for training higher clergy, canon law barristers and controversialist theologians.[19]

Thus, clerical schools provided education for all classes and professions, as well as for secular and regular clergy: one must not think of the "Theological Faculty" as a *school* occupying some definite university building, but as the *corporation* of all doctors in Theology, graduated by the many schools present in religious monasteries and Colleges scattered throughout the State. The two "Faculties" of medicine and law must be conceived on the same lines, as the corporate group of pupils and graduates of each profession. The advanced part of their education, as already said,

scuole dei Barnabiti, del Seminario vescovile, e specialmente quelle dei Gesuiti, i quali abitando in faccia all'Università richiamano la frequenza delli scolari nel tempo che le pubbliche scuole sono quasi abbandonate e deserte"; it may be recalled that the Republic of Venice had long forbidden the Company to open public schools in its territory, and especially to compete with the University of Padua, E. BRAMBILLA, "Società ecclesiastica e società civile: Aspetti della formazione del clero dal Cinquecento alla Restaurazione", in *Società e storia* (1981), pp. 308-29; V. SIGNOROTTO, "Venezia e il ritorno dei Gesuiti (1606-1657)", in *Rivista di storia e letteratura religiosa* (1992), pp. 277-317; M. ZANARDI, ed., *I Gesuiti a Venezia: Momenti e problemi di storia veneziana della Compagnia di Gesù*, (Padova, 1994).

[18] Boscovich to Frisi, 16.V.1764, quoted by G. TAGLIAFERRI, "Boscovich and Milan", in M. BOSSI and P. TUCCI, eds., *Bicentennial Commemoration of R.G. Boscovich: Proceedings*, (Milano, 1988), p. 17; E. MIOTTO, G. TAGLIAFERRI and P. TUCCI, eds., *La strumentazione nella storia dell'Osservatorio astronomico di Brera*, (Milano, 1989), pp. 11-8. On special conditions for Boscovich and the government's role (mostly underrated) in promoting the Observatory, BRAMBILLA, "Le professioni scientifico-tecniche", cit. 3, pp. 438-9.

[19] CICOGNINI, Report on the reform of the Medical Faculty, 1767, ONB, Ms. 13992.

had the form of *Istituzioni* and apprenticeships; both were provided by urban *Collegi*, who conferred also the necessary permits to practice, thanks to their rights of self-recruitment and licensing. Thus, the twin systems of patrician *Collegi* and ecclesiastical Colleges had completely superseded the functions of the medieval and Renaissance university, which had withered away since the Counter-Reformation and especially during the 17th century.

3. Abolition of Professional Monopolies: The First Stage

Inevitably, however, exclusion from *Collegi* on grounds of birth gave rise to inter-professional envy and competition. On the outskirts of the privileged urban élites there were always groups bitterly opposed to the system that excluded them, not for lack of scientific titles, but because of their bourgeois, commercial or rural origins. These were the first enemies of corporate privilege; they were especially keen, on one side, to prove themselves superior in knowledge to their betters by birth; they were quite ready, on the other side, to support the government, as soon as it embarked on a course of anti-monopolistic reforms.

Starting from the 1760s, in fact, first the Austrian and then the French republican governments adopted an anti-corporation policy, whose general aim, as regards the liberal professions, was to abolish the rights of licensing and graduating of urban *Collegi*, and to transfer them to the State University, as the sole holder of the right to give *legal value* to professional titles and degrees. This legal value, in fact, must be seen as a part of the general power to legislate, which was to be the exclusive prerogative of the State: in the Austrian period, the State was still identified with the sovereign as a law-giver, and therefore with his executive, central government, as was typical of enlightened absolutism; after the French Revolution, legislative power was transferred, at least in principle, to representative elected assemblies, within the limits of a written constitution.

The struggle against corporate rights and privileges went through three stages of growing radicalism. The first, already at an end when Volta was called to Pavia, may be considered to have begun in 1765, when the Senate was deprived of its authority over the University and the professional *Collegi*, in favour of a new government agency, the Committee for School Reform (*Giunta degli Studi*); it ended around 1775, when the *Giunta* published new ordinances for the policing of the medical and engineering professions, after having reformed the University of Pavia (1771-73). The second stage covers the years 1783-88, at the peak of emperor Joseph II's energetical drive for reform – broadly defined as *giuseppinismo* – when *Collegi* and guilds were temporarily abolished. The third and most far-reaching one took place during the French republican period (1796-99), beginning with the abolition of monopolies proclaimed in the new constitution, and ending with the

general laws reorganising Universities and public schools in 1802-3.[20]

In the first stage, from 1765 to 1773-75, perhaps the most important change concerning the professional Faculties of the University of Pavia was their deliverance from the grip of local patrician *Collegi*. The transfer of the power of appointment to an agency of the central government abolished the previous system of self-perpetuating monopoly, which had guaranteed native professionals a sort of birthright to university lectureships. Vienna spared no expense to attract the most famous "foreign" teachers available – meaning those born outside the university city as well as the regional State[21] – with the aim of giving the "royal" university a more than local, possibly international, renown. As Piero del Negro has shown,[22] this was a *sine qua non* to keep teaching active, as in the few universities in northern Italy, such as Turin, and in some measure also Padua and Pisa, which could boast some scientific reputation: only where appointments were in the hands of committees of the central government, such as the *Riformatori dello Studio* in Venice, the *Magistrato della Riforma* in Turin, and now the *Giunta degli Studi* in Milan, it was possible to free university chairs from the almost hereditary monopoly of native graduates and professionals.

The Faculties of Law and Medicine in Pavia were to replace the patrician urban *Collegi*, as the new State channels for the recruitment of lawyers and physicians. Only degrees granted by royal authority were to be legally valid, giving access to practice in the whole territory of the State, and they were to be granted only after exams of knowledge and merit. From 1766 onwards, a general suspension was ordered of all corporate rights of licensing and graduating,[23] and the powers of professional *Collegi* were undermined in one important respect, since they lost the right to legislate on conditions of entry. As for doctoral titles and degrees,[24] all clerical and corporate privileges to confer them were suppressed to the benefit of the University, where graduation was reformed between 1769 and 1771, and a new and effective system of private and public exams was introduced. As for admissions to practice, new requirements were prescribed in 1775 both for the medical and the technical professions. These were published not as corporate by-laws but as

[20] *Statuti e ordinamenti per la storia dell'Università di Pavia*, (Pavia, 1925), pp. 201-309.

[21] Kaunitz to Firmian, 3.I.1774, ASM, *Studi* p.a. 381: "every national, unless he be native of Pavia, may be considered a foreigner". For the success of this policy, see for example the comment by a patrician from Genoa, 8.IV.1779, quoted by C. FARINELLA, "Gli anni di formazione di Gio. Carlo e Girolamo Serra", in *Loano 1795: Tra Francia e Italia dall'Ancien Régime ai tempi nuovi*, (Bordighera-Loano, 1998), pp. 85-6.

[22] P. DEL NEGRO, "Il principe e l'università in Italia dal XV secolo all'età napoleonica", in G.P. BRIZZI and A. VARNI, eds., *L'università in Italia fra età moderna e contemporanea*, (Bologna, 1991), pp. 11-27.

[23] For medical *Collegi* ASM, *Studi* p.a. 158, *Sanità* p.a. 186, 187; for engineers, ASM, *Studi* p.a. 150, Archivio Storico Civico, *Materie* 551; Brera National Library, Milan, AO II 30B, *Gridario relativo alle arti e professioni*.

[24] See footnote 2.

government ordinances.

Theresian reforms, however, stopped halfway on this road. Until 1786-88, a double system of recruiting continued to exist: lawyers and physicians, of higher noble and theoretical status, were obliged to attend university lectures and take their final exams and degrees in Pavia; surgeons, apothecaries, engineers – the minor technical and "mechanical" Arts – were allowed to maintain their provincial self-recruitment almost intact, with one major correction: one or two years of schooling were introduced for the study of the "first elements" or *Instituta* of each profession. In the provincial capitals, and especially in Milan and Mantua, these were entrusted to lecturers appointed by the government, although often chosen among members of the *Collegi*. In Milan, in the ancient seat of the Palatine, new professional courses of *Instituta* were opened both for the private sector and for civil service, as we shall shortly see in further detail; new and more active government agencies, such as the *Supremo Consiglio d'Economia* – replacing the *Magistrato Camerale* for fiscal and economical reforms – began to call on foreign mathematicians and university professors to give expert consultation on the building of new canals, the improvement of internal navigation and the drawing of maps; the Court, too, began to employ full-time architects for its building programs and public works, from hospitals and prisons to the royal theatre, including new halls and laboratories for the University itself.[25]

A new *Regolamento* for engineers was published in 1775 as a government reform of the Statutes issued by the *Collegio* in Milan. A two-year course in mathematics and hydraulics became mandatory before engineers could be allowed to practise. The course was not, however, enforced as a prerequisite to apprenticeship, nor had it to be attended at the University. Birth requirements were replaced by a money security, both to guarantee public trust and to qualify for "civil" condition. For the medical professions, new legislation was published the same year[26] by an offshoot of the *Giunta*, a Medical Directory headed by the bourgeois physician Giuseppe Cicognini, in which physicians, surgeons and apothecaries were represented. This agency was to replace the regulating powers of both urban *Collegi* and the *Protofisico*; but since it was not allowed to supervise hospitals and charities, it could not enforce general scientific standards for admission to practice. The hospital sector of the public health service was still independent of State legislation,

[25] For engineers, see footnote 7; their organization as a specialized branch of the civil service, on the French model of *Ponts et Chaussées*, began in the Napoleonic period, L. ANTONIELLI, "L'amministrazione delle acque dalla Repubblica Cisalpina alla Repubblica Italiana", in *L'amministrazione nella storia moderna*, (Milano, 1985), I, pp. 805-64; G. BIGATTI, "Il corpo di acque e strade e la formazione degli ingegneri in età napoleonica", in *Società e storia* (1992), pp. 267-97; for architects, A. SCOTTI, *Lo Stato e la città: Architettura, istituzioni e funzionari nella Lombardia illuminista*, (Milano, 1984).

[26] *Regolamento generale per la Facoltà medica*, (Milano, 1775) (copy in ASM, *Sanità* p.a. 187); *Regolamento generale per gl'Ingegneri nello Stato di Milano*, (Milano, 1775) (copy in ASM, *Studi* p.a. 150).

thanks to its separate administration under canon law; the Medical Directory could not impose its regulations on hospital surgeons, and nothing less than diplomatic negotiations, as if with a foreign State, were necessary to promote new schools of anatomy, surgical operations and pharmacy in the General Hospital in Milan, later to become models for similar schools in the hospitals of other provincial capitals, such as San Matteo at Pavia, Lodi and Cremona.[27] Since pious foundations could still recruit their own medical personnel, regardless of State legislation; and since schools based on medical observation, anatomical and surgical practice in the hospitals could not be unified with "theoretical", oral education *ex cathedra* in university courses, conditions were still lacking for the new, enlightened method of teaching "practical" medicine: clinics, based on case studies in hospital wards, on the model of the Leyden and Edinburgh medical schools.

4. The Religious Schools: Philosophy, Public and Private

A sharp dividing line must be drawn at this point between practitioners, whose aim was, even in the graduate professions, to follow the shortest possible course of study before entering the service of some private professional, member of a city *Collegio*, and those who had the income and leisure to cultivate scientific or "philosophical" studies for their own sake, without being driven by the need to gain quick access to independent practice and profit. Two main groups were in such a position in 18th-century Lombardy: "dilettante" patricians living on their income and members of the clergy and especially of the regular Orders, whose leisure was guaranteed by ecclesiastical rents.

The common persuasion that professional *Instituta* must be of immediate usefulness for practice was in sharp contrast with the theoretical and speculative character of the courses taught in the Philosophical Faculties of the major religious Orders, and especially in the Jesuit University of Brera. As we have seen, in the first stage of reform urban *Collegi* were preserved to police professional recruitment and practice, although in a form now corrected and supervised by the government. They could thus continue to restrict entry within the boundaries of each city and province; the "undergraduate" professions requiring only a practitioner licence or a master – surgeons and apothecaries, engineers and architects – could continue to study and be licensed in their native city. The power of attraction of the State University, based

[27] A. MALAMANI, "Il Direttorio della Facoltà medica dello Stato di Milano: Note sull'organizzazione sanitaria della Lombardia austriaca", in *Bollettino della Società pavese di storia patria*, (1979), pp. 75 and following; ID., "Le strutture dell'organizzazione sanitaria in età moderna", in *Storia di Pavia*, cit. 3, IV:2 (1995), pp. 559-79; A. CALLIGARO, "Gli studi medici nell'università di Pavia dal 1535 alla fine del 700", ibid., pp. 581-94; A. PARMA, "Dall'amministrazione patrizia all'amministrazione moderna: La sanità nello Stato di Milano", in *L'amministrazione nella storia moderna*, cit. 25, I, pp. 293-358; M.L. BETRI and E. BRESSAN, eds., *Gli ospedali in area padana fra Settecento e Novecento*, (Milano, 1992) (especially the contributions by A. SCOTTI, C. SOMASCHINI, A. MALAMANI).

on its teaching staff and new research facilities, was left therefore to compete with the corporate traditions and school opportunities offered by the *Collegi* and ecclesiastical schools, still rivalling with it in Milan and other provincial capitals. This has prompted scholars to define the Lombard system of the 1770s as "polycentric", in contrast to the Piedmontese system, where all university teaching and research facilities were concentrated in the capital city.[28]

In fact, I think that at this stage the main stumbling block to further reform were not the professional *Collegi*, but the Jesuit University of Brera. In Piedmont the Jesuit grip on higher education had been broken many decades earlier: an independent, native dynasty had moved with decision to close the Jesuit University in Turin and its dependent network of provincial high schools, replacing it with a royal, secularised school system, which had its natural centre in the capital of the State, just where the pontifical University of the Counter-Reformation had been.[29]

In Lombardy, however, the Plenipotentiary, as a royal representative in a peripheral dominion, had to tread cautiously in his relations with the privileged Estates, of whom the patrician *Collegi* and the Jesuit corporation were an influential part; and in Vienna too, as is well known, Maria Theresa refrained from a wholesale attack on the Company of Jesus, as that waged since 1766 by the Bourbon Courts.[30] Until the dissolution of the Order by the Pope in 1773, the policy of Vienna was to limit and correct, rather than to replace, the teaching primacy of the Jesuits. The rivalry of the 1760s and 1770s between the University of Pavia, and the educational institutions in Milan, Mantua and other provincial capitals, owed much to the weight of patrician and clerical opinion in favour of the old, powerful alliance between the Jesuit University and schools, and the professional urban *Collegi*.

