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THE CONTRIBUTION OF FRANCESCO ZANTEDESCHI AT THE DEVELOPMENT OF THE EXPERIMENTAL LABORATORY OF PHYSICS FACULTY OF THE PADUA UNIVERSITY

Abstract

Francesco Zantedeschi was elected to membership at Padua university in 1849, and he taught physics to the undergraduates of physical and pharmacy courses. His principal and incessant commitment was the development of the physical laboratory purchasing a remarkable quantity of scientific instruments that had to be used for didactics but also to carry on his researches.

Through the numerous letters exchanged with French and Viennese companies that supplied the scientific apparatus, the correspondence with the management of university and of Venetian county, it is possible to retrace his inexhausted search of financing. Moreover we can have an insight of the developed topics in the lessons and in this way we can date the instrumentation restored and preserved in the Museum of Physics History in Padua.

Laboratories and instrumentation in the physics of '800

At the beginning of 1800 it was not possible to consider that there was a discipline well codified corresponding perfectly to the science which today we call physics. Anyhow it existed a discipline called experimental physics that we find in the documents of the courses related to high schools and in particular to universities. But it was separated from the mathematical science which was called natural philosophy at that time and which was closely associated to the mechanical problems.

However people involved in scientific studies in the middle of 1800 began to acquire a first consciousness of themselves and shared a particular view of the world and a curiosity to know it. Progressively they shared a common formation that today we define as scientific. Particularly in France it is possible to observe that with the Grandes Ecoles begin the phenomenon called the emerging of two cultures, one based on science and the other on human disciplines, with the consequent modernization of academic system.

At the beginning of 1800 the scientists equipped of a mathematical formation were involved in a new way of labour to understand the nature of most extraordinary gatherings about which they were studying in that period, that is to say the heat, the light, and electromagnetic phenomena.

French people that had invented the experimental physics science to englobe Franklin's researches and those of his contemporaries about electricity, had obtained since Fresnel a remarkable tradition in pure and applied mathematics which had developed in the science now called theoretical physics.

The people involved in the experimentation with physical sciences began to require of specifically designed equipments, which became more and more expensive and increasing in number. The scientist that built his instruments was fading, because machines were more and more sophisticated. But on the

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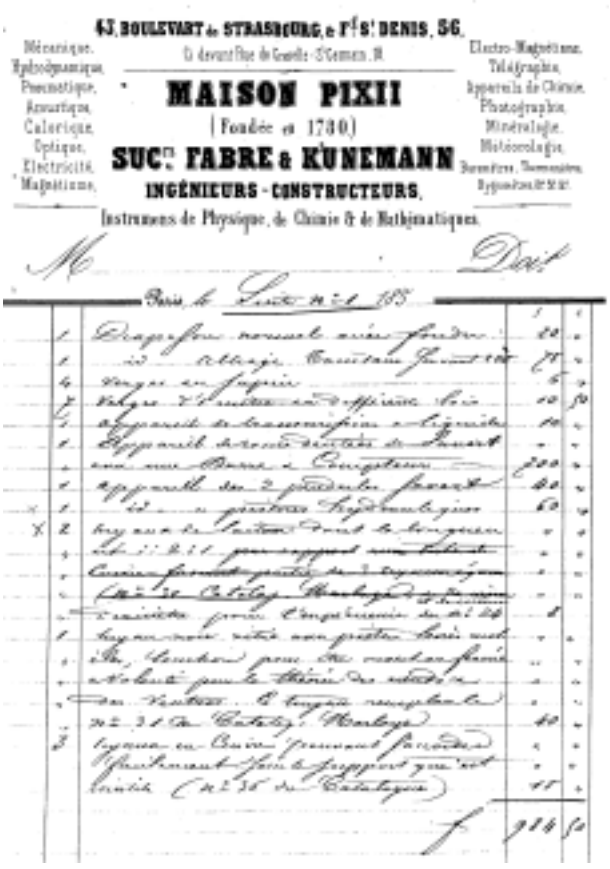
other hand there were industries and artisans which had started and interesting market of instruments, thanks also at the direct collaboration of science men. The physics laboratories rather than to be simply the kitchens, cellars, lofts or hangars, thereby spaces retrieved with various, different, accidental standards were built with specific characteristics. The new standards of accuracy in the measurements began to direct the physics towards the development of what we call today "big science". However the second half of nineteenth century was not a good period to persuade physicists to entrust entirely the instrumental method. The system of explanation seemed to be very efficient, the theories operated also very well and ensured the coherence between events. Moreover it guided to right predictions. Many scientists thought therefore that a well defined theory was a guide to realise as reality works.


