Giuseppe Venturoli (1768 - 1846) Hydraulic Engineer in the Papal State

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The proposed study intends to shed new light on the history of the applied sciences, architecture and engineering constructions in the period of the dawn of the Papal State, from the point of view of a member of the intellectual and professional élite of the time, the Bolognese engineer Giuseppe Venturoli, an eminent citizen of the Papal State. His active lifetime spanned from the French Revolution to the dawn of the 1848 revolt in Rome. He was born in Bologna, on 21 January 1768, his parents being Domenico and Anna Persiani, and died there the 19 October 1846. He studied in his native town, being distinguished in grammar and humanism in the Schools of the Archbishop Seminar, and went on in the studies of philosophy in the Montalto College, under the supervision of Professor Giuseppe Vogli, obtaining the degree in philosophy on 16 April 1789 (Cagni 1988). Guided by Professor Sebastiano Cartezani, he devoted himself later to mathematics in the Papal Archiginnasio of Bologna, where he took the laurea in March 1795. At 23 years old he became affiliate of the Accademia delle Scienze di Bologna, having a few years later the appointment of secretary. The Academy had as president Luigi Galvani (1737 – 1798), one of many scientists who refused to swear loyalty to the French Cisalpine Republic. Galvani entered in a debate with Alessandro Volta (1754 – 1827) about some conclusions regarding his experiments and theses on animal electricity. In the dispute Giuseppe Venturoli also took part who, together with Silvestro Gherardi, Bassiano Carminati, Lazzaro Spallanzani, Germiniano Grimelli, Giambattista Beccaria, and Giovanni Aldini (a relative of Galvani). In defence of the scientific results of Galvani it was published: Opere edite ed inedite del professore Luigi Galvani, raccolte e pubblicate per cura dell'Accademia delle scienze dell'Istituto di Bologna, Bologna: Tipografia di Emidio dall'Olmo, 1841, in which one could find also: L'Elogio del celebre professore Luigi Galvani, composto dal ch. signor professore Giuseppe Venturoli e da esso recitato nell'Accademia pubblica delle Scienze dell'Istituto di Bologna il 24 maggio 1802, pp. 107 – 19 (Piccolino, and Bresadola 2003).

In 1795 he became honorary lecturer in mathematics in the Bolognese Studium, to become professor in natural sciences in 1797. At this period belongs a work of translation done by Giuseppe Venturoli, now in the Library of the Department of Astronomy, University of Bologna: John Flamsteed, Atlante celeste (Ms. Traduz. Italiana di Giuseppe Venturoli, 1797, dall'ediz. di Londra, 1781), Università di Bologna, Dipartimento di Astronomia, Collocazione: XX. 6 a (II), 12 c., fol., Fondo mss). He was invited at the Comizi di Lione in December 1801 (an Assembly of élites representing the various cultural, political and administrative Italian governments then belonging to the newly born Cisalpine Republic). In Lione, under the leadership of Talleyrand and Bonaparte, a constitution, in fact pre-arranged by Bonaparte himself, was approved. A new attitude towards the

church was adopted and, at the same time, the Republic (whose plenipotentiary president was Napoleon, at that time First Consul of France), took the name of Italian (1802). One of the first reforms (4 September 1802) adopted concerned public education, with the institution of "licei", in relation to the departments, two National Universities, in Pavia and Bologna, four special Schools (metallurgy, hydrostatics, sculpture and veterinary science), and in addition two Beaux Arts Academies (Giumanini 2002). A few months later, the government established the National Italian Institute, situated in Bologna, under the President Alessandro Volta. The governor of the Italian Republic F. Melzi d'Eril had suggested Venturoli, considered to be worthy of admission among the planned 60 members (scientists, artists, scholars and historians), but Melzi's proposal was rejected (Pepe 1994). A general reform movement in the educational field involved various political realities of Italy (Brizzi and Varni 1991). A new national conscience arose, thanks to the efforts of the Istituto Nazionale Italiano that published the most important discourses on recent scientific progress achieved by Italians (Discorsi sui progressi recenti delle scienze dovuti agli italiani) as: Memorie dell'Istituto nazionale italiano. Classi di scienze morali; politiche; ec. di letteratura; belle arti, Bologna: Masi fratelli, 1806-1813, in various volumes. It should be remembered that the Istituto became first Regio and then Imperiale, while its principal seat was moved to Milan. The disciplines were divided into two classes: science and mechanical arts in one group, and humanities and liberal arts in the other. During the "Restaurazione" the works continued with the *Memorie del Reale Istituto*, followed by the *Memorie dell'Imperiale Regio Istituto del Regno Lombardo Veneto*, published by the Imperiale Regia Stamperia between 1819 and 1824 in three volumes.

