

The Scientific Heritage of the Museum of Engines and Mechanisms

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Abstract: The Museum of Engines and Mechanisms was inaugurated on February 25th, 2011 at the University of Palermo. It preserves more than 300 pieces, which narrate the evolution of science and technology in the field of thermal machines and their components and testify the development in scientific disciplines, technologies and industrial applications during more than one century. A rigorous chronological path through the various typological groups allows a historical walk along the last 150 years, in the area of automotive, airplane and marine engines; in the area of hydraulic machines and stationary engines; in the area of mechanical measurements and laboratory devices for scientific and educational purposes. A very interesting documentation was set up, gathering several didactic models dating from the courses given at the end of 19th century up to more recent machines, on what has somehow affected our everyday life during the years: the history of science and technology is our history as well. The collections were dug up from the sheds where they had been stored during the years and a scrupulous and patient restoring work, together with very accurate historical researches, have cleared everything from the coating of so long oblivion and have given the proper museum dignity to each element, making it available for the students and all the country: for whoever is interested in reading the history in a different way.

Keywords: Museum of Engines and Mechanisms, University of Palermo, www.museomotori.unipa.it.

1. The Historical Museum of Motors and Mechanisms

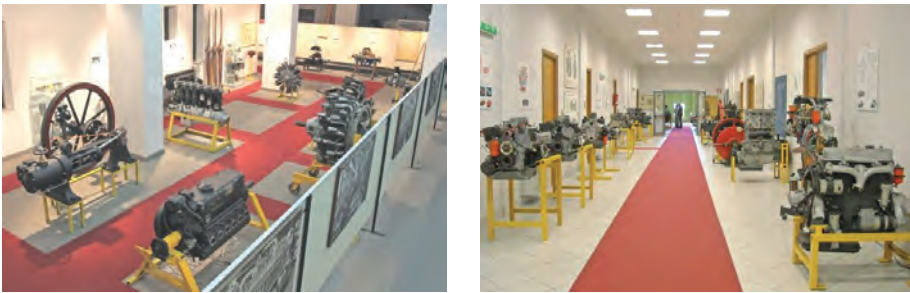
The Historical Museum of Motors and Mechanisms, which opened on February 25, 2011, contains more than 300 elements that describe the evolution of science and technology in the field of machinery and of their constituent parts; it testifies to the progressive development of scientific disciplines, technologies, and their industrial application through more than one century.

It is located in the Polytechnic School of the University of Palermo in the Department of Chemical, Management, Computer Science, and Mechanics Engineering; it covers an

area of 500 m² that is divided into 7 main exhibition areas, each dedicated to a particular theme. The Museum also has its own restoration workshop, a conference hall with 160 seats, some spaces for temporary exhibitions, and a large inner garden accessible for events.

A strictly chronological path allows, within the various typological groups, to retrace the last 150 years of history in the field of automotive engines, as in that of the heavy traction; in the fields of aircraft engines, hydraulic machines, industrial engines for fixed installations; in the fields of mechanical measurements, training equipment and laboratory.

From the teaching models that were used during the courses of instruction that took place in the second half of the nineteenth century, and until recently dating machines, a document of great interest has been rebuilt, on what has supported the every-day life of each of us over the years; the history of science and technology is also our story.



Figs. 1-2. The Museum: exhibition halls

Exhuming all pieces from the warehouses in which they had been kept over time, a meticulous and painstaking restoration, accompanied by careful historical researches, has released each element from the consequences of many years of neglect, restoring his rightful dignity to be shown and making it available to the enjoyment of the students, the City, the Country: all those who are interested to read a page of history in a different way.

Precisely for this purpose, the Museum organises several cultural events in collaboration with several organizations with the aim to promote and disseminate scientific culture.

2. The collections

The history of the collections of scientific and teaching equipment that the Museum houses began in the second half of the nineteenth century with the founding of the Royal School of Application for Engineers (1860).

They testify, on the one hand, the evolution of technical and scientific cooperation in the field of Machinery and Mechanics in general, but also those transformations, contextualized in terms of academic history, showing what has been the evolution of the structures of research and education in the field of mechanical engineering at the

University of Palermo, from its founding to the present, whose development is closely connected to that of industry and technology.

These collections are then, in a more or less direct way, also witnesses of generations of teachers and non-teachers that have occurred over time, of their activities and of the evolution of methods of work in time, of the places in which the Engineering Faculty was born and then developed: from the ancient seat of Via Maqueda until the new headquarters of today inside the Parco d'Orléans.