Short of closing the schools of the Company and transferring the State University to Milan, as Victor Amadeus II had done in Turin – a proposal that emerged nonetheless, not without a detectable anticlerical undercurrent[31] – the more relevant steps taken in the late 1760s against clerical hegemony were the laicisation of censorship, which freed philosophical and scientific disciplines from inquisitorial control, and the suppression of the "popish" Theological Faculty of the Jesuits. The significance of these reforms deserves to be more closely examined, in relation to

[28] V. FERRONE, *I profeti dell'Illuminismo*, (Roma-Bari, 1989), p. 119.

[29] M. ROGGERO, *Scuola e riforme nello Stato sabaudo: L'istruzione secondaria dalla* ratio studiorum *alle Costituzioni del 1772*, (Torino, Deputazione subalpina di storia patria, 1981); ID., *Il sapere e la virtù: Stato, università e professioni nel Piemonte tra Settecento e Ottocento*, (Torino, Deputazione subalpina di storia patria, 1987).

[30] R. DE MAIO, "Maria Teresa e i Gesuiti", in *Economia, istituzioni, cultura in Lombardia*, cit. 3, II, pp. 793-812; for the wider context, F.A.J. SZABO, *Kaunitz and Enlightened Absolutism 1753-1780*, (Cambridge, 1994), pp. 213-47. The crucial years were 1768-69, CAPRA, cit. 8, pp. 386-414; F. VENTURI, *Settecento riformatore, II: La chiesa e la repubblica dentro i loro limiti, 1758-1774*, (Torino, 1976) (especially on Du Tillot's reforms in Parma as a model for all other States, and the "anticlimax" since 1770, after his fall and the election of Clement XIV), pp. 226-36, 326ff.

[31] BRAMBILLA, "Le professioni scientifico-tecniche", cit. 3, pp. 407-13, 441.

one aspect of the clerical school system: the "double standard" that ecclesiastical censorship had imposed, both on teaching and on the recruitment of teachers.

For this purpose, one must consider separately two components of the Jesuit school system, and more generally of the schools kept by regular Orders: one was the "family" or College, a term defining both the members of the Order in any single place, and the residential and "private" building in which they lived in common, filling the duties assigned to them by their superiors and laid down by their rule. The other component were the public schools, where some of them were assigned the task of teaching. The out-schools, performing what may be defined as the public or popularising function, must be thought of as separate from the internal instruction of members, which may be defined as the self-recruiting function. Science was an optional part of the *ratio studiorum* of religious Colleges,[32] as far as its advanced sectors were concerned, because it was not a subject for their out-schools: elementary *teaching* in public classrooms was not the same as private or advanced *learning*, designed to select teachers and controversialists for the Order.

As regards teaching, novices and *scholastici* as internal students were expected to become *lectores* for the lower grades, as soon as they had been promoted to the higher one: they had therefore to qualify for the whole range of subjects included in the *ratio studiorum*. But since these were limited to the elementary Institutions, according to the standard textbooks produced and approved by the Order – not for the use of pupils but for the *lectores* themselves – teaching could be assigned to junior members, and each of them could be gradually moved to teach any part of the *ratio. Lectores* were not professional but "generalist" teachers. Theirs was just one of the many tasks that could be assigned to any member of the corporation, often a transient stage in their clerical career.[33]

As regards learning, the Jesuit tradition was to train selected and gifted members for advanced sciences. Studies beyond the *Elementa* were not for teaching, but constituted a further grade of specialisation, meant not for the classroom but for internal promotion, to prepare not so much teachers as controversialists – and by implication also scholars and scientists. This private circle was admitted to learn, under careful supervision, what was censored in the public classroom. Thus, in 1767, at least two of the Fathers in Brera were expert mathematicians, the French astronomer Louis Lagrange (not to be confused with his namesake, the Piedmontese Giuseppe Luigi, later president of the Berlin Academy of Sciences) and the engineer and expert in hydraulics Antonio Lecchi, soon to be joined by Boscovich, who in 1768, as already mentioned, was transferred from the College in Pavia to Brera, in

[32] N. and J. DHOMBRES, *Naissance d'un nouveau pouvoir: Science et savants en France, 1793-1824*, (Paris, 1989), pp. 553-55.

[33] ROGGERO, *Scuola e riforme*, cit. 29. pp. 30-41. A good description of this system is also given by PIETRO PAOLO GIUSTI (son of Luigi, Secretary of the Department for Italian Affairs in Vienna), in his long report on education in Lombardy, "Memoria sopra la riforma generale degli studi nella Lombardia austriaca", 12.VII.1768, ONB, Ms. 13483.

order to supervise the building of the Observatory, but they only taught selected "private" pupils and student-members of the Order.

5. Newtonian and Cartesian Physics and Physiology

A look at the teaching of sciences at the University of Pavia before the reforms[34] may throw some light on the role of censorship in public schools in the 1760s. In 1767 the Franciscan Father Marzari,[35] on the staff of the Philosophical Faculty but living in his convent in Pavia, in reply to the general inquest launched by the *Giunta degli Studi*, gave a summary of his teaching, on which we also have the comments by Gian Rinaldo Carli[36] and Pier Paolo Giusti, sent to Lombardy in 1768 for a general survey of its conditions.[37] Marzari reported on *fisica sistemale*, or physics of systems, which could also be called general or theoretical physics, or "ordinary" philosophy, and held second place, after metaphysics, in the hierarchy of all-year philosophical lectures. He explained that his course consisted of two parts: one was elementary mathematics, limited to the first 5 books of Euclid, and this he taught privately, in the so-called "home" or "domestic lessons"; the other was natural history, concerning "the questions of the existence and essence of bodies", and therefore it was related to cosmology: its presentation in the form of *quaestiones* highlights an important feature of clerical teaching methods, logical argument by way of theses, to be decided upon through abstract (syllogistic) deduction. In this way, Marzari presented cosmological systems as hypotheses, "according to the differing opinions of the Ancients and Moderns", and limited himself to pointing at the "more probable":[38] he could thus avoid admitting that the "modern" Copernican-Newtonian system was more certain and verifiable than the "ancient" system of Ptolemy, or that of Tycho Brahe. For this reason his general physics was called *fisica sistemale*.[39]

[34] U. BALDINI, "L'attività scientifica nelle accademie lombarde del Settecento"; ID., "L'insegnamento fisico-matematico a Pavia alle soglie dell'età teresiana", in *Economia, istituzioni, cultura in Lombardia*, cit. 3, II, pp. 503-32, esp. on the distinction between pure or speculative mathematics and physics, the "surreptitious modernization" of teaching, and private academies and patrician "dilettante" circles; ID., "L'attività scientifica nel primo Settecento", in G. MICHELI, ed., *Storia d'Italia, Annali 3: Scienza e tecnica*, (Torino, 1980), pp. 383-529; BEVILACQUA and FERRARESI, "Per una storia dello sviluppo della matematica e della fisica", cit. 3, pp. 206-9.

[35] 30.I.1767, ASM, *Studi* p.a. 375.

[36] Proposals for the mathematics course, January 1767, ASM, *Studi* p.a. 375.

[37] GIUSTI, "Memoria sopra la riforma generale degli studi", cit. 33, to be compared with the criteria laid down in Secret Instructions for the Committee for School Reform: his appointment, 23.V.1768, ASM, *Dispacci Reali* 241; the text of the "Istruzioni segrete", ONB, Ms. 12970.

[38] "secondo le diverse opinioni degli antichi e dei moderni ... coll'indicare la più probabile", 30.I.1767, ASM, *Studi* p.a. 375.

[39] Marzari offered to teach all the books of Euclid (always in private classes) if he was to abandon the part of his *fisica sistemale* devoted to "natural history" (ASM, *Studi* p.a. 375, 30.I.1767); still

The same position cannot be attributed to the Company of Jesus: the Fathers had updated their scientific culture, especially since Benedict XIV had reformed the Index;[40] in their corporate tradition, however, an advanced mathematical and astronomical competence could coexist with a highly hypothetical or "speculative" approach to "terrestrial" physics, still very far from the experimental method.[41] Furthermore, this did not apply to their public teaching, but was confined to the private instruction of members and friends – just as access to the "secret library" of the Roman College was reserved for those selected to confute heretical and irreligious theories.[42]

Carli and Giusti presented in 1767-68 their proposals for the reform of the Philosophical Faculty, commenting on the reports by professors. Both agreed that Marzari's physics of (cosmological) systems must be abolished as thoroughly out of date; both discussed the reform of the philosophical curriculum in general terms, to be applied indifferently in Milan, in Pavia or in provincial *gymnasia*. Their interventions show that the abolition of the old (meta)physics could not yet give way to a new, coherent system of scientific disciplines, mostly because of the still uncertain status of physics.

Carli, coming from the mathematical and engineering tradition of Padua, limited his proposals to the reform of those parts of physics that had a mathematical core, and were relevant for military and civil engineers:[43] pure mathematics was to include algebra and infinitesimal calculus, to be followed by hydraulics for civil engineers; applied mathematics was to apply calculus to astronomy and cartography, to be followed by architecture for military engineers. To this older, twin courses he added

in 1806, he addressed the government for arrears of his pension as late professor of *Metaphysics*, ASM, *Studi* p.m. 973.

[40] A decree of the 16th General Congregation of the Order in 1730 strongly recommended that, although it considered Aristotelian philosophy more suitable (*magis utilis*) for the teaching of theology, modern authors be used in the teaching of physics, thus encouraging Boscovich and other Jesuit professors in the Roman College to teach Newtonian physics; Benedict XIV "in the revised edition of the Index of forbidden books of 1757 ordered Copernicus' *de Revolutionibus* to be removed", possibly thanks to the intervention of Boscovich as teacher of logic and mathematics in the Roman College until 1760, J. CASANOVAS, "Boscovich as an Astronomer", in *Bicentennial Commemoration of R.G. Boscovich*, cit. 18, p. 59.

[41] S. D'AGOSTINO, "Boscovich's Reception of Newton's Legacy", in *Bicentennial Commemoration of R.G. Boscovich*, cit. 18, pp. 27-45.

[42] In 1739, Algarotti's popularization of Newtonian physics had been condemned by the Congregation of the Index especially because it was directed at the general public; on this and the Secret Library of the Roman College, V. FERRONE, *Scienza, natura, religione: Mondo newtoniano e cultura italiana nel primo Settecento*, (Napoli, 1982), pp. 35, 48f. On resistance by the Milan archbishop to introducing the teaching of sciences for clerics (who might later become teachers), Pozzobonelli to Kaunitz, 24.VII.1774: "la Chiesa ... non approva mai il lusso, e la soverchia applicazione de' chierici a queste scienze per il timore, che li distraggano dagli studi più analoghi al sublime loro stato ...", ASM, *Studi* p.a. 333.

[43] The *Piano* by Carli, 30.I.1767, ASM, *Studi* p.a. 375.

Newtonian physics, which he was unable, however, to harmonise completely with the previous system. His proposals show, in the first place, that two disciplines could be derived from the highly speculative physics of late-Aristotelian culture: cosmology, as an optional subject to be treated in domestic lessons, was to be taught as a *history* of science, instead of a set of equivalent, probabilistic hypotheses on the structure of the universe; the Aristotelian questions about "the existence and essence of bodies" were to be replaced by mechanics.

Carli gave a Newtonian definition of mechanics, as including the laws governing motion and gravity, and the queries on light, fire and sound; but these were still on the frontiers of research, as was made clear by their loose connection with experimental physics. Carli invited its teacher to synchronise his weekly experiments with the professor of pure mathematics, and to follow him as he dealt with the Newtonian "queries" of mechanics or "special" physics; but experiments, in fact, were then still conceived as a series of almost theatrical performances (*ostensioni*), aimed at exciting wonder and amusement in the general public, rather than as a methodical program of observation and experiment, designed to gain a better understanding of natural "phenomena".[44]

Carli's proposals were directed to engineers, designing a very up-to-date curriculum[45] to be founded on mathematics, and to be completed by Newtonian "natural philosophy". The latter would be further divided into *physica generalis* (mainly concerned with the structure of matter in general) and *physica specialis* (which took account of the various kinds of *imponderabilia*, responsible for heat, electricity, light).[46] In fact, only in the engineering tradition this kind of physics, as a

[44] See the report (undated, but 1767) by the Somasco Saverio Vaj, then Professor of experimental physics in Pavia (ASM, *Studi* p.a. 375): public experiments and lectures were limited to holidays when there was no regular teaching, because "the entertainment provided by the experimental spectacle might attract all the youth, emptying the halls where professors teach" ("poiché il piacere dello spettacolo sperimentale potrebbe attirare a sé tutta la gioventù, e lasciare vuote le scuole de' professori"), and compare with a letter by Achille Alessandri to Lorenzo Mascheroni from the University of Padua (16.XII.1786), complaining that Simone Stratico taught experimental physics only on Sundays ("le lezioni del Professore Stratico di Fisica sperimentale mi piacciono assai; ma non legge se non che la Domenica", Bergamo, Civic Library Angelo Maj, Coll. Barca Lurani, vol. I, f. 160). See also the very hostile remarks by Spallanzani on Volta's mathematical culture, in the polemical pamphlet *Lettere due del Dottor Francesco Lombardini*, (1788), written at the height of the scandal (1787-88), at Spallanzani's pretended "thefts" from his Natural History museum (quoted by W. BERNARDI, *I fluidi della vita: Alle origini della controversia sulla elettricità animale*, (Firenze, 1992), p. 167f): according to the "bourgeois" Spallanzani, the patrician Volta limited himself to "physical tricks" ("giocolini della fisica"); he preferred (as a patrician) to spend his days visiting and dining with the best society, instead of applying himself to "a course of physics, without neglecting geometry and algebra, mechanics and optics", of which he was supposedly "quite ignorant" ("innocentissimo").