43, BOULEVART de STRASBOURG, & Pte St. DENIS, 56.

MAISON PIXII

(Fondée en 1730)

SUCC. FABRE & KUNEMANN

INGÉNIEURS - CONSTRUCTEURS,

Instruments de Physique, de Chimie & de Mathématiques.

Fig. 1 A letter sent to Francesco Zantedeschi (Paris, 8th May 1856) coming from Maison Pixii of Fabre & Kunemann, French constructors of

scientific instruments, with a listing of apparatus ordered by Zantedeschi for his laboratory.

In the second half of century a second important event was the diffusion of the scientific education. The supporters of science underlined that it was not only able to supply a new vision of the world, but it also instilled practices of rigorous observation, a sceptic and exact scientific experimentation, the adherence in relating those observed.

The physics cabinet of Padua university

In this short lapse of century in the middle of 1800 an interesting personage of Veronense origin operated, and his name was Francesco Zantedeschi, born in Dolcé in the Val Lagarina. Initially his career was a clerical one with the course in theology, but rapidly he was interested almost entirely in physics. After having taught in some high schools in Milan, Brescia and Venice, 14th July 1849 he was elected to membership at Padua university with the assignation of pro tempore professor to teach physics to the students of the physical courses and later to those who studied pharmacy. In this assignment he followed professor Antonio Perego.

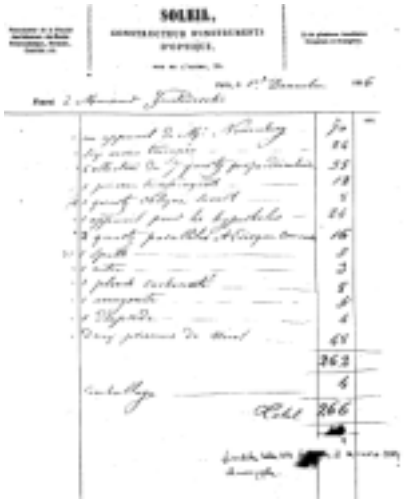


Fig. 2 A letter of the company Soleil of 1st December 1846 directed to Francesco Zantedeschi when he was still teaching in a high school in Venice with a listing of the materials sent among which there was the Nörrenberg apparatus. It is an apparatus with which he studied the polarized light composed by a sloping glass sheet that reflected the light then analyzed by a Nicol's prism inside the ocular.

The most interesting period we want to examine is the one during which Zantedeschi taught at Padua university, until his retirement for health reasons. This period is very interesting above all for the instrumental aspect that Zantedeschi studied with maniacal method enriching the possibility of experimentation in the sphere of physics.

When Zantedeschi arrived in Padua he immediately visited the laboratory, the privileged place of experimentation and didactics. He discovered a laboratory which was in bad condition, incomplete and inadequate to the requirements of a rigorous university course.

It is necessary to remember that the laboratories were very important elements in the field of sciences, coming from the experimental theatres of eighteenth century in which those attending sciences built experiences and handed down the acquired knowledges. Natural history and physics cabinets were fundamental for the university because much work was performed in an experimental way. Just for these reasons teachers needed more and more apparatus to proceed in their researches.

Thanks to the abundant documentation fund that Zantedeschi's brother sold in 1878 to the Civic Library of Verona it is possible to explore the long itinerary in this physician in the work of acquisition of various materials. We concentrate particularly on his contribution in the development and enrichment of physical laboratory thanks to a full-bodied correspondence exchanged between our physicist and the constructors of scientific instruments, French and German, with the directorship of philosophy faculty, with the deputyship of the Venetian county and in two situation directly with Franz Joseph emperor of Austria.

A further documentary source is the legacy Zantedeschi kept at the Agriculture Science and Letters Academy of Verona consisting of many administrative registers with the relative listing of materials and instruments bought or built.

