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Angelo Mosso: Transmission and Measure of Physiological Signals

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***Abstract* – Professor Angelo Mosso (1846-1910) was an Italian physiologist who worked in the University of Turin in the second half of XIX century. His researches were devoted to record and measure vital and mental processes. He invented many instruments and the signals were recorded on blackened paper on kymograph. A quite important aspect of Mosso's laboratory was the quality of the work done by technician Luigi Corino, which offered the possibility of the best utilization of the potentiality of the instruments. In the storage rooms of ASTUT we preserve many of these instruments with documents, pictures and original tracings.**

I. INTRODUCTION

The Archivio Scientifico e Tecnologico dell'Università di Torino (ASTUT) was founded in 1992 when some researchers realized that it was necessary to create an institution devoted to the preservation of the heritage of scientific instruments, witnessing the history of science of our University.

In the University of Turin, six centuries old, there are important historical archives that preserve a large quantity of books and documents, but nobody had thought of collecting the material heritage.

In 1991, in the ancient rooms of the Archivio di Stato, Record Office of Turin, an exhibition, named "Strumenti ritrovati"[1], was organized: it highlighted many examples of instruments of the past related to the different scientific academic disciplines taught in our University. One year later ASTUT was born.

The choice of the name was considered fundamental, it would have been "Archives" and not "Museum", an institution devoted to preserve, catalogue, study and bring out the instruments and the objects of science and technology that are under risk to disappear but with the consciousness that it would hardly ever become a real museum open to the public.

We organise temporary exhibition about different themes using the available materials, paying a special attention to right setting and using originals photographs and when it is possible we make instruments work again and realize videos to help people understanding how they actually work.

We continue every day to collect instruments and other objects forsaken in the modern laboratory in order to take care of them as a "memory for the future". In a not too far future they will be important as they will be studied to understand all the steps of the history of science and technology.

We have more than 3,000 square meters of exhibition rooms and stores where we house thousands of specimens from the scientific and teaching history of the University since XVIII century to yesterday *(Fig.1. and 2.).*

Fig.1. One of the exhibition rooms

Fig. 2. One of the stores

II. ANGELO MOSSO

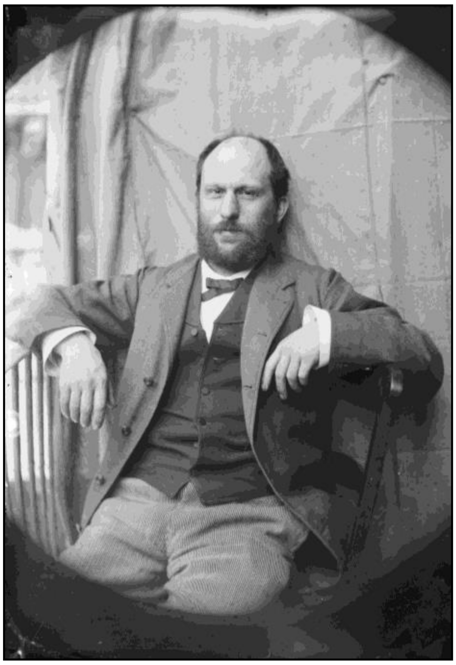

Fig. 3. Angelo Mosso

Angelo Mosso *(Fig.3)* was born in 1846, he studied medicine and succeeded Jacob Moleschott (1822-1893) as professor of Physiology in Turin. Moleschott was a materialistic philosopher rather than a physiologist and his researches were devoted especially to biochemistry. Mosso after the academic degree in 1870 moved to Florence and had the opportunity to attend the laboratory of Moritz Schiff (1823-1896) and then went to Leipzig, where he worked with Carl Ludwig (1816-1895). In Germany he knew and began to use the kymograph *(Fig.4)*, a new instrument invented by Ludwig to record biological phenomena. This instrument had a revolutionary importance: for the first time it was possible to obtain a graphic record of biological events.

