Teaching through history: the preservation of modern French scientific heritage in optics

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ABSTRACT

We describe a project underway since 2015 at the Université de Franche-Comté in France where we have been preserving the history of optics and photonics, with the particular aim of ensuring our students are made aware of this rich scientific heritage. We have successfully located and preserved a wide range of instrumentation and archival material dating from the mid-19th century to the 1960s, including some of the first European studies of lasers, holograms, and their applications. We are currently placing an emphasis on recording oral histories of current and former researchers and educators to ensure that our history during the latter part of the 20th century is fully recorded whilst memories are still fresh, and whilst supporting equipment and laboratory material can be found and archived.

Keywords: Optics education. History of physics. History of optics. Scientific heritage.

1. INTRODUCTION

Optics teaching is greatly enriched by describing its history, and most textbooks attach great importance to recognizing giants such as Newton, Gauss, Young, Fresnel etc [1]. The study of history can be a valuable tool in teaching, as it allows students to gain a deeper appreciation for the evolution of scientific thought. Students can also be inspired by seeing that major scientists in the past have often struggled with developing models for concepts that are taught in undergraduate courses today. Scientific societies and related bodies of course play a crucial role in preserving the history of science. In optics, anniversaries such as Laserfest in 2010 and the International Year of Light in 2015 have provided important opportunities to record historical snapshots of the field, and international professional societies such as Optica and SPIE publish and record a number of important historical milestones [2]. In the more general field of physics, the AIP Niels Bohr Library & Archives is a unique and valuable repository of over 30000 photographs and images and over 1500 oral histories recording recollections of major scientists [3]. Of course, with time and space limited, these efforts tend to focus on high-profile scientists with international visibility, but this raises the more important question of how local or national history is to be preserved. Of course, national societies such as the *Société Française d'Optique* also record important historical events, but again these tend to focus on the most prominent scientists [4].

This question as it relates to optics history has been concerning us at the Université de Franche-Comté since around 2015 when we first developed a major exhibit of our historical hologram collection [5] during the International Year of Light [6]. But whilst searching through our laboratory archives, it became apparent that we possessed a very rich heritage of other achievements in optics and laser physics, and yet no systematic effort was being made to preserve this. Certainly a few motivated members of the laboratory over the years had saved important material and created local exhibits, but there was no structure in place at the time to allow this history to be studied in a more systematic way, or to be linked with broader national programmes related to scientific heritage. The success of our efforts in 2015, however, made it clear to us that there was a very real need to develop a systematic programme in preserving scientific heritage.

Luckily, the timing appeared to be right for such a programme as we were able to benefit from a growing awareness of the importance of science history within the French Ministry of Higher Education and Research [7], and personnel support through a very active Arts Science and Culture Service that managed science communication and outreach within the university. As a result, we have now been able to develop a scientific heritage programme in our laboratory that has combined together efforts to save "physical" history such as instruments and documents, as well as parallel work to preserve oral history and recollections from current and former staff. This brief communication is a timely opportunity to present a progress report of our results to date.

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2. SCIENCE HERITAGE AT THE UNIVERSITE DE FRANCHE-COMTE

The University of Franche-Comté was founded in 1423 and this year 2023 represents its 600th anniversary. This particular celebration has provided us with the opportunity and impetus to formalize our efforts in preservation of scientific heritage through a systematic search through available archives. Significantly, this work allowed us to develop a complete record of all appointed Chairs of Physics at the university since the establishment of the science faculty in 1850, and to learn of the many and varied contributions they have made to both general physics and to optics. However, as we were carrying out this historical study, it soon became apparent that our colleagues amongst the university teaching staff had no knowledge of this history, an as a result the many excellent results and the long scientific tradition of the university was not being communicated to our students. This is a particular problem in a small university such as ours that sometimes struggles with visibility relative to large neighboring institutes from larger cities. Stressing that we ourselves possess a significant scientific history is very important to increase visibility and to attract students from outside our region. Moreover as we showed elements of this work to both scientific and general visitors, it became very clear how attractive it was, and in addition to its intrinsic historical value, how it could have a very positive impact in developing new collaborations and funding opportunities.