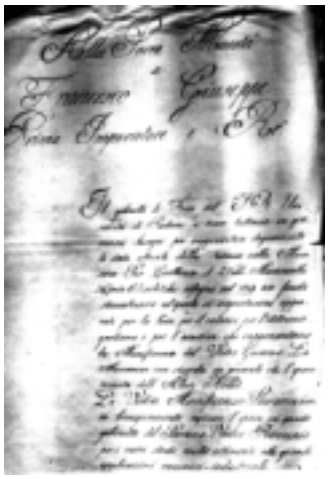


Fig. 3 Letter of Francesco Zantedeschi directed to Emperor Franz Joseph in which he pleaded the granting of funds for physics laboratory.

An important source of documentation, biographical information and index cards relating to the instruments is the Physics history Museum of Padua in which almost the whole material acquired in the time under management of Zantedeschi is kept. The museum is incessantly in evolution with enrichment of the collection and the listing of new scientific objects.

The activism of Zantedeschi to propose purchases to potentiate the physical laboratory are already documented in the Venetian period, previous to the Paduan time, when he taught physics at S. Caterina high school. Because his interests were very wide and he was also interested in photography, a technique which was developing in those years. In fact he had tried to buy a daguerrotype apparatus which the authority put at the head of administration refused him to (Letter of headmaster of High School of Venice to FZ, Venice, 3rd July 1840). But Zantedeschi didn't lose heart easily and in fact he succeeding in obtaining other purchases, with an alternation of concessions and refusals. Again in 1846 money was refused him to buy new instruments (Letter of Imperial Royal Govern to directorship of High School of Venice and for acquaitance to FZ, Venice, 8th May 1846) essential for the cabinet of natural history, that already comprehended at least 4.000 pieces in its collection, and that the administration judged sufficient.

When Zantedeschi arrived in Padua in July 1849 as pro tempore professor to follow the deceased professor Perego, he began immediately to advance his requests for funds, that were mostly fulfilled. As soon as he had the professorship he received from headmaster of Philosophical faculty the application to clarify the situation of the physical laboratory: he wished above all the details of expenses that had already been requested on behalf

of professor Betti and a listing of the instruments that were effectively present in the laboratory.

Zantedeschi took the opportunity to reply with the first request of money to satisfy the necessity of the academic year 1949-50, but these requests weren't satisfied. At the end of the year the university vice chancellor Poli submitted again the problem of finalization of the purchase of missing machines for the lab. However Zantedeschi was not satisfied of the slowness of the bureaucratic machine so he had not fear to ask formally to Emperor of Austria and Hungary Franz Joseph (Letter of FZ to Emperor Franz Joseph, Padua, 1850) reminding that the physical laboratory was in "very precarious requirements". Naturally he sent also a demand to buy instruments for mechanics that had already been financed partially by count Radetzchi. The instruments advantaged the research about light, caloric, electromagnetism and acoustic.

The available documentation concerns the letters exchanged between Zantedeschi and Menin, headmaster of philosophical faculty of Padua, with pro-rector Santini who guided temporarily Padua university and the political administrative regency also to obtain fiscal exemption for the instruments coming from foreign countries. The deputyship of authorities had in fact power to decide to admit the exemption of duty for the materials coming to Veneto, carrying out a policy as much as ever favourable to the research with high tax relieves. Austrian government had always encouraged research, especially with technological purposes even if from the point of view its military organization, probably more important than that civil one, encouraging at the same time the atmosphere of diffusion of culture that in those years was still restricted in few social classes, above all if we remember that the illitterates were almost the 75% of the whole population. In any case there was always a large means of financing for which Zantedeschi requested many times during every year of his command.

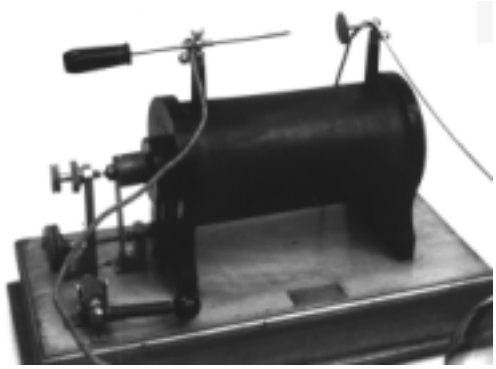


Fig. 4 One of the Ruhmkorff's induction coil purchased by Zantedeschi.