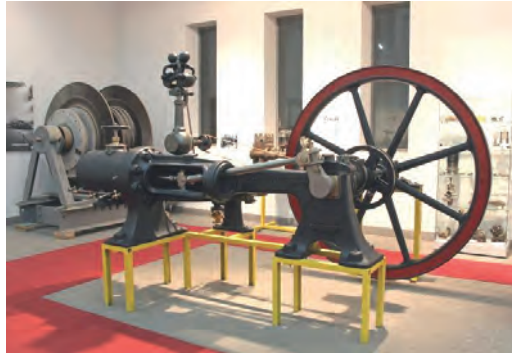


Fig. 3. Steam engine of the late 19th century

The awareness of the considerable historical and collectible value of these assets, and the need to preserve them imposed the restoration and suggested the organization in the form of a museum; a meticulous historical research and an acquisition of technical data have been undertaken to this end, in order to be able to return each piece to its correct value.

The analysis and synthesis of the large amount of data collected also allowed the creation of a vast iconography.

The organization of the Museum, which is simple and linear, groups the items shown according to their type following, in each of the sections, a strict chronological order; all elements are then accompanied by a display panel containing the main technical and historical data, as well as photographs and explanatory drawings.

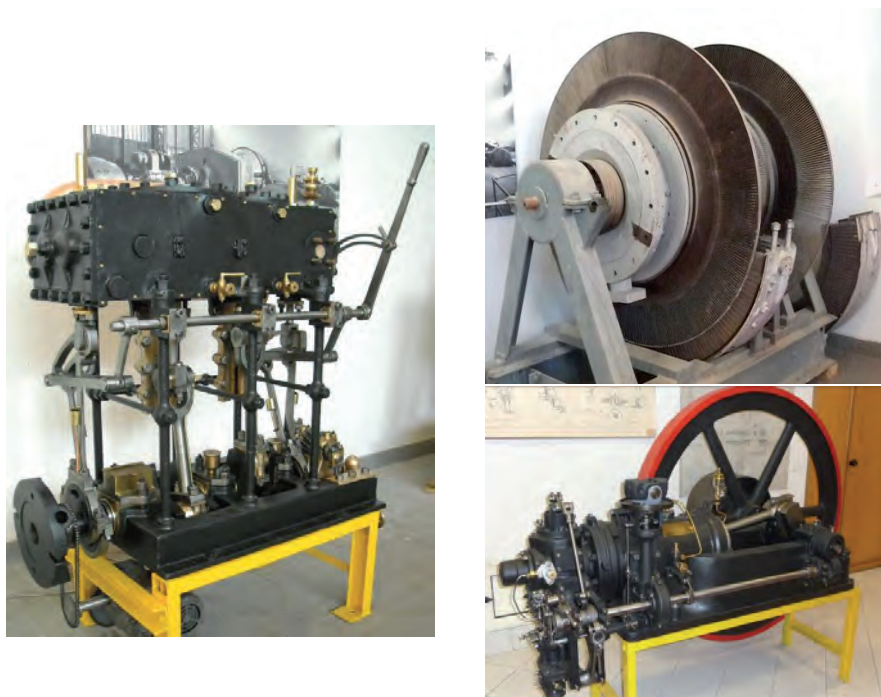
The Museum, in addition to cherish and preserve the historical and scientific heritage related to the field of Machine and Applied Mechanics, has the task of making it available to the public; because of the academic location, the educational aspects were carefully focused during the implementation phase of exhibition taking into account not only the presence of the students of the Engineering Faculty, but also of the students of the secondary schools for whom an exposure with such features is certainly a very interesting opportunity.

With this aim, the section of educational models and scientific equipment plays a key role; there, it is possible to follow in detail the various steps of the evolution of the mechanics of machines, as well as providing a fairly broad overview of the possible solutions of the individual mechanisms.

3. Steam engines

Steam engines are an example of the first modern machines used for the transformation of energy; they have played a crucial role in the second half of the eighteenth century, during the First Industrial Revolution, and later on, during the Second Industrial Revolution (the second half of the nineteenth century).

Their use in processing of raw materials, consumer products and subsequently in the field of transport and electricity production had, as is well known, significant and irreversible effects that have led to the transition from a socio-economic system predominantly of the handcraft, trading and agricultural type to a modern industrial system.



Figs. 4-5-6. Ship steam engine, dual expansion (left); Ljungström steam turbine (top); Hille-Werke AG diesel engine (bottom)

In the Royal Application School for Engineers in Palermo the first studies relating to steam engines date from the second half of the 19th century, as evidenced by the oldest scientific equipment in the Museum.

At that period belongs the great steam engine used to drive machinery in a manufacturing plant: the looms of a textile factory, the machine tools of the mechanical industry or the pumps for the water extraction in the mines; the pattern of the industrial plant has then remained almost unchanged until the first half of the 20th century.