[45] I think Carli's proposals may have been adopted for the *Piano Scientifico* of 1773, on which see the comments by BEVILACQUA and FERRARESI, "Per una storia dello sviluppo della matematica e della fisica", cit. 3, pp. 212-3.

[46] D'AGOSTINO, cit. 41, pp. 38-9.

"science of the inanimate world", was rapidly advancing thanks to the new logic of mathematical language, capable of accounting for "forces" moving both terrestrial and celestial objects, and thus unifying physics and astronomy.[47]

Such a view, however, was far from being generally accepted. In order to be Newtonian, "natural philosophy" had of course to be much more rigorously defined than Marzari's "natural history". Giusti was even more outspoken than Carli against *Fisica sistemale*, commenting scathingly that it was just a relic of the controversial spirit of the Schools – meaning the Theological Faculties and the schools of the regular Orders – that had so long hindered the advancement of science.[48] Metaphysical reasoning, he pointed out, allowed one to present cosmological systems as pure hypotheses, without verification by experiment; physical truths themselves were not accepted unless they could be made to serve extra-scientific aims and dogmatic bias. But in fact, rather than referring, as Carli did, to physics for engineers, Giusti might be seen as a spokesman for a medical view of natural philosophy: in his proposals another, larger field of uncertainty comes into the foreground.

Carli had avoided another moving frontier of research, the effort, made especially since the middle of the century, to distinguish "the science of the inanimate world ... from Natural History and Chemistry." In Giusti's proposal, special physics was to include, within the mechanics of fluids, both the hydraulics of civil engineers, and the *physiology of the human body* of the physicians. When one refers to the mathematization of physics, the latter is already defined as the science of the "*inanimate* world": this was the path followed by the French and Piedmontese schools of military engineering, tailored for a very specialised profession, and proceeding to an ever narrower definition of physics – both general and special – as divorced from the various objects of "natural history". In Lombardy, however, the medical establishment was at least as influential as civil engineering, while there was no native military-mathematical tradition. Newtonian physics was still unreconciled with the vitalistic, qualitative approach of medicine, for which physics

[47] FERRONE, "Paolo Frisi e l'illuminismo scientifico piemontese", in *Ideologia e scienza nell'opera di Paolo Frisi*, cit. 3, I, p. 307; on the connection between Cartesian and Newtonian philosophy in the Lombard Enlightenment, M. MAMIANI, "Newton in Lombardia", in *Economia, istituzioni, cultura in Lombardia*, cit. 3, II, pp. 215-22; on the impact of the development of calculus on physics, from Euler to the end of the century, N. and J. DHOMBRES, *Naissance d'un nouveau pouvoir*, cit. 32, pp. 483-96.

[48] GIUSTI, "Memoria sopra la riforma generale degli studi", cit. 33, f. 66r: "È altresì un inconveniente la diversità dei principj negl'Elementi delle Scienze che hanno del rapporto fra di loro, diversità introdotta dagl'Ordini religiosi in Italia, molti dei quali essendo Proffessori nelle Università, ciascun di loro si attiene scrupolosamente ai Libri elementari composti da Autori dei rispettivi loro istituti ... onde non di rado arriva, che uno insegni la Logica e la Metafisica di S. Tomaso, un altro la Filosofia di Scoto; uno la Teologia e la Morale di Molina, l'altro quella di Giansenio; l'uno il Gius Canonico del Van Espen, l'altro l'istoria e il diritto ecclesiastico del Bellarmino".

still included the *animated* world; the controversial ground was again "special" physics versus mechanics.

Giusti did not give a Newtonian, but a Cartesian definition of mechanics, as including "those common phenomena that have been discovered and made apparent to anybody's eyes in geometry, the physical properties of extension ... the existence of matter and motion, the *impenetrability of bodies* as the cause of their reciprocal action ...".[49] This was a medical definition of (iatro)mechanics or "iatrophysics", as it had been transmitted from the Leyden school of Boerhaave to the Vienna Medical Faculty of van Swieten. But an influential medical opinion in Lombardy, as elsewhere in Italy, rejected the application of Cartesian mechanics to living matter;[50] this rejection was reinforced by the philosophical tradition of the Company of Jesus, opposing the mathematization of "terrestrial" physics or "natural history".[51]

The abolition of *fisica sistemale* could raise no serious objection when applied to astronomy: here the Fathers themselves had long since set aside, in their internal tradition, the censorship applied until the 1760s in the public classroom. But things were not so simple as one descended from the skies to the "natural phenomena" on earth. Here the choice was between late *Cartesian* mechanics, as in Giusti's proposals, and "natural physics", both in the Jesuit and medical "vitalistic" tradition.[52] If in 1767 friar-teachers still presented in public the operation of mathematical laws in astronomy as a probability, even more doubtful, in their view, was the application of mechanical laws to the organic, living world of "natural history". Here any Cartesian approach to the questions of "the existence and essence of bodies" threatened to challenge the action of spirit on matter and their *reciprocal compenetration* – specularly opposed to mechanistic impenetrability – and this, it

[49] GIUSTI, ibid., ff. 64-66: "i fenomeni quotidiani scoperti dall'osservazione alli occhi di tutti nella Geometria, le proprietà sensibili della estensione; nella meccanica, l'esistenza della materia e del moto, l'impenetrabilità dei corpi cagione della loro mutua azione".

[50] BERNARDI, *I fluidi della vita*, cit 44; ID., *Le metafisiche dell'embrione: Scienze della vita e filosofia da Malpighi a Spallanzani (1672-1793)*, (Firenze, 1986); G. MONTALENTI and P. ROSSI, eds., *Lazzaro Spallanzani e la biologia del Settecento*, (Firenze, 1982); M.T. MONTI, "Bonnet et les poulets de Haller: La rhétorique du 'rêve' et la stratégie de la persuasion", in M. BUSCAGLIA, R. SIGRIST, J. TREMBLEY and J. WÜST, eds., *Charles Bonnet savant et philosophe (1720-1793)*, (Genève, 1994), pp. 183-210; B. MAFFIODO, *I borghesi taumaturghi: Medici, cultura scientifica e società in Piemonte fra crisi dell'Antico Regime ed età napoleonica*, (Firenze, 1996).

[51] For the separation of mathematics from physics, the former being purely "speculative" but admitting application to "practice" in astronomy and geography (cartography); the latter including "practical" applications both to medicine and natural magic, see the theses presented in the Jesuit University of Parma in 1616: "latius enim sumpta physica et mathematica, utraque sub se comprehendit aliquas etiam scientias practicas, physica quidem medicinam, et magiam naturalem ... mathematica vero totidem practicas quot speculativas, nempe geometriam practicam, ... astronomiam practicam, etc.", quoted by BARONCINI, "L'insegnamento della filosofia naturale", cit. 13, p. 194.

[52] R. REY, *Naissance et développement du vitalisme en France de la deuxième moitié du dix-huitième siècle à la fin du Premier Empire*, (Oxford, 1999).

was feared, could start a landslide towards materialism and atheism: first leaving no room for natural magic, *mirabilia* and miracles, then excluding from physiology the question of the divine infusion of the soul.

Hardly more than a decade had elapsed since Benedict XIV had reformed canonisation procedures, and therefore the criteria for ascertaining miracles; his reform had been closely followed by the debates on natural magic and witchcraft, first studied by Franco Venturi.[53] Giusti's inclusion of human physiology within the mechanics of *fluids* was consistent with his proposal to reform *meta*physics, "the general doctrine of substances (*entes*), that is spirits, bodies and human soul": these had to be reduced "to those principles only that can be the object of some demonstration". Here too different systems were set one against the other, vying to explain "the prodigious phenomena produced by the soul by means of the body"; but here the approach must be opposite to that of physicists, who adopted the Newtonian system on the strength of its mathematical certainty. Systems, and the party strife that went with them, must be carefully avoided, and experiments used to cut through the "useless and arrogant" dissensions of the schools.[54]

According to Spallanzani, while the art of healing had made little advance since Hippocrates, enormous progress had been made in physiology or, in its French name, *économie animale*: "Nous avons au contraire découvert la circulation du sang, les propriétés de la fibre, *les lois de la sensibilité* [my italics] le mécanisme des sens, la distribution des lymphatiques, le mode de la digestion, la cause du chaleur animale, la composition des humeurs; nous avons enfin soulevé un coin du voile qui couvre la génération, presque resolu [sic] le grand problème de la nutrition".[55] Giusti's and Spallanzani's words are a useful reminder that besides Newtonian, mathematical physics, another, Baconian field could still be included under the same name of physics in the second half of the 18th century. Haller's "irritability", and later experimental research on the interaction between muscles and nerves (with the related studies on electricity, as the nervous fluid to replace the old animal spirits), had from the 1750s onwards an extraordinary impact not only on medical and scientific learned opinion, but also on the everyday language and self-consciousness of the general public: it might be worthwhile to retrace more closely not only its

[53] Apart from the controversies on generation, it is worth remembering, for instance, that in 1765 the Carmelite Atanagio Cavalli published in Milan *Delle apparizioni ed operazioni de' spiriti*. On magic in the 1750s the standard text is still F. VENTURI, *Settecento riformatore, I: Da Muratori a Beccaria*, (Torino, 1969), pp. 355-85.

[54] "Facile quindi è di giudicare quanto inutili e temerarie siano le discussioni, di cui risuonano le scuole de' varj sistemi, con cui si sono molti sforzati di spiegare i prodigiosi Fenomeni che si operano dall'Anima col mezzo del Corpo": in these the professor should avoid both to take sides and to build new and arbitrary systems, as it was done in many Universities ("fabbricare egli stesso a suo grado nuovi sistemi, come in più d'una Università non si ha ritegno di fare"), GIUSTI, "Memoria sopra la riforma generale degli studi", cit. 33, ff. 57v-58r.

[55] Quoted by M.D. GRMEK, "La théorie et la pratique de l'expérimentation biologique au temps de Spallanzani", in *Lazzaro Spallanzani e la biologia del Settecento*, cit. 50, p. 323.

scientific history, but also its transmission from science to theories of *sensibility* in philosophy and to general use in literary correspondence and polished society.[56]

6. Pavia and Brera in the 1770s: Religious and Lay Schools in Competition

As already said, in the 1760s Habsburg policy followed a different course from that adopted in Turin since 1729, and attempted in those same years by the Bourbon Courts in Parma and Naples: steering clear of anti-Jesuit opinion and avoiding a direct confrontation with the Pope, Vienna rejected proposals to close the pontifical University in Milan (and its dependent system of provincial *gymnasia*), to take over its government from the Company of Jesus, and to use their Palace in Brera as the seat of the "royal" University, to be transferred from Pavia to the capital of the State. This explains why reform, until 1773, was limited to graduations and exams: the *Piano di Disciplina*,[57] published in 1771, abolished the legal value of degrees other than those of the State University, such as had been conferred by patrician *Collegi* and religious Colleges. As for teaching and research, the key reform was the laicisation of censorship in 1768, which deprived of their power inquisitors and theologians, appointed by pontifical and episcopal authority independent of the State – including the bishop of Pavia as Chancellor of the University – and transferred it to enlightened clerics of royal appointment, such as Paolo Frisi for philosophy and science.[58] However, the proposals hotly debated in 1767-68, when it seemed that the

[56] An example is the following (quite typical) letter by a fashionable dame to his noble suitor: "Non c'è dubbio, la *sensibilità* è il primo movente che ci fa essere ò virtuosi, ò viziosi; le machine bene organizzate, ch'hanno un'anima bene educata, quando sono sensibili divengono utili alla società, e deliziose agli amici, ma se codesta *sensibilità*, anche nei buoni, non è seguita dalla riflessione, e dalla Ragione, essa non formerà, che un entusiasta incostante", Caterina Dolfin Tron to Gabrio Serbelloni, 9.VIII.1783, in G. DAMERINI, *Settecento veneziano*, (Milano, 1939), p. 280.

[57] Most likely drawn for the most part by CICOGNINI: see his "Ricordi per un regolamento provvisionale degli studj dell'Università di Pavia", 20.I.1767; "Parere sopra lo stabilimento generale degli studj in Lombardia, correlativo agli Statuti e ad altri scritti già consegnati", 30.VIII.1767, ASM, *Studi* p.a. 375. Plans and correspondence between Firmian, Cicognini and the Medicine Dean in Pavia on medical degrees and surgical licences (X.1770 to I.1771), and the Provisional Ordinance (*Regolamento Interinale*) approved in January 1771, ASM, *Studi* p.a. 158. The published text of the "Piano di Direzione, Disciplina ed Economia", in *Statuti e ordinamenti per la storia dell'Università di Pavia*, cit. 20, pp. 201-27. A survey of the correspondence and orders for the reform of degrees, until August 1769, is given in the "Analisi del carteggio per la riforma degli Studj nell'Università di Pavia", HHSA, Lomb. Coll. 84.

[58] A. TARCHETTI, "Censura e censori di Sua Maestà Imperiale", in *Economia, istituzioni, cultura in Lombardia*, cit. 3, II, pp. 741-92; A.P. MONTANARI, "Il controllo della stampa, "ramo di civile polizia": L'affermazione della censura di stato nella Lombardia austriaca del XVIII secolo", in *Roma moderna e contemporanea*, 2 (1994), pp. 347-78. Compare for Piedmont, L. BRAIDA, "L'affermazione della censura di stato in Piemonte dall'editto del 1648 alle Costituzioni per l'Università del 1772", *Rivista storica italiana*, (1990), pp. 717-95; ID., *Il commercio delle idee: Editoria e circolazione del libro nella Torino del Settecento*, (Firenze, 1995). For a very

reform of censorship might be soon followed by the laicisation of the Jesuit schools, were abandoned in 1769, not to be re-examined, decided upon and published until 1773, as the new *ratio studiorum* for the lay State University: the modernisation of university curricula (the *Piano Scientifico*) had to wait until the Company was dissolved by Clement XIV.

