

## A posthumous tribute to Professor Gérard Lallement (1936–2019)

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Gérard Lallement was born on September 26, 1936 in Bertincourt in northern France.

After the Bachelor degree, he is admitted in 1954 to the Institute of Chronometry in Besançon which will later become the ENSMM. He graduated in 1957.

His military service completed, he was recruited in 1961 with Claude Oudet, by Raymond Chaléat, Professor of Mechanics, to open a new laboratory in the field of mechanics and dedicated to chronometry problems. At that time, Besançon was renowned as the watch capital and the Chronometry Institute mainly trained engineers for the watchmaking industry. Raymond Chaléat (1924–1990) who had been a student of Jules Haag (1882–1953) pursued his pioneering work in the field of chronometry (theory of synchronization, analysis of the isochronism of hairsprings as a function of amplitude, etc.). It was the golden age of the mechanical watch whose precision was sought to be improved and tested by the Besançon Observatory. The quality of the watch depended on the isochronism of the balance spring, and this mechanism thus became the focus of research studies, in particular to understand the effect of the geometry of the balance spring and its constituent material on the precision of the device. During his PhD, Gérard Lallement designed an ultra-precise torsion machine to investigate the effect of temperature and stress on Elinvar properties. This material is a nickel steel alloy with a Young's modulus which is insensitive to temperature. These studies were complemented by Claude Oudet who made an electro-magnetic precision traction machine. To establish the link between the observed phenomena and the structure of the materials used, Raymond Chaléat completed this team in 1966 by Claude Oytana, a physicist from the University of Grenoble. In parallel with these studies oriented towards the mechanical behavior of materials, work was carried out on vibrating devices (tuning fork gyrometers by René Fillod, metal and quartz oscillators). Moreover, Claude Oudet applied his skills in electromagnetism to the development of micro-stepper motors for electronic watches. The laboratory was then still strongly oriented towards chronometric studies, as illus-

trated by the telemetry device developed by Daniel Jacquet, which allowed wrist movements to be recorded in order to optimize the settings of mechanical watches.

In 1966, during a congress in Kiev, Raymond Chaléat met Otakar Danek, researcher at the Institute of Thermomechanics in Prague. A stamp collector like himself, they become friends. Despite the administrative difficulties of that time, he managed to invite him for a 2-months stay at the lab in 1967. This initiated the cooperation and exchanges which enabled many researchers from the laboratory to stay in Prague. At that time analytical developments were limited to the analysis of structures with simple geometries and the laboratory had no computers and little measurement equipment. On the other hand, the Institute of Thermomechanics which worked mainly on industrial subjects had developed approximate analytical methods adapted to complex structures which opened new perspectives for the laboratory. In particular, these methods made it possible to conduct the first work in the field of structural vibrations with a study proposed by Alsthom on the dynamic behaviour of turbo-alternator casings (Jean Piranda's PhD).

In the 1970s, after several stays at the Institute of Thermomechanics, Gérard Lallement abandoned his first field of research to devote himself exclusively to structural dynamics. Thanks to the laboratory's equipment for computation and experimental characterization, Gérard Lallement was able to set up a "Structural Dynamics" research team dedicated to modal analysis and model updating.

Owing to his engineering background, Gérard Lallement could efficiently manage theoretical and practical developments. He was a tireless worker and loved taking on new challenges. In parallel to his research activities, he developed a controlled rolling mill for the group "Spiraux Français" that insured a 0.1 micrometre precision over the thickness of the watch spring. Following his retirement, he continued his research at the laboratory as an Emeritus Professor and returned to the work of Raymond Chaléat to optimise the behaviour of the balance spring system. He was instrumental in training students in this field

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**Fig. 1.** Gérard Lallement speaking at the 50th anniversary celebration of the FEMTO-ST Department of Applied Mechanics (2012).

which had been previously abandoned in academic programs.

Over his nearly 40 year career, Gérard Lallement contributed to many hot topics in the field of Structural Dynamics and served as Director of the Department of Applied Mechanics from 1996–2001. He published over 60 journal papers, with more than 100 conference communications and countless internal, European, NATO, industrial and contract reports. Interested readers are invited to refer to [1] for a summary of the contributions of Gérard Lallement to Structural Dynamics, which was published for a special session organized in 2002, during the 20th IMAC conference, just after Gérard's retirement.

Gérard Lallement passed away on August 1st, 2019, and we pay tribute to him through this article and thank him for his contributions to science and higher education.

## Reference

- [1] S. Cogan, F.M. Hemez, M. Link, J.E. Mottershead, B. Wada, C. Zhang, A tribute to the contribution of Gérard Lallement to structural dynamics, Proceedings of the 20th IMAC conference, February 4–7, 2002, Los Angeles, CA, 2002

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