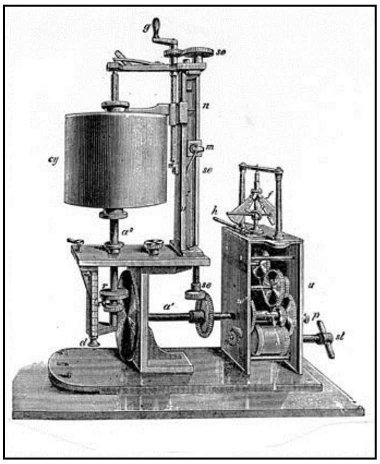

Fig. 4. Kymograph

After his German period he went in Paris, where he knew Claude Bernard (1813-1878) and Jules Marey (1830-1904) and began to use the tympanum of Marey.

These are the words used by Mosso about this technique: “Every heartbeat, every wheezing breath, tremor of the muscles, speed of blood circulation, speech, thought and perception can leave an indelible trace of themselves through the graphical method.”[2].

When Mosso came back in Italy he could use kymograph and tympanum to go beyond the investigations and analyses developed by Moleschott. The kymograph consists of a drum that is covered by a smoked sheet of paper. It rotates at a constant speed by a clockwork mechanism so that a fine stick can draw a line that represents the variations in time of physiological parameters. The tympanum is made of a metal cylinder, closed by an elastic membrane on a side. Changes in pressure transmitted to the tympanum via a pneumatic or hydraulic system acted on the membrane and caused the movement of a pen.

III. NEW TRANSDUCERS

The availability of a graphic recorder induced Angelo Mosso to invent many transducers.

The first of all was the pletismograph [3]: it was made of a glass cylinder into which the distal part of a limb could be introduced. From the cylinder full of water a flexible tube acting as a hydraulic transmission system caused the movements of a mercury column which moved a pen on the recording paper of a kymograph. The recorded changes in volume of a limb are index of the local blood flow, as well as of the effects on the flow by emotional states and variations of physiological activities.

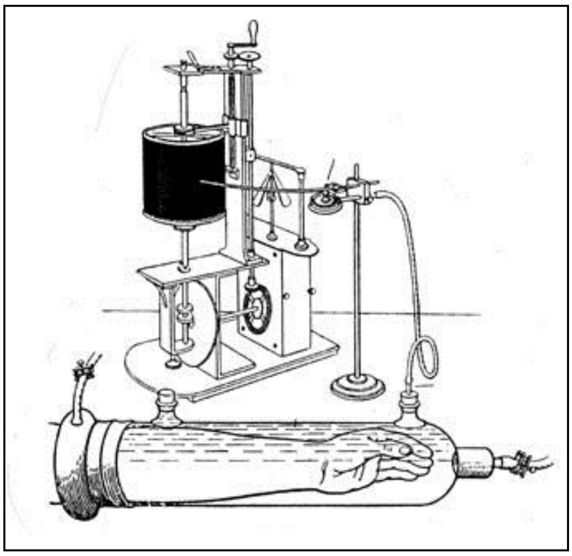

Fig. 5. Hydrosfigmograph

The inertia of the recording system was too big and Mosso transformed his instrument and built the hydrosfigmograph [4], based on mixed hydraulic and pneumatic transmission system *(Fig.5)*. With this tool the physiologist studied the movements of the brain in people with skull defects. He put a tympanum of Marey *(Fig. 6)* in contact with the head skin where the lack of bone allowed to perceive the movements of the meninx, and via a pneumatic system the volume variations of brain were recorded and it was possible to find relationships between mental activity and cerebral circulation.

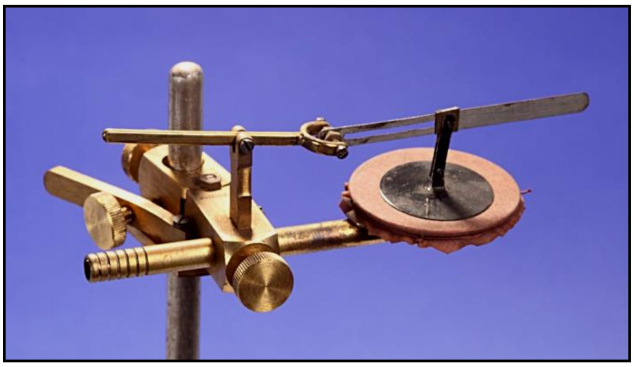

Fig.6. Tympanum of Marey

Mosso invented also a sphygmomanometer [5]: it was a mercury manometer, with a pen on the meniscus surface. The patient had to put middle and ring fingers of both hands into rubber glove fingers placed in four metal tubes. The space between the walls of the tubes and the glove fingers was filled with water which transmitted the pressure oscillations to the manometer via a hydraulic system. In 1896, pediatrician Scipione Riva-Rocci (1863-1937) from Turin modified Mosso's instrument and obtained the arm cuff sphygmomanometer which is still used at present.