The ramified network of professional and religious corporations was opposed the suppression of the Jesuit school system: for this reason, the scientific reform of the University of Pavia was delayed, and Milan and Mantua – the seats of the two Jesuit Universities of the State – emerged as alternative centres of higher education for the "natives" of each city and its province. The conflict between a clerical and an anticlerical party, in the age of enlightened reforms, did not oppose lay to priest, but cut through both the laity and the priestly Orders, opposing Roman to anti-Roman, Jesuit to anti-Jesuit opinion. This party conflict is especially evident in two contrasting proposals: one was to transfer the University of Pavia to Milan, debated in 1767-68 and rejected by Vienna, it may be inferred, not only because of Maria Theresa's piety, but also in order to avoid the resistance of the local Estates, embodied in the powerful alliance between the patrician city government, the Jesuit University of Brera and the Senate. The other was the plan to make of Brera a replica of the celebrated *Istituto delle Scienze* in Bologna, advanced by the *Giunta degli Studi* in 1773:

> our project would be to leave the University of Pavia where it is with the Colleges existing in that city, implementing the Court's instructions ... Brera could be used for the high schools, and for the *Istituto delle Scienze for the city of Milan* [my italics]. The building might therefore be improved. To Brera should be moved all the Palatine schools; the Hall for the demonstrations of experimental Physics; the Optical Chamber; the Laboratory for metal melting; the Museum of Sacred and Civil Antiquary; and the Museum of Natural History ... To the said Istituto delle Scienze might be transferred the Pertusati (Senate) Library ... The Observatory will remain in Brera.[59]

perceptive analysis of the "double standard", which an enlightened reader who was also state censor in Florence, Giuseppe Pelli Bencivenni, applied to himself and to the "uneducated" public, R. PASTA, *Editoria e cultura nel Settecento*, (Firenze, 1997), pp. 193-223.

[59] Report by Pecci and Daverio, 16.X.1773: "il nostro progetto sarebbe di lasciare a suo luogo l'Università di Pavia colli Collegj esistenti in detta città, e col perfezionare altresì le disposizioni della Corte ... Brera potrebbe servire per il Ginnasio, ed Istituto delle Scienze per questa città di Milano. Si potrebbe pertanto perfezionare la Fabbrica. Si dovrebbero unire in Brera le Scuole Palatine; l'Aula per le dimostrazioni della Fisica esperimentale; la Camera Ottica; il Laboratorio per la fusione de' Metalli. Il Museo delle Antichità Sacre e Civili, ed il Museo di Storia Naturale ... Al detto Istituto delle Scienze si potrà trasportare la Biblioteca Pertusati. Resterà in Brera la Specola ..." The printing press was to be provided by the Cistercian monasteries, according to the *Piani di Consistenza* for the reduction of regular clergy, ASM, *Studi* p.a. 205. A similar proposal resurfaced in 1778, perhaps prompted by the example of the Bourbon Court in Naples, who had founded an Academy of Sciences that year (*VE*, II, Appendix; A. MASOTTI, ed., "Scritti inediti di

With the final addition of a printing press, the close imitation of Bologna's "House of Solomon" can be easily recognised by anybody familiar with the "Stanze" for the Baconian sciences in the celebrated model, recently renewed and revived thanks to Benedict XIV's patronage. To appreciate the meaning of this proposal, implying a "division of labour" between Pavia and Milan, we must turn again to censorship and the "double standard" of teaching. In lay universities, public lectures had steadily declined since the end of the 16th century, due to the competition by professional *Collegi* and religious Colleges; but also because, being public, they were subject to papal and episcopal censorship, and had to limit themselves to the canon of classical and dogmatic authorities, from Aristotelian books to the Digest and to Papal Decrees. The less they could change, the more audience they lost; but here too a double standard had appeared, implying resistance to, rather than collusion with ecclesiastical censorship. Professors, especially since the end of the 17th century, had moved their real teaching, when there was any – as in Padua and Pisa – to "private" academies or lessons they gave at home for a fee, to selected and richer students often boarding with them, and related to them by family and patronage connections.[60]

In the medical and juridical Faculties, domestic teaching often overlapped with patron-apprentice relations for professional training, since many university professors were also practising city lawyers or physicians.[61] But the same was not true for the preliminary courses of philosophy, which gave access to no profession: here, in private academies, the theories of the "moderns" could be taught, even if they were banned from public halls; pupils could be selected to succeed their masters, who guided them to more advanced studies and "connoisseur", voluntary research. In an ever-increasing degree, this domestic teaching was directed to *naturae curiosi,* "dilettante" patricians and *people of independent means*, who had no need of degrees to earn their living. By distinguishing public lectures from private academies, university professors could get around official censorship,

Paolo Frisi", Istituto Lombardo di Scienze e Lettere, *Rendiconti, Classe di Scienze Matematiche e Naturali*, 82 (1949), pp. 55-61).

[60] D. GENERALI, "Repubblica delle lettere fra censura e libero pensiero: La comunicazione epistolare filosofico-scientifica nell'Italia fra Sei e Settecento", in *Intersezioni*, 6 (1986), pp. 73-94; J.F. WAQUET**,** "Élites intellectuelles et reproduction du savoir: Le témoignage de la génération des pré-Lumières", in *Problèmes d'histoire de l'Éducation*, (Roma, Università La Sapienza, 1988), pp.1-12; B. DOOLEY, "Social Control and the Italian Universities from Renaissance to Illuminismo", in *Journal of Modern History*, 61 (1989), pp. 205-39; M.L. SOPPELSA, "Le scienze teoriche e sperimentali tra Sei e Settecento", in *Storia della cultura veneta*, (Vicenza), 5:1 (1985), pp. 282-9. For a comparative view, M. INFELISE, "La censure dans les pays méditerranéens, 1600-1750", in H. BOTS and F. WAQUET, eds., *Commercium litterarium: La communication dans la République des Lettres 1600-1750*, (Amsterdam, 1994), pp. 261-79.

[61] The most obvious aim was to increase salaries, just as they were increased by the sharing among professors of the fees (*propine*) paid by students for degrees and licences: professors in the Philosophical Faculty, which did not confer degrees, joined the boards or *Collegi* of the professional Faculties for graduations, to share the income of graduation fees.

provided they restricted their teaching of the "moderns" to "domestic lessons", and did not encroach on official days and hours, which were reserved in the academic calendar for the canonical, unreformed and censored exposition of the "ancient" authorities.

Since the end of the 17th century, the *Istituto delle Scienze* in Bologna had institutionalised this double standard; this was the most famous model for what I would propose to define as a "restricted modernisation" of science. In the venerable University city of the Papal States, public or official lectures on the old canonical authorities were left to stand in the deserted public classrooms, but beside them a new, advanced institute was founded, both as a realisation of the Baconian utopia,[62] and as a means to modernise aristocratic culture, along Habsburg military and cameralistic models.[63] With the one condition that it did not encroach on the schedule and calendar of public university lectures, learning, research and teaching of the "moderns" were allowed in the Institute for the selected few, without dismantling the corporate University or endangering formal obsequy to canonical doctrines. The "polycentric" system that took form in Lombardy between 1765 and 1775 may be seen as another kind of this "restricted modernisation": a not too clear-cut compromise between a State-driven, full laicisation of the University and the whole school system, and the particularistic, city-based alliance between the professional *Collegi* and the ex-Jesuit and religious schools.

Data for Brera and Pavia throw light on the competition between the civic-clerical and State schools in the 1760s and 1770s. In 1769-70 the Company still preserved the bulk of public teaching in Milan, both in humanities and philosophy;[64] in 1773, its Philosophical Faculty had even increased to seven "classes", and a course of physiology and natural history had been added to general physics and elementary mathematics.[65] At the same time, a whole series of new, public lectures

[62] M. CAVAZZA, *Settecento inquieto: Alle origini dell'Istituto delle scienze*, (Bologna, 1990); ID., "L'insegnamento delle scienze sperimentali nell'Istituto delle scienze di Bologna", in *Le università e le scienze: Prospettive storiche e attuali*, (Bologna, Alma Mater Studiorum, 1993), pp. 155-68; ID., "Laura Bassi e il suo gabinetto di fisica sperimentale: Realtà e mito", in *Nuncius*, 10 (1995), pp. 715-53; W. TEGA, ed., *Anatomie accademiche*: I, *I Commentari dell'Accademia delle scienze di Bologna*; II, *L'enciclopedia scientifica dell'Accademia delle scienze di Bologna*, (Bologna, 1986, 1987); A. ANGELINI, ed., *Anatomie accademiche*: III, *L'Istituto delle scienze e l'Accademia*, (Bologna, 1993).

[63] R. GHERARDI, *Potere e costituzione a Vienna fra Sei e Settecento: Il "buon ordine" di Luigi Ferdinando Marsili*, (Bologna, 1980).

[64] Classified correspondence between Kaunitz, Firmian and the Jesuit College to avoid the abolition of the Faculty, March 1771, ASM, *Studi* p.a. 259 ex 273; Kaunitz to Firmian 21.XII.1771, forbidding the Fathers to teach theology after the *Piano di Disciplina*, which reserved degrees to the State University, ASM, *Studi* p.a. 279.

[65] Report by Pecci and Daverio on the Schools of Brera, 16.X.1773: "Vi sono di presente in Brera 5 classi per le Scuole inferiori di Lingua latina, cioè Rettorica, Umanità, Grammatica superiore, inferiore e infima, e sette classi per le Scuole superiori, cioè Logica e Metafisica, Filosofia morale, Fisiologia e Storia Naturale, Fisica generale, Elementi di matematica", ASM, *Studi* p.a. 205.

of *Istituzioni*, as already mentioned, had been started in the Palatine for professional training. These had increased to 17, shifting the balance between the civic and Jesuit schools in favour of the city; but they had altogether around 280 students, while the Fathers had more than 500. Moreover, teaching in the Palatine schools was still heavily weighted towards theology, law and forensic practice; however, three chairs were directed to engineers, one started in 1763, when the Senate had called from Pisa the enlightened Barnabite Paolo Frisi. While he taught applied or experimental physics (mechanics, hydraulics and architecture), elementary and advanced mathematics were assigned to the Jesuits Luini and Boscovich in the Brera Observatory, causing bitter rivalry between the anti-Roman Barnabite and the Company's philosophers-mathematicians.[66]

Thus, when the Company was dissolved in 1773, and the scientific curricula for the University were finally published,[67] an alternative system was already in place, more than able to compete with the University; all the more so as, in 1775, the professional lectures of *Istituzioni* were moved from the cramped civic palace to the lofty and spacious halls built by the Senate for the public schools of Brera, and a new Academy of Fine Arts was added to them.[68] The new chairs in Milan and in other provincial capitals introduced formal schooling and a higher scientific qualification, to replace birth and status requirements for admission to practice. This reform of the medical and engineering professions, however, was only partially linked to the reform of the University: since students from Milan, Mantua or Cremona were allowed to learn their *Instituta* in their native city, only natives of the city and province of Pavia were interested in attending lectures in Pavia. This is reflected not only in the relative stagnation of enrolments in the Philosophical and Medical Faculties, as compared with the growth of law and theology students, but still more in the total number of students, which was much lower in Pavia than in the civic and ex-Jesuit schools in Milan.

Data for 1777 show that the total expenditure for the University amounted to 75,000 lire, just one thousand more than Brera (74,000 lire including the Observatory); the latter got more than Pavia if we include the Academy of Arts (23,000), while no less than 90,000 lire were spent to provide pensions to ex-Jesuits.[69] As for the teaching staff and student body, we may refer to data for 1774

[66] Correspondence Frisi-Sperges, 1769, ASM, *Autografi* 169, Biblioteca Ambrosiana, Milan, Mss. Y 152 sup; BRAMBILLA, "Le professioni scientifico-tecniche a Milano", cit. 3, pp. 413-29, on the proposals by Frisi, Boscovich and Carli.

[67] The curriculum for Pavia was meant to apply to the whole system of higher education – both to the ex-Jesuit *gymnasia* and to the still extant episcopal seminaries and religious schools of Barnabites and other teaching Orders.

[68] A. SCOTTI, *Brera 1776-1815: Nascita e sviluppo di una istituzione culturale milanese*, (Milano, Quaderni di Brera, 1979).

[69] "Piano e prospetto generale del Fondo e spese di pubblica istruzione", drawn after the consolidation of funds coming from the secularized ex Jesuit patrimony, upon order from Vienna 17.IV.1777, ASM, *Studi* p.a. 206; Report on school finances by Pecci and Daverio, 13.III.1777,

and 1775, when the municipal and ex-Jesuit schools were being unified. The Fathers still had 10 teachers, besides the Observatory and its instrument cabinet,[70] for a total of 730 students, about 500 in the Latin schools and 160 in the Philosophical Faculty, of whom 139 in the classes of mathematics and physics. To these were added the now flourishing and well established ex-Palatine schools – including special or experimental physics and another cabinet for machinery and mechanics – with 14 excellent professors including the poet Parini and the moral philosopher Soave, with 733 more students.[71] But here too the most popular courses were still those for the clerical and legal professions, with 457 students attending the reformed anti-Jesuit (or anti-papal) lectures of theology and canon law, and 124 more those for notaries and solicitors. Altogether, Brera had 24 professors, of whom 10 ex-Jesuits and 9 more clerics and friars, and almost 900 students in the philosophical and professional courses; to these should be added the two schools of anatomy for surgeons, and chemistry for apothecaries, financed by the management of the General Hospital.

Pavia, having increased its professors from 17 to 27, as prescribed by the *Piano Scientifico*, was a trifle superior to Brera in the teaching staff, but was decidedly losing in the competition for students. A complete list for 1777, when the new norms of 1771-73 had been fully implemented, shows that the balance between the scientific-medical and the theological-juridical disciplines had somewhat shifted toward science, but was still weighted in favour of the former, with 17 chairs to 10:

ASM, *Studi* p.a. 382. Besides invoices for Pavia, Milan, and the pensions for ex-Jesuits, 67,400 lire were earmarked for provincial *Gymnasia* and the royal boarding Colleges in Milan (Longone-Imperiale, kept by Barnabites) and Monza, for a total expenditure of 354,000 lire.