In recognition of his merits and competencies in 1802 Venturoli was given the chair of applied mathematics in the new University of Bologna, reformed by Napoleon's decrees pertinent to the state lay public schools. In 1808-9 Prof. Giuseppe was Reggente, Vice Reggente in 1809-10, and again Reggente in 1815-7, according to the list of Rectors taken from the Archives of the University, (according to the list published in the Annuario dell'anno accademico 1987/88). The position of Rector, reinstated by Napoleon, held by a professor (a sign of autonomy) starting from the nineteenth century on, was extremely important and meaningful. In fact it was the new assertion of the lost autonomy of the University, since the role of Rettori had been abolished and substituted by the Papal "Cardinali Legati", when from the beginning of sixteenth century Bologna was forced under the Catholic Church Rule, although not without uprisings.

The prestigious Bologna University, called Alma Mater Studiorum was the oldest in the peninsula (dated from the end of twelve century, in 1988 the ninth centenary occurred). The teaching of sciences was as authoritative as the tradition of teaching the arts (the word arti, a translation in Italian of the Latin artes, retained some of the original classical meaning), disciplines that were introduced in the fourteenth century. The study of science came along with a love for the arts, and the reform of Pope Benedetto XIV promoted new university courses on mechanics, physics, algebra, optics, chemistry, hydrometry (the science and practice of measurement within the water cycle) and hydraulics (theory and practice). From the letters received by Venturoli by his

collaborators it appears that the economic situation was very critical for the new Institution and it was extremely difficult to find enough funds for research and teaching. By 1803 Giuseppe had joined the Società Italiana dei XL (founded in 1782), which was active in publishing the scientific periodical Rendiconti (Marini Bettolo and Capasso 1991), writing various articles (consultable online, http://www.accademiaxl.it/Biblioteca/Pubblicazioni/browse). Among his contributions we mention: Sull'efflusso pei tubi addizionali, Memoria, Serie:1, Vol:XII,15, 1805, Sezione: Matematica, pp. 277 - 291; Pendolo idrometrico composto, Memoria, Serie: 1, Vol: XIV,19,1809, Sezione: Matematica, pp. 158 - 166; Elogio del fu Sig. Gianfrancesco Malfatti, Serie: 1, Vol: XV, 22, 1811, Sezione: Fisica, p. XXVI; Analisi Geometrica dell'Ariete Idraulico, Memoria, Serie: 1, Vol: XIX (Fasc. 1, 2), 29, 1821/1823 Sezione: Matematica, pp. 62 - 96; Dell'antico e del presente stato del Porto d'Anzio, Memoria Serie: 1, Vol: XXIII, 37, 1844, Sezione: Fisica, pp. 320 - 35.