Exhibited in the Museum is also a marine steam engine of the *double expansion*

type with two cylinders *double effect*, which was employed in small motor boats such as yachts and fishing boats until the end of 19th century; it has been fully restored to show the motorized movement of its organs.



Fig. 7. Ruston Proctor & Co. gas engine

The large steam turbine Ljungström turbine from the ancient power plant of Via A. Volta (Porta Carbone) in Palermo dates on the contrary from the 20s of the 20th century. This turbine is characterized by a particular type of construction, now disused, and is a piece of history of the city: while remaining intact during the bombings of World War II, it has provided electricity to most of the city until 1952.

In the course of the 20th century the piston steam engines or for fixed installations were gradually replaced by the gas and diesel-fuelled ones, though retaining the overall architecture of the former and their essential elements for the regulation of power: example of this evolution are the two diesel engines for fixed installation, the Hille Werke AG and the HMG, and the two gas engines, also for fixed installation, the Ruston Proctor & Co (Series CD) and the Langen & Wolf, all of the early 20th century.

4. The aero-engines

After the first flight of the Wright brothers in 1909, the aviation industry underwent rapid development and the early aircraft engines, originating often from the automobile industry, have evolved until the advent of the jet engines towards the end of World War II. The series of aircraft engines in the collection begins with those for German military aircrafts dating back to World War I; they are part of a batch of engines given away by Germany as part of war reparations.

Their arrival in Palermo is linked to that of prof. Antonio Capetti, Professor of Aircraft Engines of the Politecnico di Torino, who became Rector some years later and held the chair of Thermal and Hydraulic Machines of the Royal University of Palermo in 1925.

The Siemens Halske aero engine (1915-1918) is particularly interesting. It is a special type of air cooled radial engine in which the cylinders turn around the crankshaft; the propeller is connected to cylinders while the crankshaft is fixed to the frame. In this

arrangement all the rods lie on the same plane with clear advantages with regard to the inertia load balancing, the engine length, and the good cooling capability. Other engines of various kinds are observable: radial or in-line cylinder engines, liquid or air cooled.



Fig. 8. Siemens Halske aero engine

During the 20s and 30s several Italian manufacturers have developed a large variety of aircraft engines up to the World War II. The Museum collection includes some representative exemplars of that period such as the FIAT A.80, FIAT A.74 and a Mercedes DB605, technically very advanced for its time, which was used in German and Italian fighter planes, such as the Messerschmitt Bf 109 and the Fiat G.55.



Fig. 9. Radial aero engines, from left to right: Fiat A 50, Fiat A 74, Fiat A 80

Finally, to the period of the Cold War belong the large jet engines, such as the American General Electric J47 and the English DH Ghost.

5. The automotive engines and heavy traction engines

The section of automotive engines houses various types of automobile engines for various applications, most of which have been gradually acquired and used for research purposes and for educational purposes, as is still the custom of the School, in the wake of a continuous technical and scientific development.



Figs 10-11. Mercedes Daimler-Benz 605 aero engine; General Electric J47 jet engine

The oldest of these is the engine type Fiat 101, produced from 1919 to 1926 for the car Fiat 501, which, in chronological order, was followed by the engines produced in the 30s and 50s and 60s: a Fiat 1100 engine, one of a Fiat 500 Giardiniera and an Alfa Romeo *twin-OHC* for the Alfa Romeo Giulietta 1300, which was produced for a long time in various versions.

Of the same period is the 6-cylinder V engine of the prestigious Lancia Flaminia 2500 exhibited along with his clutch-gearbox-differential *transaxle type*.

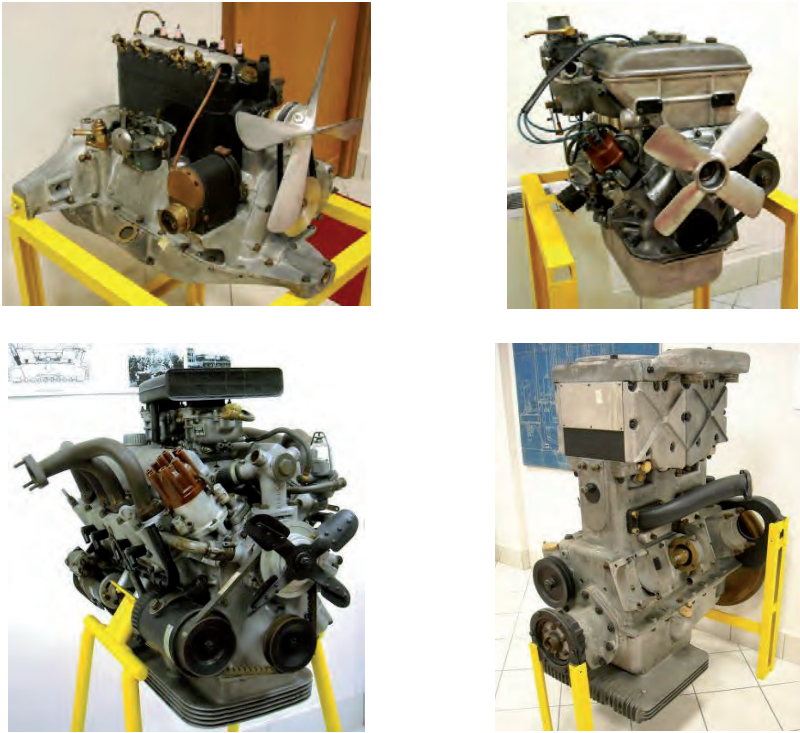
Among the most significant engines, the Fiat engine with eight in V cylinders can be seen, which was designed for the sports car Fiat 8V, was produced in only 112 copies and won numerous sporting events, including the 1955 Targa Florio.