[70] Kaunitz to Firmian 14.III.1774, ASM, *Studi* p.a. 258; reports to Firmian, 8.III.1775 and 3.VII.1775, *Studi* p.a. 259. Brera had 4 teachers for the humanities (3 in 1775) with 509 students (288 in lower grammar, 94 in higher grammar and 127 in rhetoric); 4 teachers for the Philosophical Faculty with 160 students: Draghetti for logic and metaphysics with 82 students, Count-abbé don Francesco Gambarana for general physics with 27 pupils, the Austrian ex Jesuit, baron von Cronthal, for elementary arithmetic and geometry and algebra (in Italian, on prescription of the 1773 Scientific Plan), with 16 pupils, Gianella for advanced geometry and infinitesimal calculus with 35; to these were added the Benedictine Witman for botanic and the Botanical Garden; three ex-Jesuits (after the dismissal of Boscovich for internal dissensions), worked without teaching duties in the Observatory, assisted by a technician.

[71] A. VICINELLI, *Il Parini e Brera*, (Milano, 1965), pp. 321-59; Kaunitz to Firmian 14.III.1774, ASM, *Studi* p.a. 258, on the ex-Palatine to be transferred to Brera: the Gerolimino friar E. Serrati for experimental or special physics (transferred in 1785 to the lay patrician Marsilio Landriani) with 61 students; Frisi for mechanics with 17 students; canon Fromond as supervisor of the instruments and machinery cabinet; Parini for eloquence with 27 students, and Soave for ethics with 55. Of the ten professional chairs, two were for lawyers (institutions of civil law 75, public law 7), three for barristers, solicitors and notaries (provincial and municipal law 18, criminal law 21, notarial art 49), four for clerics (institutions of canon law 194, dogmatic theology 147, moral theology 116, palaeography and diplomacy 2), and one for civil service (public economy 5). All lectures implying modernization, such as public law, public economy and mechanics, were almost ignored by students.

fourteen juridical and theological disciplines, and three more linked to them in the philosophical Faculty,[72] were now matched by five scientific courses in the preliminary philosophy level, and five more in the Medical Faculty, including the old pharmacy for physicians (*materia medica*), modernised with the addition of chemistry to botany.[73] As for students enrolled in Pavia, they were 467 in 1774, of whom 140 (30%) in philosophy and medicine, and 327 in law and theology. In 1777 they had increased to 641, of whom 228 (35,5%) in the scientific group. Only about one third of the students were qualifying for a scientific profession, and probably less, since we do not know how many in the Philosophical Faculty were heading for a medical, a legal or an ecclesiastical career.

7. University Reforms from Joseph II to the Italian Republic

During the decade of Joseph II's personal reign, a new and more radical program of reform was put under way, starting with the Edict of tolerance at the end of 1781. On the side of the professions, this second stage of reform included the abolition of urban guilds and *Collegi*, a measure that may well be termed as pre-revolutionary: although it was partially repealed after Joseph II's death, its effects were not wholly erased in the early 1790s, and they prepared the final abolition of all corporations and monopolies – together with the nobility itself, as the monopoly by birth of political rights and offices – written into the Constitution of the Cisalpine Republic.[74]

From 1781-83, the medical schools in Pavia were reformed on the Austrian-German model, and no effort was spared to attract men of outstanding celebrity for the two professorships that were to become the pillars of the new system: one was clinics, which was assigned in 1783 to the Swiss protestant Tissot, and in 1785 to the Göttingen professor Johann Peter Frank; the other was anatomy with surgical operations, which went to Scarpa, heir of the great Paduan school of Morgagni. Botany and chemistry were disengaged from their ancient connection with pharmacy for physicians (*materia medica*), and came into their own in the Philosophical

[72] Logic and metaphysics, moral philosophy, and eloquence with history (the latter a professional chair for clerics, deriving from the old sacred eloquence and ecclesiastical history).

[73] Kaunitz to Firmian 23.XII.1776, ASM, *Studi* p.a. 381; Report by Pecci and Daverio, 13.III.1777, ASM, *Studi* p.a. 382. But here too, elementary mathematics and general physics were still taught by the ex-Jesuits from Brera Gianella and Luini, experimental physics by the Piarist Barletti, an all-purpose "philosopher" and *lector* (but it was transferred to Volta the following year); advanced mathematics and natural history were also taught by friar-scientists, but quite in step with the advances of their discipline, the Piarist Gregorio Fontana, brother of Felice of the Cabinet of natural history of Florence, and the *abbé* Spallanzani.

[74] Art. 356 of the Constitution abolished every kind of corporation, but was partially qualified by art. 357, prescribing special legislation for the professions "having an influence on public morals, the safety and health of the citizens": new comprehensive regulations, however, were published for physicians and engineers only from 1806 onwards.

Faculty alongside natural history and mineralogy. After the death of Frisi in 1785, the schools for engineers were moved from Brera to Pavia; Cicognini died in the same year, and since 1788 the Medical Directory was transferred to the University, to be integrated with the Medical Faculty under the direction of Frank and Scarpa. The professional schools in Milan were streamlined, and competition with the *Istituto delle Scienze* of Brera came to an end.[75]

As the government of hospitals and charities was secularised, financial management by patrician boards was divided from medical direction entrusted to physicians, and the most important of the medical chairs shed its old name, theoretical-practical or later rational medicine, to assume the new one of clinics: since its teacher ceased to be a physician illustrating case-histories from private practice, and could officially enter the hospital wards of San Matteo, the "medicalization of hospitals" could begin. From 1783 onwards, with the appointment of Scarpa, the teaching of anatomy soared to scientific excellence, and began to be combined with surgical operations in the hospital; from 1788, with the final transfer of the Medical Directory to Pavia, a number of students began to appear aiming at a degree in philosophy and surgery, rather than in philosophy and medicine.

Frank, as the head of the new Medical Directory, included among his tasks not only the reform of medical teaching, but the whole field that would be covered today by a Ministry for Public Health. His famous projects of *Medizinische Polizei* included the government of the "Medical Faculty" in its broadest 18th-century meaning: not only private professional practice, but also an embryo of a modern National Health Service, with supervision of doctors and surgeons paid by town Councils, rationalisation of hospitals, the policing of the pharmaceutical sector, and the monitoring of hygiene and epidemics, through the new Medical Delegates set up in provincial capitals, who were to correspond directly with the central Office in Pavia.[76]

Engineers were promoted to higher studies, and for the first time entered university classrooms and laboratories. Their arrival in Pavia, after the death of Frisi and the closing of his school in the capital, marked the beginning of an autonomous

[75] A prospects of the Brera schools and laboratories in 1786 (excluding the lower Latin schools) lists a total of 12 professors, 15 including anatomy and chemistry in the General Hospital (on which ASM, *Luoghi Pii* p.a. 384, 385), and natural history in S. Alessandro; they were further reduced to 6 in 1795, ASM, *Studi* p.a. 259.

[76] The role assigned in Lombardy to Frank's Directory, since 1788 strictly integrated in the University, in Piedmont was attributed to the Academy of sciences, an institution under the protection of the King and directly attached to the Court, as in France: B. MAFFIODO, "L'Accademia delle scienze di Torino e la promozione della medicina in Piemonte", in *La politica della scienza*, cit. 3, pp. 319-44; ID., "Medicina, scienza e cultura delle riforme in Piemonte tra la fine dell'antico regime e l'età napoleonica", in M.L. BETRI and A. PASTORE, eds., *L'arte di guarire: Aspetti della professione medica tra medioevo ed età contemporanea*, (Bologna, 1993), pp. 119-34.

course of mathematical sciences in the University. Now coming from all over the State, engineers were obliged to attend a two-year course in 1786, raised to three in 1788: for their training mathematical teaching was not only increased but revised and modified, the "pure" mathematics – elementary and advanced – of the religious Colleges being combined with the practical applications by engineers to mechanics and hydraulics.

The corporate system had hindered both the communication of knowledge and the circulation of men among professions, which were similar in scientific or technical content, but were artificially separated by corporate laws on birth and status. The abolition of *Collegi*, meaning abolition of such laws, favoured contact among these separate traditions, and promoted the ascendancy of "bourgeois" scientific professions. In the Philosophical Faculty of Pavia, the practical knowledge of civil engineers was enriched by the theoretical and speculative tradition of Jesuit Universities, and the use of mathematics in hydraulics and architecture began steadily to grow. The Faculty itself started to lose its propaedeutic high-school profile, as separate curricula were agreed upon, dividing the scientific disciplines from a handful of rhetorical and moral subjects, left for the students of law and theology.

The same happened in the Medical Faculty, when surgeons were ordered to attend the University, there to follow a curriculum parallel and equivalent to that of physicians.[77] By sweeping away the hierarchical subordination of the mechanical art to the philosophical science, and by promoting surgeons to medical instruction (ranging from physiology to microscopic anatomy and diagnostics), it became possible to gradually abolish the ancient division of roles, which became specialisations within a new, unified profession, that of "general doctor" – a reform against the *Ancien Régime* corporate system, which in France could be started only after the Revolution.[78]

For physicians and surgeons the old, separate apprenticeship systems were abolished, to be replaced by common attendance to university courses, without discrimination of birth and status. For their training the old, elementary anatomy for surgeons was vastly expanded and brought up to date: on the one side, it branched off into the microscopical investigations, surgical dissections and operations by Scarpa; on the other, it evolved into comparative anatomy, which became the necessary and general basis of physiology. Medical and surgical clinics, now taught both *ex cathedra* and in the hospital wards of San Matteo, became the centre-piece of medical education, for students specialising both in surgery and medicine, and it

[77] Annexes to the *Piano Scientifico* of 1773 (but more likely 1767-8), in favour of and against printed manuals, ASM, *Studi* p.a. 380.

[78] On continuity and discontinuity between *Ancien Régime* corporate organization, and professional discipline after the Revolution, M. RAMSEY, "The Politics of Professional Monopoly in Nineteenth-Century Medicine: The French Model and its Rivals", in G.L. GEISON, ed., *Professions and the French State 1700-1900*, (Philadelphia, 1984), pp. 225-305.

was required to qualify them for graduation. The scientific degree was clearly distinguished from the licence to practice, which was transferred, from the urban professional *Collegi*, to the Central Medical Directory: to obtain it, two more years of hospital practice were required, to be accomplished either in Pavia, or in Milan or any other provincial hospital.

Consultations and debates, however, were needed to clarify the division of disciplines, both in the mathematical course for engineers, and in the new curricula for medical and surgical students. But it must be stressed that the new plans for medical instruction, in 1786-88, were discussed and adopted separately from the ones for engineers, and that experimental physics was still included in the reform of the Medical Faculty, not in the new course for engineers. By the same token, Volta took part in the reform of the medical plans in co-operation with Frank and Scarpa, being entrusted with the task of selecting the lectures to be attended by students in the Philosophical Faculty aiming at a medical degree. Inversely, the professors of pure and applied mathematics (now increased to four, with the appointment of Mascheroni from the Mariano College of Bergamo) were separately invited to propose a new division of their subjects for the mathematical course for engineers.[79] This separation is still reflected in the archival records in Milan, where quite a few originals by Volta are filed together with the ponderous new Medical Plans by Frank, under the heading Health (*Sanità*), and not Schools (*Studi*).[80]

In sum, the new system introduced by Frank in the Medical Faculty (while causing strong resistance and bitter controversy)[81] remained distinct from the

[79] The government's correspondence, 1785-1788 in ASM, *Studi* p.a. 385; the plans for engineers, *Studi* p.a. 151, 152; the subject-matter and textbooks for general physics proposed by Carlo Barletti, 20.II.1788 (on government order 25.I.1788), concerning the division of subjects with Volta and Mariano Fontana, ASM, *Autografi* 110, and *VE*, II, pp. 429-37. The professors of mathematics were asked as early as 1785 to submit proposals for the new *Piano per l'Istruzione degl'Ingegneri*: according to Giuseppe Raccagni (Rector of the Barnabites' S. Alessandro College in Milan), this was mostly drawn by Mariano Fontana ("disteso per la massima parte dal P.D. Mariano"), and was discussed by letter with Mascheroni; the final decision, however, rested with the government (Bergamo, Civic Library A. Maj, Coll. Barca Lurani, vol. II f. 446). The plan by Mariano Fontana was especially concerned with the division of his subject matter from that covered by Gregorio Fontana, who sternly refused to teach any elementary mathematics ("pare determinato di ritenere la solita sua cattedra delle pure matematiche superiori"), ASM, *Autografi* 128; BEVILACQUA and FERRARESI, "Per una storia dello sviluppo della matematica e della fisica", cit. 3, pp. 218-9.

[80] "Articoli del Piano Medico Chirurgico ordinati da Sua Maestà che riguardano i Professori in generale", and "Osservazioni per mettere in corso il nuovo Piano medico-chirurgico", signed together by Volta and Frank but written by Volta, 31.I.1786, ASM, *Sanità* p.a. 188. In the "Prospetto dell'ordine degli studi" approved by the government, general and experimental physics were to be credited for the first, pre-medical year, also if studied in provincial *gymnasia*, while "animal physics" with natural history was accepted only if attended at the University. For the same trend in the French period, see footnote 86.

[81] HHSA, Lomb. Coll. 84, 85, for pamphlets and anonymous libels against Frank; ASM, *Sanità* p.a. 189.

mathematical plan for engineers. In the revised scientific *organon*, however, general and experimental physics were required in the first, pre-professional year, both for future engineers and for physicians; the latter had then to study "animal physics" with natural history, the subjects taught by Spallanzani.[82] If one could argue from its position in the curriculum, therefore, it would seem that Volta's discipline was still expected to evolve together with physiology, the physics of organic and living bodies, as much as applying itself to mechanical bodies and matter: he was located at a crucial turning point, in the relations between the vitalistic and Cartesian, the medical and engineering traditions.

The reforms of the 1780s, moreover, marked a wholly new start in the balance between the professors of sciences and those of theology and law, as well as in the students' choice between the old legal and clerical robes, and the new scientific and technical careers. A list of the teaching staff around 1786-88 registers its pre-revolutionary maximum of 30 professors: the Theological Faculty had been enlarged to meet a new student body coming to Pavia, as mandatory attendance was imposed on the clergy aiming at a degree, both from regular Orders and episcopal seminaries.[83] But even so the two traditional Faculties, Law and Theology, with the propaedeutic subjects in the philosophical class, accounted for 17 professors, as against 13 for scientific and medical disciplines: these were now assisted by a minor technical personnel of 11, attached to the richly endowed laboratories and museums. In the last year of Austrian rule, when the attempt was abandoned to give a new direction to the rhetorical and juridical culture of the clergy, the two groups had evened out, with 14 teachers each, without reckoning assistants to science professors and laboratories.