The first half of the nineteenth century in Italy was a complex age of the so-called “Risorgimento” (Resurgence of a supposed glorious past) and patriotic wars (1789 – 1848). It was a period of transition in the arts that went from neoclassicism, through romanticism, to purism. The architectural culture of the Ecclesiastical State was characterized by a tight relation that involved art, science and catholic faith. That relation was strictly supervised by the Pontifical Academies (focused in various disciplines), submitted to the High Clergy and Holy Congregations (among which the Congregation of the Studies, one of the many organs of the Papal Curia, in the nineteenth century), through the protection of the Camerlengo (Chamberlain). From the political point of view it was a time of continuous oscillation between “Revolutions” (included insurrectional movements and social turmoils) and “Restaurations”, characterized in Italy by French occupation, religious intolerance and ideologies, nationalism and aspiration to political unity. The process that should be considered in the European context lasted at least seven decades of the nineteenth century. The stereotypical concepts, related to the myth of the “Risorgimento”, are historical categories no longer widely accepted without sound criticisms by the recent international outstanding historiography (Pécout 1999; Aliberti 2000; Nenci 2004; Beales and Biagini 2004). Many conventional paradigms were due to the anticlerical, if not masonic, emphasis (Conti 2003) both in catholic church conservatism, considered behind the times, and on a too reactionary church theocracy. Many are the questions and controversial debates around the long troubled period of unification of the Peninsula, from patriotism to liberalism, from republicanism to federalism, from democracy to the “controrisorgimento”, that is a kind of counter-resurgence, in the Papal state and south of Italy to record (Del Boca 2003). The main goal to achieve was what Massimo d’Azeglio underlined in a famous parliamentary discourse soon after the first step of unification in 1860: “Made Italy, now we have to make the Italians” ("Fatta l'Italia, dobbiamo fare gli italiani", Mignone 1995, p. 4). A political, economic, social and cultural integration was needed to shape a people made of Italian citizens in search of the national character. Besides it was crucial to find a new balance between the urban in an accelerated phase of growth and the traditional rural model in slow dissolution, between centre and periphery, rich and poor, North and South. In spite of many attempts to submit the paradigms of the Risorgimento to revisionism, lately discussed by historians like E Nolte, FP

Casavola, B Mantelli, D Losurdo and S. Patriarca, it is also undeniable the delay (sometimes overlooked by the ecclesiastic contemporaneous history) of the Church State in the modernization process. In respect of France, England, Germany and Holland, the setback was in different degrees shared by the Italian country as a whole, being a consequence of many interconnected grounds, including not only the negative influence of the catholic church, resistant to modernity, but also political fragmentation and submission of some important Italian regions to foreign oppressing powers, mainly interested in exploiting the land overruled. In the Ecclesiastical State the stagnation was particularly evident in the field of politics, in which there was a condemnation of liberalism, perceived as a persecution and as a masonic strategy used against the catholic church (Pellicciari 2003). The main problems were an inadequate development of industrialization, scarcity of new technology, and a continuous procrastination of the required urban and environmental renewal. Modernization had to be attained also through the building of public works, environmental structures and radical change of management, administrative and fiscal policies. In the Ecclesiastical State the situation was furthermore worsened by the lack of control over the territory, a negligence that had already brought serious consequences in the economic and social conditions of the population, highly under- or unemployed, while the environmental calamities and accidents (especially earthquakes and periodic floods) remained substantially without reactions and solutions too. The exploitation of natural resources, useful for the development of irrigation-based agriculture, was insufficient as well. However, the historians have extended their disapproving judgments about the critical conditions of the Papal State in the first half of the nineteenth century to all aspects of its civilization in general. In particular the seminal and original contributions to modernity, in spite of the negative conjuncture, of the scientists, architects and civil engineers (called architetti-ingegneri) engaged within the Papal State has been overlooked. Participating in the movements of reform and political renewal of the Peninsula, sometimes putting their lives at risk, publishing their theories and discussing their practical experiences through the specialized press and periodicals, they did stimulate international debates, concerning the rise of new professional fields, proposing innovations on construction techniques and design. At the same time architects, engineers, archaeologists, scholars and antiquarians brought to public attention the question of the care and restoration of the architectural heritage, underlining the aesthetic point of view on the historical landscape. The concern of new generations of architetti-ingegneri for the urban and rural environment, under the pressure of Napoleon's experience and reforms, was specially concentrated in urban plans and in more concern about the quality of space. The supervision was given to the "Commissione d'ornato pubblico" (Commission to beautify the urban public space), structured on the model of the French "Commissions pour le plans d'embellisement de la Ville Eternelle", established when Rome was declared second Capital of the Napoleon's Empire (De Caprio 2003). The School of Engineers in Rome encouraged the study of applied hydraulics, the design of adequate architectural structures, research in new building materials, and projects and use of construction machines in building yards. In particular the account of the foundation (in Rome and in Ferrara, where it lasted only two years) of the new School of Engineering, where the students could be formed to become architects – engineers deserves special interest (Di Gioia 1985; Pepe 2002).