Another interesting type of available documentation concerns the registers of rectorate containing the statments of accounts about the various

expenses “disposed to account in hands of the Rectorate of Padua Royal University of Imperial Royal Power of Venice with edict ... for purchase of Machines to be used by that Physics Cabinet” then sent to the accounting of state. These registers include the detail of relating expence and eventual notes.

Through these documents it has been possible to date some instruments kept in the Museum Physics History of Padua University, acquired or made built, and of which was not possible to find any appropriate documentation in the university to date with certainty, because the catalogue of laboratory written in that period had been lost. Moreover we could deepen and improve the knowledge of themes developed in the didactic features of that time. For example in 1848 the university spent L 184 for restoration of the apparatus of Davy “to inflame of coal through voltaic electricity and reform of magnetic declimeter”. The university acquired also Bunsen's piles, a Ronerschek's electric thermometer, and a trumpet of Petris was built, during the direction of professor Antonio Perego. On the other way, in 1850, Zantedeschi acquired some optics apparatus of the Dubosq company in Paris, a Melloni's thermo-electric apparatus used for the reflection, refraction, polarization and diffusion of heat.

The option to purchase abroad the instrumentation for the physics laboratory confirms also the distribution of the best constructors that worked in Europe during Nineteenth century. In fact during the last decades of ‘700 there was in France a consistent increase and a clear advance in the production of scientific instruments. This industry in ‘800 became the most important in the world and in particular the precision industry, that was concentrated in Paris because of schools and research institutes having and saving, a world-wide eminence.

Fig. 5 Winter's electric machine built in Vienna in 1860, based on electrification for rubbing of two glass discs (a very uncommon model) in which it is possible to pick up the positive charges from glass and negative ones from pads.

In the first decades of '800 the works of Arago, Ampère, Fresnel and other scientists opened the field to physical researches developed in relation to new problems that requested thereby innovative apparatus and new instruments to collect observations and measurements in the researches about optical and electrical phenomena. Since scientists had to turn to constructors in order to build new apparatus, and consequently a new collaboration was born between them. The constructors changed also social status, in fact they were not considered simple mechanics any longer but cooperators with the research scientists, and became partially advisors for technical issues. University workshops and laboratories interacted in synergy and alliances scientist-constructor were created rapidly. The constructor could put forward improvements or adjustments indicating also theoretical hints.

This situation had created a market that had provided a great experience and the manual competence acquired rendered these craftsmen very skilled to mount the complicated laboratory experiments, and they were often auxiliary of a scientist in public lessons

The universal exhibitions, as the one in Paris in 1855, were an huge showcase of industrial products and the constructors of scientific instrumentation were on the scene to make visible and valuable their products. The Frenchmen won a lot of medals that were promoted in their catalogues. Many constructors were specialized in instruments suitable to work almost in a unique field of physics: Duboscq built optical instruments, Deleuil balances, Alvergniat glassworks for laboratory, Ruhmkorff apparatus to study the electromagnetism. A lot of orders placed by Zantedeschi regarded Maison Pixii (well known builder of continuous current generator) with the successors Fabre & Kunemann, that promoted its apparatus for mechanics, hydrodynamics, the pneumatic machines and for telegraphy, the optician Alessandro Duroni supplier of lenses, the sales representative of French factories Charles Fay.

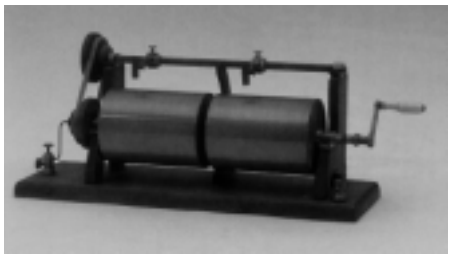


Fig. 6 A demonstrative little model of autographic telegraph to transmit writings and images.

Besides the information about the apparatus it was also possible to know which materials of common use were employed to produce or to complete the physical experiences about many different phenomena. In fact Zantedeschi

followed different researches trends among which the problems about electromagnetism, the chemistry-physics and chemistry linked to photography, to electrometallurgy. We can deduce these curiosities by and order of 1854 to purchase metallic platinum for experiences, mercury, nitric and sulphuric acid for chemical amalgamations, piles, pneumatic bath, brass, cast iron, copper plates, pipes and flexes, colophony, shellac, lamp-black, aragonite.