As for the student body, the abolition of *Collegi* swept away former restrictions of birth, liberalised the access to all professions, and subjected all to the requisite of a scientific degree. These changes had an immediate effect on student numbers: not only a rapid growth of enrolments started from 1787, increasing the student body to about 800-900 yearly, but for the first time, in 1788, more than half of them[84] chose science and medicine rather than law; this trend was emphasised during the French and Napoleonic period, when the scientific Faculties attracted a constant, solid 55-70% share of the total students (See Graphs and Tables 1-2).[85]

The last two decades of the century saw the final breakdown of the hierarchical

[82] "Prospetto dell'ordine degli studi", 1788, ASM, *Sanità* p.a. 188.

[83] *Studi* p.a. 405 f. 25 The date may be inferred from the doubling of the chairs of dogmatic and moral theology, the presence of Bertola (appointed 1784) and of G.A. Scopoli (died 1788).

[84] Excluding the Faculty of Theology, which registered exceptional numbers in the short period of Joseph II's reforms in 1787-89, and was abolished in 1797.

[85] More data in BRAMBILLA, "Libertà filosofica e giuseppinismo", cit. 3, pp. 393, 432-3 (the total number of students for 1802-3 to be corrected from 112 to 1112). The increase in medical students continued until the 1830s, when the market for the profession (mostly *condotte*) seems to have been saturated, A. FORTI MESSINA, "Studenti e laureati in medicina a Pavia nell'800 pre-unitario", in *Mélanges de l'École française de Rome*, 97 (1985), pp. 489-530.

order of the sciences[86] which had been safely encompassed in the Aristotelian philosophical *organon*, and had been followed, in the *ratio studiorum* of religious Orders, by teachers trained for the whole range of "philosophical" disciplines. As the old, broad partitions branched off into an increasing number of new disciplines, each one rapidly advancing in cumulative growth, "philosophy" ceased to be accessible to any "generalist" lecturer; at the same time, the progress of calculus and the mathematization of mechanics began to exclude from advanced science not only the average philosophy teacher but also the gifted "connoisseur".

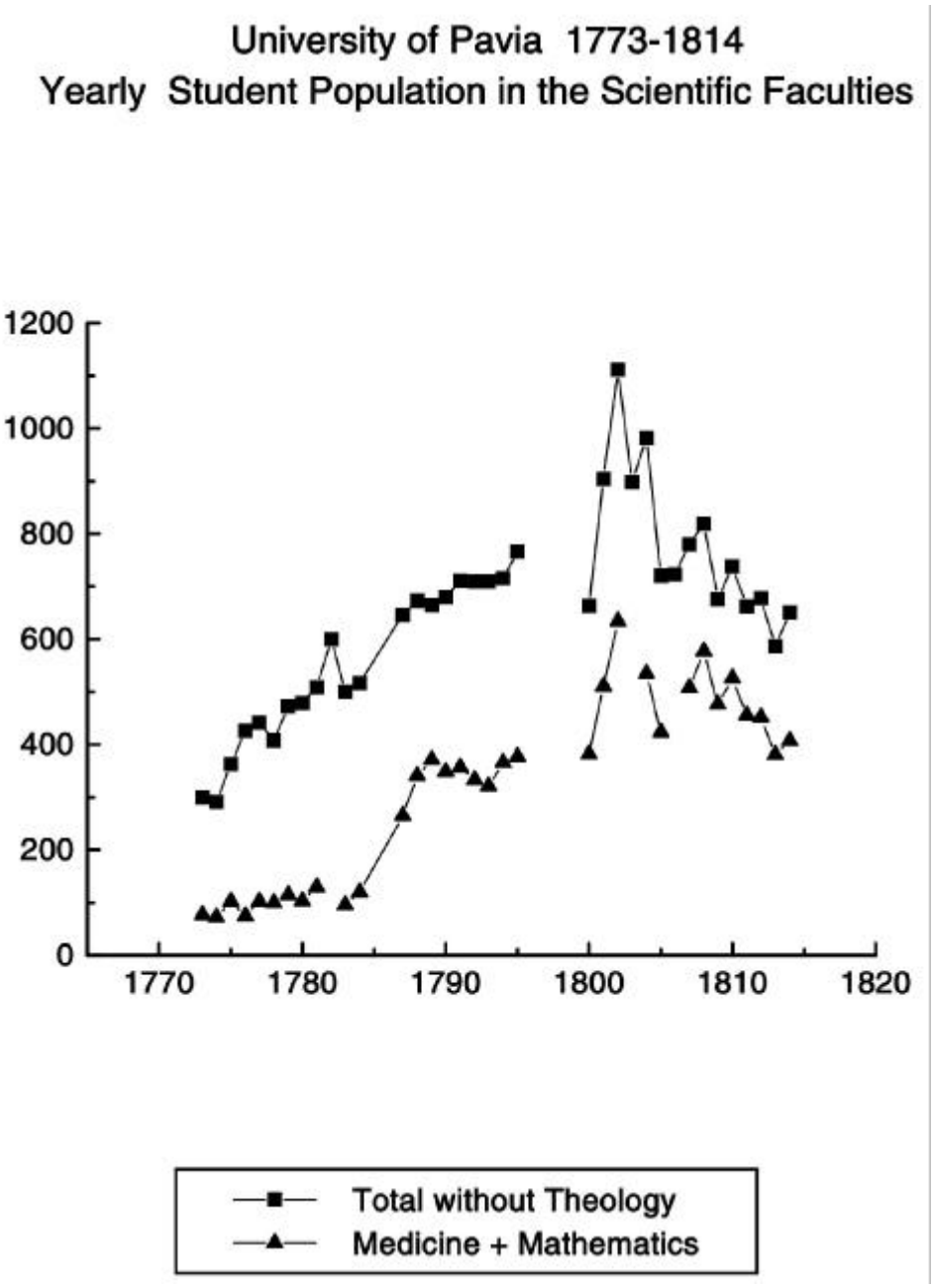
This shift, already well under way at the end of *Ancien Régime*, was not only confirmed but vastly accelerated by the Jacobin reforms of the republican period, during the first and second (1800-2) Cisalpine Republics. In 1797 the Theological Faculty was abolished, and that of Law was deeply transformed in the direction of Political Sciences. Almost all teachers were affected by the political turmoil of that brief but crucial period, about one third being either dismissed, or promoted to a political career. In a staff list registering the scientific organisation of 1803, the chairs were still 27, but only 8 professors belonged now to the old rhetorical-juridical tradition; the theological-philosophical group had disappeared, and that old container itself, the Philosophical Faculty, had been abolished and its disciplines re-classified.[87]

Science teaching had come under the influence of French *idéologie,* that last stage of Enlightenment which transmitted its legacy first to the Revolutionary Assemblies, then to the Directory and Consulate, when scientists assumed a leading, if not a dominant role.[88] Sciences were divorced from *belles lettres*: since no

[86] R. STICHWEH, *Zur Entestehung der modernen Systems wissenschaftlicher Disziplinen: Physik in Deutschland 1740-1890*, (Frankfurt am Main, 1984). Of course, in a wider perspective one should include the earlier and powerful influence of the encyclopaedic French model: W. TEGA, *Arbor Scientiarum: Enciclopedia e sistemi in Francia da Diderot a Comte*, (Bologna, 1984); G. ABBATISTA, ed., "L'enciclopedismo in Italia nel secolo XVIII", *Studi settecenteschi*, 16 (1996); but I doubt that it had any *direct* influence on Italian University curricula, before the French reforms started in 1796.

[87] In the *Piano Scientifico* of 1803 the chairs are 34, 11 in the Physics and Mathematics Faculty, 12 in Medicine, and 11 in Law including Belles Lettres. The list of the real staff of 27, in July 1803, annex to the Economic Plan soon to be published, ASM, *Studi* p.m. 1; for changes in 1796-99, *Studi* p.a. 387, 405 (in particular Report 26 brumaire a.V-16.XI.1796 by the Committee for Public Education).

[88] N. and J. DHOMBRES, *Naissance d'un nouveau pouvoir*, cit. 32; S. MORAVIA, *Il tramonto dell'Illuminismo: Filosofia e politica nella società francese (1770-1810)*, (Bari, 1968); R. FOX, "Science, the University and the State in Nineteenth-Century France", in *Professions and the French State*, cit. 78, pp. 66-145. In the light of 19th-century developments, Fox argues that no "professionalization of science" existed until the 1880s: his term of reference is the Anglo-American model of advanced science applied to industry, a very different point of view from that of French historians such as Dhombres. Another, sociological model seems to be preferred by German scholars, having to account for the very special role of German Faculties as government consultants, while the Kuhn model of "scientific community" seems to be preferred by Italian historians.


University of Pavia 1773-1814
Yearly Student Population in the Scientific Faculties
1200
1000
800
600
400
200
0
1770
1780
1790
1800
1810
1820
Total without Theology
Medicine + Mathematics

University of Pavia 1773-1814
Yearly Student Population in the Scientific Faculties
(percentage)

University of Pavia
Yearly Student Population in the Scientific Faculties (Medicine-Mathematics)
1773-1814

	TOTAL (without THEOLOGY)	MEDICINE+MATHEMATICS	
		N°	%
*1773	300	76	25.3
1774	291	71	24.4
1775	363	101	27.8
1776	426	74	17.4
1777	442	101	22.8
1778	408	99	24.3
1779	472	114	24.1
1780	479	102	21.3
1781	508	129	25.4
1782	600		
1783	500	95	19.0
1784	517	119	23.0
1787	646	264	40.8
1788	673	340	50.5
1789	664	371	55.9
1790	680	348	51.2
1791	710	356	50.1
1792	709	333	47.0
1793	709	320	45.1
1794	716	365	51.0
1795	766	376	49.1
1800	663	381	57.5
1801	904	510	56.4
1802	1112	633	56.9
1803	898		
1804	982	534	54.3
1805	720	423	58.7
1806	723		
1807	780	507	65.0
1808	819	576	70.3
1809	676	476	70.4
1810	737	525	71.2
1811	662	455	68.7
1812	678	451	66.5
1813	586	380	64.8
1814	650	407	62.6

Table 1 *Academic year 1773/4, and so to follow. *Sources*: ASM, *Studi* p.a., 459-460, 247, 361; *Studi* p.m. 684-685, 42, 387, 597, 900, 941, 946, 997, 1192-1196. Archivio di Stato di Pavia, Università, Registri 814-818; Rettorato, 231-234; Rettorato, Cataloghi generali, *sub anno*.

University of Pavia
Yearly Graduates in the Scientific Faculties (Degrees and Licences)
1780-1812

	PHYSICIANS SURGEONS	ENGINEERS SURVEYORS	TOTALGRADS (with Lawyers)	TOTAL SCIENCES	
				N°	%
1780	28		75		37.3
1781	23		65		35.4
1782	28		89		31.5
1783	45		99		45.5
1784	22		80		27.5
1785	33		90		36.6
1786	*46	21	124	67	54.0
1787	18	40	102	58	56.9
1788	40	56	160	96	60.0
1789	42	11	136	53	39.0
1790	63	24	159	87	54.7
1791	41	30	127	71	55.9
1792	38	31	169	69	40.8
1793	34	29	140	63	45.0
1794	46	38	152	84	55.2
1795	60	18	175	78	44.5
1796	12	16	55	28	50.9
1800	57	49	156	106	67.9
1801	84	53	231	137	59.3
1802	87	51	257	138	53.6
1803	75	66	260	141	54.2
1804	102	36	279	138	49.5
1807	108	76	281	184	65.5
1808	73	99	260	172	66.1
1809	90	29	211	119	56.4
1810	57	**76	186	133	71.5
1811	88	54	198	142	71.7
1812	74	54	210	128	60.9

Table 2 *Since 1785/6 surgeons were required to take a doctoral degree instead of a licence. **In the years 1810-12, more than three hundred land-surveyors presented their licences, as required, to be legalized by the University, but being adult and practicing professionals they have not been taken into account. *Sources*: Archivio di Stato di Pavia, Università, Registri 30, 33, 34; 613 (ex 61), 609bis (ex 327); Giurisprudenza 623 to 629, 632; Facoltà matematica, 1, 118, 140; Facoltà medica 47-49. Data on graduations are less significant than total student numbers, because they register only strictly professional vocations; an unknown, but probably substantial percentage of those enrolling in Pavia, however, either did not graduate there but moved to other universities, or did not plan to graduate at all, considering the university rather as a finishing school, where to complete their general and especially scientific education.

independent Faculty of Literature could exist at university level (the market for secondary school teachers being still dominated by clerics) literary disciplines retained their propaedeutic role: as a pre-professional year introducing to the Law Faculty, it could be attended both at the University, and in provincial *Lycées* and ex-Universities. General, introductory sciences, on the contrary, gave rise to a new, independent Faculty of Physics and Mathematics, and underwent a second realignment, along the lines already laid down for the course for engineers in the 1780s: the "Newtonian" sciences were definitively disengaged from their previous subordination to Medicine, while the old position, ancillary to the Medical Faculty, was still occupied only by "Baconian" sciences.[89]

8. Teaching and Research

A striking feature of the first stage of reform in the Philosophical Faculty, both in the University of Pavia and in the professional and patrician schools in Milan, had been the persistence of the Jesuit method of teaching, which in their out-schools had been based on dictation word by word: the same method was in use in the University

[89] Botany had been divided from chemistry since 1797, and the latter from pharmacy or *materia medica*; for the medical professions, a further development had divided the new "scientific" subjects – comparative anatomy and physiology, in addition human anatomy – to be pursued through experimental research, from the old core of practical medicine, now confirmed as clinics both for the "theoretical" pre-graduate courses, and for post-graduate specialization. As concerns the order of studies, a decree by the Ministry of Interior of the second Cisalpine (Bologna, Archivio dello Studio 414, 13 piovoso a.IX-2.I.1801), laid down the progression to be followed in the "schools for physicians and surgeons" in the University of Pavia: included in the first year were general and special physics and natural history, in the second (both for surgeons and physicians) "experiments of physics", together with botany, comparative physiology and anatomy, and human anatomy. A comment on the new *Piano Scientifico* of 1803 (ASM, *Studi* p.a. 940, *Piano B*), gave an ascending order for the whole course of medical and surgical studies, and here again experimental physics was the starting point, in what seemed a progression from natural history to medicine, or from general to professional subjects ("una tal quale gradazione secondo che una Scienza sembra discendere da un'altra"): experimental physics was to be followed by natural history, agronomy, botany, general and pharmaceutical chemistry, physiology, human anatomy, comparative anatomy, and lastly by the professional disciplines: general surgery and obstetrics, surgical clinics with operations, pathology with forensic medicine, therapeutics, medical clinics. Another decree of 18.IX.1804 (ASM, *Studi* p.m. 940) specified the *Istituzioni Fondamentali* or pre-first year disciplines, to be credited also when studied in the ex-Jesuit schools and ex-Universities (maintained as Lycées): for all were mandatory the humanities of the Jesuit *ratio*; to these elementary algebra, geometry and design had to be added for engineers and land-surveyors; general and experimental physics, however, were required only from future physicians and surgeons (and apothecaries from 1803 onwards). Thus, although experimental physics was now in the Mathematical Faculty, it retained an old link, within the medical curriculum, with physiology and "animal physics", the organic processes of living bodies.

before the reforms of 1771-73, as well as in the clerical and papal Colleges.[90] The professor prepared once for all a manuscript text for his courses, often patched together from existing books and manuals,[91] and employed half the time of his public lecture to dictate from it, and the other to explain it. This method rested on the assumption that students did not need printed books and manuals. They rather made their own manuscript ones, writing them down bit by bit under dictation. They were then supposed to learn them by rote, either studying "privately" at home, or in the "repetitions" in the boarding Colleges, inhabited only by noble and patrician inmates. In the Ghislieri College, for example, university professors came in to teach their subjects,[92] and got an extra stipend for this task, while an internal staff of *ripetitori* were employed to supervise the "private" study of boarders, which was based on repetition and rote learning.