The School took as model the experience already gained in the University of Bologna, in the years 1802 – 17. After the diploma was taken in the Studium Urbis's Collegio Filosofico (College of Philosophy, in which there were biennial courses on "matematiche miste", such as Pure Elementary Mathematics, Physics, and Applied Mathematics).

The Pope Pious VII Chiaramonti (1800-23) in 1816 authorized the institution at the Sapienza of the chair of Sacred Physics. The chair was given to Feliciano Scarpellini (1762 – 1840), who held it during his whole life span. The chair took the name of Fisica Sacra or Mosaica, because it was forbidden to contradict the Holy Bible (considered the only text depository of divine and absolute truth, also from the scientific point of view), and was a sort of catholic compromise in order to consent to get a deeper knowledge in Physics and Astronomy, although the studies should be done with great caution and under strict church supervision.

In order to overcome the still discomforting incident of the Galileo's famous condemnation and forced "abiura" in front of the Inquisition, the Church tried to solve the embarrassing episode and serious mistake. The work on Astronomy by G Settele, in which the scholar applied the galilean theory on the revolution of the Earth (Elementi di ottica e di astronomia, Roma: s.n., 1818 – 9), obtained the papal imprimatur. In 1820 the new attitude was underlined by the Church with the Suprema sacra congregazione del s. Officio sopra uno scritto stampato, rimesso alla S.C. da Sua Santità fattole presentare dal ... p. Filippo Anfossi ... Roma, s.n. (Vernacchia Galli 1984; Maffei 1987; Brandmuller, and Greipl (eds) 1992).

An alternative to the degree in the Collegio Filosofico, was to apply to enter the School of Engineering in Rome after having obtained a distinctive recognition (Premio Accademico) in the Accademia di Belle Arti di Bologna (Giumanini 2002) or in the School of Architecture of the Academy of Saint Luca (Adorni 1997). Venturoli, incidentally, was also a member of the Pontificia Accademia di San Luca (Cerutti Fusco 2000). In this political and cultural context in rapid transition developed the personality and the role of the Bolognese hydraulic engineer Giuseppe Venturoli, one of the co-founders of the "Scuola d'ingegneri" in Rome, being also the first Chairman of the Institution itself. The paper will try to sketch a brief profile of his activity, his theoretical as well as his practical professional works, in the cultural dynamic context of the urban and rural social and political strategies. The university and academies élites shared important functions and responsibilities in state administration and public works.

Venturoli's major achievement is related, though, to the School of Engineering in Rome (Scuola d'Ingegneri), where he was summoned in order to supervise and direct the new institution. The School itself was founded by order of Pious VII with a "motu proprio" in October 1817: there were courses on statistics, hydraulics and static architecture. The School initially was intended as autonomous from the Studium Urbis, being instead dependent from the Presidenza delle acque e delle strade (Nicolai 1829), an important organ of the public administration, that ruled the Consiglio

d'arte (of which Venturoli soon became Presidente), in charge of advising and making decisions about the construction of public works, mainly the so called Fabbriche Camerali (Rev. Cam. Apost. Works), roads, bridges, questions related to applied hydraulics or programmes of draining the Pontine Marches, affected with the dangerous malarian fever. Venturoli became an expert in reclaiming flooded land, such as Pontine Marshes and Bientina Marchland (or Lago di Sesto). Giuseppe was called to advise about the project of draining the lake presented by Felice Matteucci, a proposal of a drainage channel to be built on the right bank of the river Arno (1835). The project, not executed, obtained Venturoli's approval in 1845. Eventually Venturoli's report for the Tuscan Government was published as: Relazione sopra un progetto di bonificamento del lago di Bientina del commendatore professore Giuseppe Venturoli, Firenze: Le Monnier, 1850.