High performance engines are also the two Fiat Dino, 2000 and 2400, born from the collaboration between Fiat and Ferrari, which were produced and used on sports cars by both manufacturers in the 60s and 70s.

The Dino 2400 equipped also the Lancia Stratos that, in the competition versions, met with many successes, including the winning of the Group 4 World Rally Championship from 1974 to 1976.

Among the diesel engines for heavy-duty vehicles, the Museum collection includes a rare and technically refined Lancia Junkers two-stroke opposed piston engine, used in the 30s in the truck Lancia Ro, widely used during World War II.

The Museum collection also includes some motorcycle engines and other less conventional ones, such as a Wankel engine and an experimental prototype of rotary engine with toroidal combustion chambers, built at the Institute of Machine of the University of Palermo in the 60s.



Figs. 12-13-14-15. Top (left to right): Fiat 101 motor and Alfa Romeo 1300 motor; Bottom (left to right): Fiat 8V motor and Lancia-Junkers truck engine

6. Scientific and educational equipment

In the exhibit hall dedicated to the scientific and educational equipment the oldest objects of the Museum are preserved, dating from the second half of the 19th century.

The scientific instruments have been used over time in different laboratories to prepare tests in the field of Machines and Applied Mechanics. In the collection there are several devices for the analysis of mechanical vibrations, for measurements of pressure, temperature and velocity, for experimental studies on internal combustion engines and powertrain systems.

The Museum has a collection of more than one hundred didactic models of elementary machines, mechanisms, transmission components, mechanisms for the description of the coupling profiles between mechanical elements.

Furthermore, others items represent sections of the main types of steam engines, which were used in the 19th century in various fields of civil engineering and industrial applications. These models were built for educational purposes by specialized German and Italian workshops in the second half of the 19th century and belonged largely to the

Cabinet of Applied Mechanics of the Royal School of Application for Engineers. Even today some of them are used as teaching tools useful for their ability to clearly represent some of the most important principles of mechanics remained unchanged over time.

7. The Fiat G.59 aircraft

Among the most recent acquisitions, an important place is certainly taken up by the Fiat G.59 plane, a two-seater trainer aircraft of the 50s, one of the only five complete surviving exemplars, and therefore one of the most important exhibits of the Museum.



Fig. 16. Fiat G.59 military trainer aircraft

The trainer aircraft Fiat G.59 was one of the last high-performance aircraft equipped with reciprocating engine before the advent of modern turbojets, as well as a symbol of the rebirth of post-war Italian aeronautical industry.

In 1947, the engineer Giuseppe Gabrielli, one of the most important Italian aircraft designers, developed the G.59 from Fiat G.55 Centauro, which was considered one of the best fighter aircraft of World War II.

The G.59, always appreciated both in Italy and abroad, was produced in the factories of Fiat Aviation in Turin since 1950, to be mainly used until 1965 as the Air Force aircraft for advanced training and acrobatics. It has a wingspan of 11.86 m and a length of 9.50 m, with an unladen mass of 2850 kg. The aircraft has a Rolls Royce supercharged V-12-cylinder with a maximum power output of 1660 hp. Thanks to this engine, driving a four-blade propeller with automatic variable pitch system, the aircraft can reach a top speed of 609 km/h at an altitude of 6400 m and an operative ceiling of 12,000 m.

The Fiat G.59 4B having the Military Serial number 53530, after ending its operational service in the Air Force (in Rome), was purchased in 1964 by the former

Institute of Aeronautics of the University of Palermo and today, entrusted to the Museum of Engines and Mechanisms for its restoration, is displayed in a glass case specially set up outdoors, and is then fully and freely accessible to the public.

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