The successive stages of reform, from the first plan in 1773 to the great laws on public education of 1802-3, were all aimed at abolishing this double standard of teaching. Professors were forbidden to give private tuition for a fee to the same students who followed their public lectures,[93] and were ordered to transfer all

[90] On Kaunitz's disapproval of domestic lessons and dictation, and his insistence for public lectures and oral explanation, as in the University of Vienna, see dispatches to Firmian, 3.II.1765, 15.IX.1766, 2.II.1767; for the same opinion by Cicognini in his "Forma degli Statuti", 30.VIII.1768, ASM, *Studi* p.a. 375; also this report by Boscovich: 15.VI.1768 "quantunque siano partiti i Collegiali, e con ciò mancato tutto il concorso all'Università, la metà de' miei scuolari pubblici, che sono giovani Ingegneri (from the city and neighbourhood of Pavia), seguita a venire e fo scuola dal letto (è "malato o incomodato") ogni giorno anche le vacanze: sul fine della settimana finirò di spiegar loro la trigonometria, che ho dettata dopo l'Algebra, e mostratone l'uso", ASM, *Autografi* 115. In the "Regolamento generale intorno alla disciplina del clero regolare e sua dipendenza dai Vescovi diocesani nella Lombardia austriaca", (sent to Milan 27.VII.1781, published 20.VII.1782, HHSA, Lomb. Coll. 68), obliging the teaching Orders to study philosophy and sciences in Pavia, each Order was required to provide one or two *ripetitori*, who were to live in their convents in Pavia, and to help friar-students to learn by rote repetition what they had heard or written to dictation from university professors. Mentions of this use (strictly linked to private academies and manuscript *zibaldoni*), are easy to come by also for other universities: A. De Giorgi Bertola to C. Amaduzzi, Napoli 22.V.1779: "I cattedratici di Ferrara dettano in latino: io vorrei dettare in italiano per molte ragioni, che qui sarebbe troppo lungo il riferire",in M.F. TURCHETTI, *Cultura e vita sociale nel Settecento italiano: Il carteggio Bertola-Amaduzzi*, graduation dissertation, C. CAPRA, superv., (State University of Milan, 1997-8), p. 156 and on *zibaldoni* p. 153; on Padua, P. DEL NEGRO, "I 'pensieri' di Simone Stratico sull'Università di Padova (1760)", in *Quaderni per la storia dell'Università di Padova*, 17 (1984), pp. 191-229.

[91] GIUSTI, "Memoria sopra la riforma generale degli studi", cit. 33, f. 64, points out the faults of such manuscript drafts and "Compilations", especially the excess of "useless definitions" and the lack of simplicity; they are usually put together by the most mediocre professors, since the best ones shun such a "pedantic" task.

[92] On this reform of the Ghislieri College, 25.VI.1767 and 16.XI.1767, ASM, *Dispacci Reali* 240; *Studi* p.a. 405, for a list of *ripetitori approvati* in 1794-95.

[93] On private exams "by the old method", unlawfully continued by professors at home for their private pupils, see the reports by Brunacci 1802, 1806, ASM, *Autografi* 168; for the prohibition of 1803, a report on the disciplinary Plan, 9.X.1803, *Studi* p.a. 683: while professors were forbidden,

teaching from private homes to public halls, classrooms and laboratories.[94] Public teaching was to be based on a new obligation imposed on professors: they had to replace manuscript and dictation by composing and publishing a printed manual for their discipline.[95] These new texts marked the abandonment of the old "canonical" authorities: the last to go were the Holy Scriptures, with the abolition of the Theological Faculty, and Canon Law and the Corpus *Juris*, replaced by the Code Napoléon in the Law Faculty since 1806.

The printed manual, which had been for use of the *lector* only, had now to be put in the hands of the students, freeing the teacher from dictation, to be replaced by a more modern kind of lecture: neither the explanation of a text written down by the students during the course of learning itself, nor the solemn opening lectures, limited to the beginning of the academic year; rather, creative oral teaching, in which the professor could leave aside the basic knowledge to be drawn from a printed manual, now in possession of his audience, and expand on its more interesting, advanced or difficult points. These new prescriptions not only started a lively debate between the professors and the government on the method of public teaching,[96] and not only did they produce quite a number of *new* manuals, but they were also accompanied by proposals to publish original research in a university journal, following the model of the *Acta Academica* of Göttingen, Leipzig and other German universities.[97]

private paid tuition was explicitly allowed to *ripetitori*, teaching assistants to be appointed by the Rector and Deans or by the Government, ASM, *Studi* p.m. 940.

[94] On protests for the diminution of income due to the new prohibition, and the persistence of "private academies", see a letter by Cremani from Pavia, 6.XI.1783 (Biblioteca Comunale, Trento, Ms. 572, f. 11ff.), on his appointment as *ripetitore* in the Borromeo College, and on government hostility to the "great number of academies": Cremani replies that "in the old system public lessons were so few, that it was absolutely necessary to have many repetitions each week in the Colleges" ("nel sistema antico dell'università le lezioni pubbliche erano sì poche, che si riduceva a necessità il fare ai Collegj più ripetizioni per settimana"). Private repetitions continued to be especially in demand for mathematics and chemistry: Brugnatelli (5.XII.1803), asked permission to keep with his assistant Mantegazza "a private Academy of general Chemistry for graduate physicians, foreign and national students interested in chemistry ("una privata Accademia di Chimica generale per varj medici laureati, studenti forestieri e nazionali amatori della chimica"): students themselves had asked him, and were quite prepared to pay him, ASM, *Studi* p.m. 962, 963. In 1806-7 approved *ripetitori* or teaching assistants had increased to 22, 15 in the medical and mathematical Faculties, and all but one either engineers or doctors, ASM, *Studi* p.a. 683; in an 1813 proposal (rejected) to limit their fees, their profits are said to reach up to 6,000 lire yearly, double the average salary of a full professor (Conference of the Interior Ministry, on the final report by Rector Brugnatelli for 1811-12, ASM, *Studi* p.m. 941).

[95] On the government decree of 1786 prescribing the use of a printed manual, and on the subsequent debate among the professors (especially Scopoli and Cremani) and the government, ASM, *Studi* p.a. 385, 387, 408; the prescription was renewed in 1808 by the General Director of Education Moscati, extended to the Lycées, and accompanied by a policy of subsidies to cover printing expenses, ASM, *Studi* p.m. 293, 294, 684.

[96] ASM, *Studi* p.a. 385.

[97] VOLTA, *VE*, II, 1786, p. 367ff.

In these projects and debates, I think, we can see the model of "restricted modernisation" coming to an end: the museums, cabinets and laboratories for research were now an integral part of the University, instead of being separate from it, as in the University and the *Istituto delle Scienze* in Bologna.[98] To effect this union, two conditions had been met. On the one side it had been necessary to build new research facilities completely from scratch, in the *same* buildings that had formerly been made only of teaching halls. On the other, the reforms had to affect the contents of *public* teaching, freeing the lecture from official allegiance to the old authorities, so that it was now possible to transfer into university teaching the results of research.[99]

In this way, another old barrier was beginning to crumble: the old "double standard" of the regular Orders, separating the out-schools for public teaching, from the private study and learning, reserved for members to prepare them for teaching, the "popularising" function from the recruiting function. Accordingly, different opinions began to emerge as to the nature and aims of university teaching itself, focusing on the question whether it should be limited to the "elementary" part of each science, such as could still be rendered "uniform" with the aid of a printed manual,[100] or whether it should present new findings and recent developments in each discipline,[101] and thus be opened to the different theories and "systems"

[98] For a summing up of the progress made on scientific laboratories and research facilities since the 1760s, see the general report, undated but around 1786, HHSA, Lomb. Coll. 104 (Annex to "Tavole Statistiche").

[99] In Bologna too, in fact, M. CAVAZZA ("L'Istituto delle scienze di Bologna negli ultimi decenni del Settecento", in *La politica della scienza*, cit. 3, pp. 435-50) indicates that at the end of the century the lectures in the Istituto were replacing, rather than adding to, those in the University – another case of "surreptitious modernization". Academies could circumvent university and corporate resistance, modernizing culture outside and around it, if it was impossible to reform it from inside: see also the case of the Academy of sciences, letters and arts started in 1779 by a group of progressive professors in Padua, with the aim to modernize the University, P. DEL NEGRO, "Istituzioni, spazi e progetti culturali nella Padova del secondo Settecento", in R. PASTA, ed., *Cultura, intellettuali e circolazione delle idee nel 700*, (Milano, 1990), pp. 174ff.

[100] An exhaustive defence of this position was given by the professor of criminal law Luigi Cremani, arguing that professors should not teach "many truths" in addition to the *Instituta* ("oltre gli elementi (non) si debbano insegnare molte verità di più"), nor should they waste all their time cultivating all too rare "exceptional minds" ("non perdersi nel favorir solamente quegli ingegni, che con ragione diconsi rari"), ASM, *Studi* p.a. 385.

[101] A brilliant defence of the teaching of new subjects and original research was presented by Spallanzani: "... gli oggetti da esaminarsi, oltre all'utilità, debbono avere il pregio della novità: in quanto ché o non siano stati discussi da altri, o stati lo siano imperfettamente, di maniera che con novelle osservazioni sperabile sia il dare qualche ulteriore passo in quel ramo di Storia naturale che ci occupa. E tra gli oggetti nuovi ve n'ha alcuni, che quando per rara fortuna si presentano all'osservatore, meritano la preferenza per essere più atti degli altri ad allargare i confini del Mondo fisico. Parlo di quelli che costituiscono come un Ordine in sé, per essere isolati dagli altri, essendo in certa guisa come anella staccate dalla catena universale degli Esseri", quoted by R.

followed by different professors, as in chemistry, electricity or in the new "Brownian" theory of illness.

Here, in fact, we are confronted with the everlasting conflict between obligations of teaching and research: to abolish the distinction between private and public courses, and to put printed manuals in the hands of students was designed to upgrade the level of scientific lectures, and to introduce the old practical and technical professions to the latest developments of higher mathematics and natural sciences; but the concentration of all lectures in public classrooms, and the new insistence on printed manuals might also mean a return to the old *Instituta* or elementary principles for each profession, mortifying that part of philosophical courses that had been pursued in private homes and academies: advanced research, although for a selected few, and not yet aimed at the "institutionalisation of science".

It was perhaps not by chance, however, that the politically troubled, but also politically intense decades at the end of the century, from 1780 to 1800, were rich in scientific advancement and discovery. Pluralism and open debate entered the university halls, and split both the professors and their students into fighting parties. In a tradition unfamiliar, however, with confrontation before public opinion, scientific disagreements easily degenerated into fierce personal feuds,[102] and prudent verification of hypothesis gave way to allegiance to new speculative "systems", eagerly adopted by students more on political than on scientific grounds.[103] This in turn aroused an opposite reaction: suspicion of *esprit de système* became suspicion of "novelties", to be excluded from public teaching. The reforms of 1803, which confirmed the abolition of the Philosophical Faculty, left only a handful of disciplines of "disinterested erudition",[104] and again shifted the stress, in some measure, to the sound, uncontroversial *Instituta* for the "useful" professions.[105]

MILANI, "Faunistica, ecologia, etologia e la variabilità degli organismi nel pensiero e nella didattica di Lazzaro Spallanzani", in *Lazzaro Spallanzani e la biologia del Settecento*, cit 50, p. 87.

[102] See footnote 78. Besides the partly anonymous and vicious attacks against Frank, also accusations of "theft" against Spallanzani.

[103] G. COSMACINI, *Scienza medica e giacobinismo in Italia: L'impresa politico-culturale di Giovanni Rasori*, (Milano, 1982).

[104] Astronomy with geography (cartography on astronomical measurement), agronomy (for the landed gentry), naval and military architecture (never active in Pavia), eloquence and poetry, and oriental languages were not required for any (professional) degree, and they were thus justified in 1802 ("Proposizione di Cattedre", 10.VIII.1802, ASM, *Studi* p.m. 940): "Esse di loro natura non entrano in veruno de' corsi, che si propongono per conseguire i gradi. Ma siccome non tutti concorrono all'Università per decorarsi dei gradi, e molti vanno o possono andare per istruirsi e coltivarsi in qualche particolare ramo di scienze, e d'altronde in un'Università bene stabilita conviene, che i concorrenti studiosi, ed il governo abbiano uomini atti ad ogni sorte d'istituzioni scientifiche, e di consiglio, così non si crede che debbano ommettersi [sic], ancorché sembrino cattedre di lusso".