As Rector of the School and President of Consiglio d'Arte Venturoli dealt successfully with the most urgent tasks to achieve: obtaining a more abundant quantity of potable water supply for the urban public and private needs and a better control of the aqueducts (first of all Acqua Felice) in order to avoid any kind of abuse against the law, which were not rare (Verdi 1998: Di Marco 2002). Another goal was the suggestion of a new set of rules for the right distribution of the water, taking into account many problems such as the variations of climate, capacity of the sources, the scarce efficiency of the reserves and tanks, possible pipes breakages and damage to the complex structures that bring water to the settlements, and a general reform in order to rationalize the whole system. Particularly important was the management of the rural territories, especially the large regions affected by swamps, as the Maremme Toscane, the Comacchio Valleys, and, in Lazio, the Pontine Marshes. A Corpo di ingegneri pontifici di acque e strade (Body of papal engineers specialized in water supply and roads), already founded during the French occupation, was confirmed with the same already quoted Motu Proprio of 23 October 1817, by Pope Pious VII. Inside the Corpo that worked for the Presidenza delle acque e delle strade, the technicians had a hierarchic order, starting from Ispettore Capo up to the simple land surveyor (perito agrimensore). However the degree of the School of Engineers opened the liberal profession of the architetto- ingegnere, an expert who usually had a sound background in classical and artistic studies as well. The reform of 1817 in addition was meant to discipline the municipal, provincial and national administration of the roads, and set rules for the water supply in the Ecclesiastical State, distinguishing hydraulic works according to their impact on geographic areas (national, provincial and rural societies). Dependent on the Presidenza, the School was an institution with clear technical and professional goals, as priority.

As director of the School of Engineers and Professor of Applied Mathematics Venturoli contributed to organizing the courses, divided into three years, needed to become architetto- ingegnere and land surveyor. The disciplines taught were various: projective geometry, static architecture, constructions, hydraulic architecture, applied hydrometry, hydrodynamics, mechanics, statics, calculus, topography, technical drawing, plus additional courses for architects, such as architectural surveying, building and land estimates and related laws, topographical, ornate and architectural

drawings, and architectural design. Examinations provided a control of the teaching and level of knowledge in the students, up to the conclusion of the *curriculum*, in order to get the academic degree. If the mathematical disciplines could benefit from exchange with French scientists, such as Prony, Cuvier, Monge and Lagrange, it is also true that many Italian students of engineering went to France (especially to the École Polytechnique and to the École des Ponts et Chaussée), while the most interesting debates found space in specialized journals in all Europe. In addition during the first half of the nineteenth century many scholars (both catholic and patriots, for opposite reasons) had to exile themselves to avoid danger and political persecutions.

As new institutions the Schools of Engineers in Rome and Bologna (and also in Ferrara, although for a short time) were not so different from those introduced in the other Italian states (as in the Universities of Pavia, Torino, Pisa, Naples, etc.). In fact there was a republic of science and literature shared by professors that increased a rapid circulation of ideas and efforts in the intellectual, scientific and academic field and prompted the specialized press, manuals, treatises and periodicals (Pepe 2000). The flow of information was encouraged by the recent experience of the French domination that gave birth to national conscience. In the early phase of transition the access to the profession required a further public examination run by university professors. This final proof was also opened to candidates who had already acquired enough practical experiences in the field of architecture and engineering and could document their works.