Our physiologist focused his attention on the distribution of blood in the entire human body. To this purpose, he built the bascule [6], an oscillating bed *(Fig.7)*.

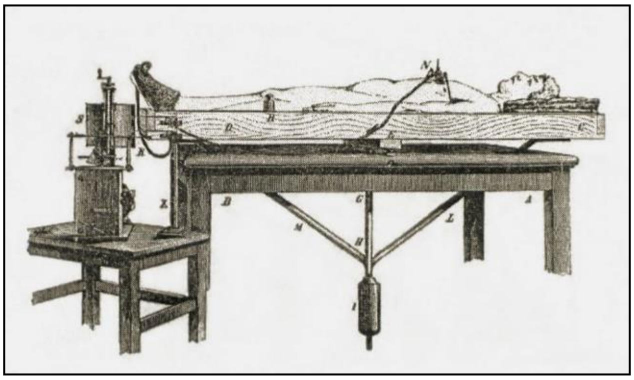

Fig. 7. Bascule

A patient resting on this bed oscillated mainly in response to the respiratory movements, so that correlations between respiration and circulation could be identified through the simultaneous record of the blood flow in the foot. Later on, Mosso tried to study the relationship between the distribution of the blood to the brain and different types of stimulation in the attempt to correlate neural activity and energy supply.

Our professor was also curious about muscle work and fatigue: he created the ergograph [7] *(Fig. 8)* whose name derived from the Greek: *ergon* means work, and *graph* means to write. In this instrument an arm is hold and locked in the right position while a string, with a weight of five, six kilos at the end, is attached to the middle finger. The contractions and releases of the finger, following the regular movement of a metronome, are recorded on blackened paper with a nib on a kymograph, in this case the signal transduction is mechanical and it is possible to draw the curve of the fatigue.

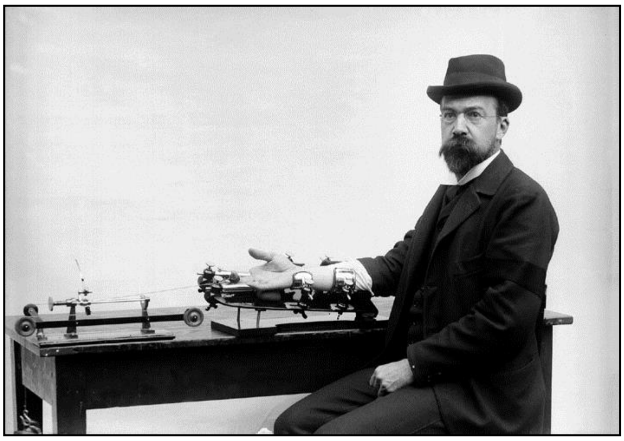

Fig.8. UgolinoMosso, Angelo's brother, and the ergograph

Angelo Mosso recorded these graphs, ergograms, submitting many people to such experiments in different physical and environmental conditions. For a better control on the nervous component of fatigue, the *ponometer* was added to the ergograph. It could disconnect the weigh from the muscle immediately at the end of the contraction, so that the muscle was disengaged from the weigh during the relaxation.

IV. CONCLUSIONS

The technique used to record on paper the traces of physiological events changed several times during Mosso's scientific activity: from mechanical, hydraulic and pneumatic, to electrical transduction. Initially, the possibility to amplify the signal was simply based on the ratio between the lengths of the two arms of the transducing lever with disregard for all mechanical variables, such as friction and viscosity and all those factors that could reduce the effectiveness of the system. Much later, only electronic devices would have allowed amplifying the electrical signals, thus magnifying signals otherwise almost imperceptible.

A quite important aspect of Mosso's laboratory was the quality of the work done by technician Luigi Corino, which offered the possibility of the best utilizationof the potentiality of the instruments. In our stores we have many instruments signed L. Corino and many others are present in different scientific instruments collections not only in Turin.

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