Now we cite only a short and representative catalogue of purchased materials, or built on order of Zantedeschi, among the most meaningful ones of his much endowed laboratory, today maintained in the Museum of Physics of Padua University.

- Apparatus of Norremberg. It is an apparatus with which he studied the polarized light composed by a sloping glass sheet that reflected the light then analyzed by a Nicol's prism inside the ocular.
- Collection of quartzes with Savart's oblique quartz and birefringent quartzes
- Pneumatic machine in column
- Electric apparatus built on advice of Becquerel
- Induction coil of Daniel Heinrich Ruhmkorff described in the stocktaking of that time as "electromagnetic apparatus of Ruhmkorff for the experiences of Faraday". The basement of support is a small case that contains the capacitor for the stopping of the spark of contact breaker. The primary and secondary contacts are connected through two cramps with screw and in front of the solid iron nucleus is placed a vibrator of the Neef's type. A bipolar commutator allows the reversal of polarity.
- Electric machine of Ramsden, built in 1843 by the Venetian Francesco Cobres, constituted by a glass disc put in rotation and rubbed by leather pads. The electricity produced on the glass was picked up by two series of spikes.
- Winter's electric machine built in Vienna in 1860. This one was also based on rubbing of two glass discs (model very unusual) and in which it is possible to pick up the positive charges from glass and negative ones from pads.
- Electric egg of 1850 composed by an egg shaped glass ballon in which the pressure has been reduced and two electrodes ending in brass spheres penetrate the engine. If the electrodes are connected to an electrostatic machine, it is possible to see a discharge that is dependant on the pressure in the egg.
- A series of telegraphic machines, dischargers, Morse key, autographic telegraph to transmit the images.
- Optic test bench with electric light
- Solar microscope with three inches lens and five achromatic objectives
- Light refraction apparatus with Schmerd's figures, two interference mirrors, an interference prism
- Model of magneto-electric engine coming from Berlin (1853)
- 80 pairs of Bunsen piles
- Machine with vibrating rod applied at Savart's cogged wheel

The whole listing and the filing of all instruments will permit to date with higher certainty the instrumentation kept in the Museum, besides we have an insight of the developed topics in the lessons among the numerous letters exchanged with scientific supplier and administration.

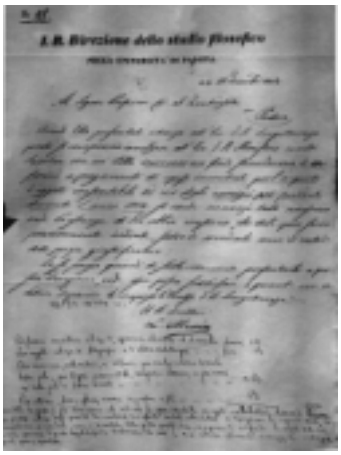


Fig. 7 Letter of the vice chancellor Menin to Francesco Zantedeschi of 18th December 1854 in reply to the demand of exceptional financing of 400 florins to purchase objects for the physics drill lesson.

From the available documentation we can understand the great enthusiasm that Zantedeschi had for the physical apparatus and instruments, the interest for the most advanced technological systems, and he didn't limit to order complete material but many times he contributed to build the instrument with his planning and the work of laboratory technicians. There is evidence that he persuaded the administration to use the electric light. Moreover he experimented in the field of photography and telegraphy that are elements of technical progress. This progress captivated him and he carried on the researches as long as the health helped him.

An anxiety of study and research rendered him a competent and endless experimenter. In away he resemblant Faraday has equipped as he was of an imagination that enabled him to precede his colleagues on different fronts. His writings, his thousands of notes coming from long observations were collected and catalogued by Zantedeschi, and then divided in thematic records and in volumes that he made rebind.

We can conclude with the evaluation showed about him by professor abbot Luigi Menin, Director of Philosophical Faculty in 1855: "The physical cabinet of our university owes to of professor Zantedeschi's cares the virtue to be at level of Science, at least in the component that concerns the most recent experiments. He doesn't forget any discovery advertised by the daily

newspapers, he repeats them, he modifies them and he exercises himself to understand them so that he could become very famous to the scientific world".

Acknowledgements

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