After the death of Pious VII, due to a new tense international climate and the increasing threat both of insurrections and the total loss of church temporal power over its territories, the situation in the Papal State changed deeply: the School of Engineers was reformed by Leone XII della Genga (1823-29), who with the Constitution "Quod Divina Sapientia Omne docet", in 1824 established that the School of Engineers should be incorporated in the Studium Urbis. The School itself was later declared autonomous from La Sapienza (but dependent on Presidenza delle Acque e delle Strade) in the subsequent Ordinationes Sacrae Congregationis Studiorum issued in 1826. The Sapienza itself, anyway, had to be even more subordinated than ever to the Holy Congregation of the Study. The Studium was governed by an Archchancellor who ought to be the Cardinal Camerlengo of the Holy Seat. The reform enhanced the role of Rome and Bologna as Archiginnasi, the two superior Universities of the Papal State. The teaching was divided in Colleges (theological, legal, medical, and philosophical). Furthermore the reform established the competition system to become professors, and some new disciplines, while more were added in the following years, notably construction of bridges and embankments.

A great deal of technical work was done by Venturoli in the role of President of Consiglio d'arte, in order to organise the public works of the Corpo degli Ingegneri Pontifici di acque e strade, based on the French model. We can recall, among many, some interventions that were illustrated by published reports, like his Parere sulla controversia concernente la derivazione dell'acqua di Reno conceduta nell'anno 1801 alla casa Spada, di Giuseppe Venturoli professore di matematica di

Giuseppe Venturoli professore di matematica e presidente del consiglio degl'ispettori d'acque e strade in Roma, Roma: Tipografia Salviucci, 1833; Relazione alla Commissione amministrativa del consiglio provinciale di Bologna sulla strada di Porretta, Bologna: s.n., 1837; and finally De artificio ad canalium Ostia de obstruenda, idoneo Josephi Venturoli, Bononiae: Ex typographaeo Emgydii ab Ulmo et Iosephi Tiochii, 1837.

The first and more important publication of Venturoli concerned the elements of applied mechanics and hydraulics (Elementi di meccanica e idraulica, Bologna: Fratelli Masi e compagni, 1807) and it had many successful editions in Italy (eight from 1809 to 1852, some of which were enlarged and updated). This important work (that applied mathematical methods and mechanics theory to the construction of structures) was also revised and updated by A. Bordoni and G. Masetti: Annotazioni agli elementi di meccanica e d'idraulica del professore Giuseppe Venturoli fatte dal professore Antonio Bordoni, Milano: tip. P. E. Giusti, 1821 and Milano : PE Giusti, 1833; Note ed aggiunte agli elementi di meccanica e d'idraulica di Giuseppe Venturoli; compilate da GB Masetti, Bologna : dalla tipografia Cardinali e Frulli, 1827, followed by Difesa del professor Giuseppe Oddi di Roma contro due accuse mossegli dal ch.mo sig.r professor Gio: Battista Masetti di Bologna sopra i suoi schiarimenti alla meccanica del ch.mo sig.r professor Giuseppe Venturoli presidente del consiglio d'arte in Roma, Roma: G Mauri, 1827 and later a second edition of Note, Napoli: Starita, 1852. A bibliography of Venturoli's published and unpublished works is in Opere edite ed indedite del prof. commendatore Giuseppe Venturoli, Bologna Tipi Sassi, Estr. dai Nuovi Annali delle scienze naturali di Bologna, fasc. di settembre 1847.

From a scientific point of view Venturoli should be considered a pioneer in studies of channels and hydraulics. His best pupil, Nicola Cavalieri San Bertolo, who followed his steps in the School of Engineers of Rome, acknowledged the importance of Venturoli's theoretical and practical works in his most important treatise, Istituzioni di Architettura Statica e Idraulica, opera di Cavalieri…Ingegnere superiore nel Corpo di Acque e Strade, e professore nell'Archiginnasio Romano della Sapienza, vv. 2, Bologna: Tipografia Cardinali e Frulli, 1826-7 (Cerutti Fusco 2005, pp. 541-3). Giuseppe worked very hard in applied Hydraulics and led many experiments on pipe flows. These experiments were supported by analytical calculations and elasto - mechanical theories about the inertial aspect of water flow in open channels, giving an important contribution to the progress of hydraulics as a scientific field. Venturoli was also the first to derive differential equation modelling to explain the phenomenon of backwater observed in a channel with rectangular section (Chevray 1976).

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