[105] A report on the *Piano Scientifico*, 9.X.1803, criticized any too detailed prescription of subject matter (as in the Plan of 1773), approving the concise definitions for the mathematical Class, and

In a new, liberalised context, the double system of public and private teaching could be defended on sound methodical reasons: it helped to prevent the "Jacobin" politicisation of science, and to distinguish the average professional education from the recruitment of lay gifted students for scientific teaching and research. "Domestic academies" were very dear to many professors, and often to the best ones, who stubbornly refused to adapt themselves to printed manuals and to the new guidelines for public teaching. This applies in particular to those mathematicians and "natural philosophers", who had come to the University from a clerical living without pastoral duties attached, like the *abbés* Spallanzani and Mascheroni, or from regular Orders, like the Piarist Gregorio Fontana and the Barnabites Frisi, G.B. Savioli, P. Configliachi, M. Fontana, E. Pini, who were already dedicated to scientific research. For these friars, appointment to university chairs meant a new freedom from monastic discipline, of which many of them were especially intolerant. Their new position allowed them to shed the plural obligations of the teaching friar, and to adopt the professional specialisation of the scholar, even before they were allowed to leave their monasteries by Joseph II's ecclesiastical reforms, and to de-frock by Jacobin legislation. From their number came many of those who left teaching for politics during the republican period, and who were among the most outspoken against the old order. The mathematician and ex-friar Gregorio Fontana made public his anticlerical and downright atheist position, formerly concealed in his private correspondence; he refused the catholic sacraments in dying, and was almost refused the traditional eulogy *in mortem* by his colleagues.[106]

9. Conclusions

Two parallel approaches have become usual to evaluate the movement of reform and modernisation, that deeply affected many *Ancien Régime* universities and academies, from the Enlightenment to the French Revolution and beyond. In relation to teaching and research, it is usual to speak of the institutionalisation of science. In relation to the output of university graduates, the talk is rather of professionalization. These two approaches have some elements in common, and may be partially combined. In the first case, the stress is on the shift from a pattern of individual discoveries, and loosely connected networks of partially self-taught "connoisseurs", to communities of specialised, professional scientists, supported by permanent and

was very critical of passages recommending that University teaching be limited to the elementary principles, to the exclusion of "novelty" and "lofty theories". A passage on advanced mathematics, struck out of the final version, read: "Il Professore avrà ... l'avvertenza di non diffondersi in troppo sublimi teorie, perché non bisogna perder di vista la massima, *che nelle scuole non si deggiono fare delle nuove scoperte*, ma si devono istradare i giovani nelle scienze per modo che rimangano abilitati a studiare da se, ed intendere le opere classiche". The caution was repeated for general chemistry, another discipline in revolutionary progress, then taught by Brugnatelli, who propounded a controversial alternative to Lavoisier's nomenclature.

[106] ASM, *Studi* p.m. 959.

well-funded institutions, generally financed by the State. As for the concept of *Professionalisierung*, its purpose is to give account of the rise of the bourgeois free professions of the 19th century; but it also suggests that a crucial element in their new definition and self-consciousness was the rising standard of specialized knowledge, that came to be required to enter the professional community. This implied a longer period of formal schooling, access to the university, or in any case to more advanced scientific courses and degrees.

This was just the case in Lombardy. One of the aims of university reforms, from the period of Austrian rule to that of French hegemony, was to improve the training of the scientific professions, switching them from the still prevailing system of apprenticeship, to the formal requirements of a partial or full university education. This trend has been examined in two ways, in relation to the teaching of sciences and to the professions.

As regards the scientific professions, the reforms may be seen as a drive towards legal equality, and against birth and status barriers: these were removed, first gradually and later completely, and access to the professions was laid open to competition by merit, in the spirit of enlightened *philosophie* and the French Revolution. In this perspective, the policies of school reform may be considered as a part of the more general trend of enlightened opinion and government against corporations and monopolies in trades, arts and sciences; its effects on the professions were on one side to promote a steep rise in student numbers, since equal career prospects were opened to any student regardless of birth, and on the other to lengthen the period of formal education, sharply dividing the years of schooling from those of practice, formerly mixed up in the apprenticeship system. In the professional Faculties, the trend of reform was to reverse the old priorities: the *Istituzioni* were moved to the foreground, evolving into a set of formal, public university lectures, which were made compulsory for getting a degree. A mandatory period of at least two years of university attendance was introduced for surgeons and apothecaries, engineers and architects, who had rarely or never before entered university halls. There it replaced *Ancien Régime* requirements of birth and status, for obtaining a scientific degree – either a licence or a doctoral degree[107] – which was clearly distinguished from the permit to practice. The title assumed an exclusively scientific content, while apprenticeship became a period of post-graduate training; the role played by *Collegi* in training and licensing was taken over by new government agencies, which supervised both public health and technical services, as well as private professional practice. In the balance between the Faculties, furthermore, a further and deeper change took place, involving the decline of the old canonical group of disciplines dominated by canon law – the main stumbling block for any far-reaching political reform – and the ascendancy of science and medicine.

[107] See footnote 2.

If one aspect of the renewal of philosophical curricula and teaching was a by-product of economic liberalism applied to professional corporations, the other was the result of the attack against ecclesiastical corporations and regular Orders. Considering the contents of education, the period of reform was characterised by the liberalisation of teaching: censorship was secularised and the clerical monopoly of philosophical courses was abolished. In this respect, school reforms must be seen as an integral part of the drive against the independent legislative and judiciary powers, exercised within the State by ecclesiastical tribunals and corporations, who considered themselves to be above the State, and refused to be bound by its legislation.

In this process, a new Philosophical Faculty took form in the State University, and here the late Aristotelian, generalist approach to logic, metaphysics and general physics was abandoned, giving way to an ever larger and more specialised set of scientific disciplines, in step with contemporary advancements of science. "Philosophy", however, continued to be thought of as a general, preparatory Faculty, halfway between high school and university. Until the last years of Napoleonic rule, as Bevilacqua and Ferraresi have shown, it remained preliminary to the higher professional Faculties, just as it had been in the Jesuit *ratio studiorum*; but since the reform of censorship and the dissolution of the Company, between 1768 and 1773, it was freed from its subordination to Theology, moving into the new, lay framework of the Pavia University and the state *gymnasia*.

The influence of the Roman Curia as a political, supranational power, law-giver, and censor of the teaching of sciences, must be treated with particular caution in contexts, such as Italy, France and Spain, where a Church exists that rejects by definition confessional pluralism. In Germany, Humboldtian reforms were applied to an already long-standing system of plural churches, on which the university system was built. Its character at the all-German level was confessional pluralism, legally and constitutionally in place since 1648. In England the established-church system, on which the university monopoly of Oxbridge was founded, had been countered since 1688 by a free or private sector of dissenting schools, which were not only confessionally pluralistic, but adverse to the State-Church monopoly of the official Universities.

In France as in Italy, the starting point was not a diverse network of religious schools, financed by different churches and paying allegiance to them; but a one-Church monopoly, to which State schools themselves had to pay obedience, on pain of attack by the over-arching power of a political Church. Just as the Roman Court maintained a deep-rooted opposition to the idea itself of religious pluralism – taking for granted not only the active prohibition of any rival confessional school-network, but also the compulsory Catholicism of all existing municipal or State schools – so the State assumed a contrary role than in pluri-confessional systems. It was here the State that, having its sovereignty limited by the legislation and tribunals of a political-ecclesiastical power above the State, had to start the movement against confessional schools. Ideas of progress and modernisation become thus strictly

associated to State intervention, in its effort to impose the principles of tolerance, the laicisation of the school system, and the neutralisation of science in a non-confessional or secularised context.

Catholic resistance to State politics of education, however, was likely to adopt the language of freedom against State intervention, without accepting the underlying assumption of confessional pluralism. A misunderstanding was therefore at the roots of the modernisation debate: two meanings of freedom, cultural independence, and collegiate self-government – the intellectual and the corporate meaning – could be easily mixed up, favouring a confusion which was not likely to happen where the cause of freedom was waged by alternative or dissenting churches against an official State-Church. The standard of cultural freedom from State intervention might only too easily be upheld to defend the corporate, self-governing rights of *Ancien Régime* religious Colleges and professional *Collegi*, whose "independence" had been based on the weakness of the State in the educational and cultural domain. Inversely, those sectors of public opinion which favoured cultural pluralism might easily be led to support the strengthening of State power, or might drift towards anti-clerical radicalism.

If we turn from the reforms freeing *philosophie* from theology, expanding the teaching of sciences, and liberalising access to the professions, to the movement of public opinion that accompanied them in civil society, we may see its support slowing down as reforms accelerated, and in 1803 it was already petering out: a reaction was under way that opposed humanism to science, as a backlash of the association of science with revolution. Bevilacqua and Ferraresi have shown the limits of Joseph II's policies of recruitment, with their insistence that professors be formed within the regular Orders; it may be added that the anti-clerical drift of school reforms – including the compulsory modernisation of the clerical teaching corps[108] – was an almost inevitable by-product of the attempt to bring some

[108] BEVILACQUA and FERRARESI, "Per una storia dello sviluppo della matematica e della fisica", cit. 3, pp. 216-8; see the "Regolamento generale intorno alla disciplina del clero regolare e sua dipendenza dai Vescovi diocesani nella Lombardia austriaca", 20.VII.1782 (HHSA, Lomb. Coll. 68): for philosophical studies (and not only for theological ones), all regular Corporations were ordered to attend the State University; student friars would live in their Pavia convents, but be exempted from monastic discipline to attend university lectures. The Orders (and especially the Benedictines and the Barnabites, Piarists and Somaschi, who had been more independent of Spanish neo-scholastic culture) were to select at least two of their most gifted students, exempting them from the usual general education, to let them pursue the specialized study of one of the scientific disciplines in the philosophical Faculty. See the new curricula for Barnabite novices, selected to become *teachers* for their Order, according to a Plan drawn up in 1783 in obedience to this decree (Milan, Archivio Barnabiti di S. Zaccaria, cart. A III): three years of high school for novices and beginners ("Studj iniziali per il primo e secondo noviziato"), would be completed in their College in Milan, including literature (Latin and Italian), elementary geometry and algebra, and natural history; those selected to pursue their studies were then to move to their College in Pavia ("Sistema di disciplina e studio per i Chierici Regolari barnabiti della Lombardia Austriaca nel loro Collegio di Canevanova in Pavia"), to complete at the University, rather than in their

pluralism into a one-confessional school-system. The alternative line taken after the French Revolution – to abolish Theological Faculties, let science teachers shed their frocks, nationalise ecclesiastical school finances – also had its weak side, in that it waived the right of the State to control clerical schools, and did not try to reform the scientific contents of their education, leaving a powerful, self-styled "free" sector to wage the battle against irreligious and "authoritarian" lay schools.

The successes of scientific Enlightenment in Pavia were built – as Giusti had proposed – upon a careful dissociation of physics from metaphysics, large enough to open a neutral middle-ground for science, on the basis of a reasonable Christianity and a vague finalist belief; but not so large as to suggest that the laws of Nature could render superfluous the will of God. A common feature of the best scientific contributions of the period was the refusal of extra-scientific, systematic superstructures; this often concealed tacit deferment to theologians, as in the division of labour between Spallanzani and Bonnet,[109] and perhaps also a deep-rooted diffidence to admit the full, binding operation of mechanical laws in the physical world of phenomena: from these, no sum of observations could abstract generalisations of more than relative certainty. This methodical exclusion could be very fruitful, in its rejection of *esprit de système*; but it might also be closely allied to a probabilistic interpretation of natural laws, still active in the second half of the 18th century on a new defensive line: against the full application of mathematics to the physical world, as it was being carried on by French scientists, who were redrawing the lines dividing the abstract objects of mechanics from living nature, physics from physiology, organic from inorganic chemistry, without fear of subordinating spirit to the laws of matter.

As French scientific Enlightenment evolved along these lines, toward the determinism and materialism of the *idéologues*, and lent its expert skills and scientific enthusiasm to the military efforts of the Revolutionary assemblies and the Directory, Italian "scientism" gave way to a reaction against the previous scientific Enlightenment. In 1803-4, science teaching in the University was institutionalised at its French, much more advanced level, not to be modified until the formation of the unitary State, and student enrolments reached their secular peak; but the Enlightenment generation of scientists had either died, as Spallanzani and Mascheroni, or had left teaching for politics, as Barletti and Gregorio Fontana, or were asking for retirement, as Volta and Scarpa, who had never fully accepted either the "excesses" of the republican regime, or the indiscriminate opening of the

internal schools, the philosophical, mathematical and theological courses ("Filosofia in ogni sua parte, matematiche, teologia e le altre appartenenti alla morale"). This was their three-year philosophical curriculum: 1st year, logics and metaphysics, ethics, elementary mathematics; 2nd year, general physics, natural history, chemistry and botany, elementary mathematics; 3rd year, the same and advanced mathematics. Afterwards they proceeded to study theology.

[109] MONTI, "Bonnet et les poulets de Haller", cit. 50; J. MARX, *Charles Bonnet contre les Lumières*, 2 vols., (Oxford, 1976).

University to lower class students.

The best of Pavia's 18th-century scientists had come from a pre-institutionalised tradition, when science had not been a profession, but just a stage in a "generalist" clerical career, or an optional for "dilettante" *rentiers*. The characters of a scientific community do not seem to apply to the first generation, formed in the heroic stage of new foundation in the 1760s and 1770s, when substantial sums had been invested to attract the best known scientists from foreign countries and universities, both in Italy and outside it; nor in the second one, formed in Pavia when Joseph II, reforming the theological schools, had taken friars out of their convents and obliged them to study in the State University, rather than in their own monastic schools. At most, one might see its beginnings in the third, more modest but more professional generation, the solid and self-sufficient, almost wholly lay staff of the later Napoleonic period.