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Birth and death of "Demonstration Experiment" in Physics

BY

S. Ganci,

Viale "Guglielmo Marconi", 6 20900 Monza.

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Abstract

In this paper, it is revisited the development of the so-called "demonstration experiment in Physics" with particular reference to the teaching in high schools in Italy

1. Introduction

The historical development of the so-called "demonstration experiment in Physics it seems useful to analyzing a short sentence in a celebrated book [1] of Richard M. Sutton:

> *"Demonstrating in Physics is an old art which has been and should be constantly developing; new methods of illustrating fundamental principles are always desirable and some of older methods need to be more clearly formulated …"*
>
> *"Demonstrations are for the student and not for the instructor.* If this simple truth were kept constantly in mind, the major crimes of the physics lecture room would be eliminated*."*

Richard M. Sutton

The book of R. M. Sutton appeared in times in which in Italy appeared a monumental book [2] published under the patronage of the Ministry of Education. At these times, the only Italian high school was "Liceo Classico" where fundamental teaching were Latin, Greek, and humanistic disciplines. Physics was studied only in the two final years and the teacher of Physics was the same of Mathematics along five years. Maths were limited to Algebra, Euclidean Geometry, Analytical Geometry, and Trigonometry the last year. We had a very useful and in-depth book on the demonstration experiment (usually carried out by a technician) without a real possibility of use (two hours in the fourth class and three hours in the fifth class). A School's pyramidal structure (Ministry Giovanni Gentile) in a unique élite School and, subordinated, Technical Schools. A choice obliged for Childs aged 11 or 12 years after the Elementary School.

That paradoxical background that led Enrico Persico [3] to write a funny article in "*Il Giornale di Fisica*". He refers about an university exam where the student cannot schematically draw an electroscope, she estimates the passage of 20,000 amps in a light bulb but at the question "write and discuss Maxwell's Equation" the candidate relaxes itself and *runs like a train* leaving the examiner in a gloomy melancholy.

2. A little history of "demonstration experiment"

Demonstration Experiment in Physics books start from XVIII Century. For example, a notable textbook by J-A. Sigaud De La Fonde [4] is devoted to the demonstration experiment "seen" with the main intent to strike and amaze. As a simple example, we find in the first volume the quantitative verification of the Archimedes principle in liquids with the same (unchanged) apparatus still present today in the Physics Equipment catalogues [5]. Along the XIX Century, a German book [6] translated in English enters the practical details of use and manufacturing apparatuses. Phywe [7] during the middle of XX Century sell single apparatus or sets of apparatuses with detailed cards, representing the German interest to the demonstration experiment. All this Literature was distributed translated in each national Language of the buyer. Demonstration experiment becomes easy to mount for the technician or the teacher and surely working.

In America, another milestone of "demonstration experiment" is the Lloyd William Taylor book [8] but out the purpose of an intermediate school.

But with the prophetic *The Times They Are a Changin'* of Bob Dylan, we found P.S.S.C. project introduced in Italy around

*Corresponding Author: S. Ganci

1963. This project spreads in Europe and, in general, the times are now ripe to lead to the 1968 revolution. It is the death of the "demonstration experiment? It is an open question. The classroom experiment is replaced by various projects (PSSC / Nuffield) but in Italy, there are now more high schools, and in one of these, devoted to the Physical-Mathematical matters (Liceo Scientifico) the scarcity of hours of Physics makes the classroom experiment resurrect as the minor of evils.

3. Pedagogical consideration

It can be useful to start some pedagogical considerations from the textual analysis of the Sutton sentence at the beginnings of this paper. "*Demonstration experiment in Physics is an old art which has been and should be constantly developing;*" A good demonstration experiment, well shown and discussed requires a lot of accurate preparation. Colin Siddons [8] jokes about the characteristic of the demonstrative experiment that it doesn't work:

It is wriggles is biology
If it stinks, is chemistry
If it doesn't work it's physics

The demonstration experiment is well remembered (particularly if it doesn't work…) so the words "old art" are fully appropriate. A Technician/Teacher mount one or more experiments as a support to a parallel lesson and always makes sure everything works by rehearsing just before the presentation. If the experiment works, it has the advantage of being well remembered and the phenomenological data are well impressed. , *if* the demonstration experiment measure something *then* it's pedagogical value is valuable.

If it doesn't work? The reason why it did not work involved more Physics but the experiment failed is equally remembered.

R. M. Sutton outlines: "*new methods of illustrating fundamental principles are always desirable and some of older methods need to be more clearly formulated*". It is evident that technology evolves and some sophisticated measures, not possible in the reality of the past century, becomes understandable and they are close to the vision of the student who lives the present era. A CRO oscilloscope is so alien that it is difficult to explain its mechanism. Older methods of analysis (as example) in resonance becomes very simple using a virtual instruments based on the sound card and few hardware found around the Lab.

4. Conclusions.

There are conclusions? It is a matter of point of view, of contingent situations, and/or more other variables. In Italy, the demonstration experiment had a value also in undergraduate courses of Physics until the middle of XX century or little more, with a specific human resource that no longer exists: "the Graduate Technician". So, University remains without a precious human resource. The true "death" of the demonstration experiment in high Italian schools is the pandemic that forced all school's Headmasters to allocate special classrooms to teaching in order to increase the distance in face-to-face lessons. Now, during pandemic, students were invited to observe phenomenology with simple experiments at home and various experiments found in web films. The Lab Technicians in high Schools are so engaged in "factotum" works and the teacher has no incentives to the use Lab apparatuses.

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Footnotes and References

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4. Joseph-Aignan Sigaud De La Fonde, Description et Usage d'un Cabinet de Physique Expérimentale (Gueffier, Paris, 1784) 2 Tomes. [5]
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7. https://www.phywe.com/catalogues/ (1950/1960 old Phywe Physics apparatuses are still the equipment of many schools in Italy).
8. AA. VV. Lloyd William Taylor, *Manual of advanced Undergraduate Experiments in Physics* (Wesley, MA 1959).
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