The organization and methodology used in our study can be readily summarized. Firstly, we focused on locating and preserving any "physical" scientific heritage such as old instruments, laboratory notebooks, photographic records and any other documents. We found that sporadic efforts had been made to preserve some older instruments dating back to the 19th century, but these were stored under far from ideal conditions. We also found many (post-1960) laboratory instruments in currently occupied research labs, but these were not being stored with any particular view to preservation and were in danger of being thrown out to make storage space. So our first key goal was very simple. We located whatever we could and we removed it to a dedicated storage room. At this stage nothing was especially organized, but at least it was safe from being discarded. Significantly at this juncture, we were able to link our local activity with a national programme to preserve scientific heritage in France [7], and a specialist visited the university to catalogue our collection. This catalogue is now preserved both locally and in a regional repository and significantly, this imposes an institutional obligation to ensure that our various instruments and other materials are preserved. We have also developed a local online database [8] that provides information about the instruments, a photograph, and where possible some summary historical information extracted from other sources [9].

In preparation for the 600th anniversary celebrations, during 2022 we began to seek ways of showcasing our collection in a small local museum setting. To this end, however, we had to investigate best practice for the restoration of old scientific instruments and we equally consulted with local historians familiar with the scientific heritage of the university. The key message from these consultations was that restoring old instruments must be done extremely careful and in full consultation with experts – it is better to do nothing at all than to attempt to incorrectly restore an old instrument and risk permanent damage. As a result, we decided essentially not to restore the instruments in our collection but rather simply to conduct a minimal amount of cleaning and dust removal so that they could be exhibited in an attractive way to the public.

In addition to instruments, we also wished to display in some way the many documents we had uncovered. However, with such an extensive collection we have not yet attempted to catalogue these records. In this regard, we note that we have also not attempted to sort these records or to separate them from the initial order in which they were stored. We have transferred them to archival boxes (and in some cases we have also kept the original storage boxes) but a complete study and analysis of this history requires further work. We judged that the best thing we could do at this stage was simply to ensure safekeeping.

Finally, we note that we have begun in 2022-2023 a further project based on preserving "intangible" heritage in the form of recording oral histories with retired and current staff members. The key aim here is to record key recollections from the development of the laboratory, and especially to record the scientific evolution of the field of optics bridging the period before and after the development of the laser. Interestingly, our laboratory in Besancon was ideally positioned to have a major impact on the early days of laser optics and applications, as the Chair of Physics in 1960 was Pierre-Michel Duffieux (1891-1976) whose position as one of the key founders of Fourier optics [10] had begun to be recognized in the 1950s [11,12]. Duffieux, and later his successor Jean-Charles Vienot (1930-2022) oversaw the evolution of the laboratory from one primarily concerned with imaging applications to one capable of performing state of the art research in both the scientific and industrial fields of photonics. Summaries of the various activities of the laboratory at various periods provide important historical snapshots [13,14].

Note that the recording of oral histories must be performed very carefully, with full openness with regard to the ultimate destination of any recordings and transcripts, and fully respecting all criteria of privacy and data protection (both moral and legal). Generally the unedited recordings will need to be embargoed for a time but agreement with the interviewee to release some parts of the interview after editing and approval is usually possible. But even in an abridged format, oral histories provide a unique and extremely valuable historical record, and discussions with former staff members can often open new unexplored directions of research within the public record for additional study.

3. TEACHING EXPERIENCES

As well as the clear interest of such a study in improving outreach efforts, we have been actively working with both undergraduate and graduate students to see how the regular programme of optics teaching can be enhanced by adding these historical elements. For example, students have played important roles in helping us study the use of old teaching instruments, and they have received appropriate credit for this work associated with e.g. Mini-Project components of Masters degree programmes. Significantly, the students have asked many questions that have fed back directly into our historical search for further information. A typical session of this kind is shown in Figure 1.

Developing a "local history" and recording stories of scientists (and even other students) from the same university adds a very important element to our broader educational aims. Certainly talking about elite scientists in our classes allows us to retrace major developments in the field, but this can also be inhibiting, as students perceive these personalities as distant and inaccessible. Focusing on local scientists can readily address this problem, especially when coupled with a discussion of how certain discoveries at our university have come about, sometimes passing through many stages of trial and error.

Figure 1. Students studying historical instruments from the 19th and early 20th century.

4. CONCLUSIONS

It is safe to say that when we began our initial project to study and preserve the history of optics at the Université de Franche-Comté, we did not fully appreciate the quantity of material that we would find, the potential of this project to raise the visibility of our university, nor the amount of work that it would entail. But neither did we anticipate the enormous interest that it would stimulate from a broad range of partners both within and outside the immediate university environment, nor did we fully appreciate the positive impact that a collection such as ours can have on teaching and outreach. Our hologram and instrument collections – although still in an evolving stage – occupy a total of around 100 m^2 of floor space, and are regularly used in outreach from high school to undergraduate levels. They are also key components of visits to the institute by dignitaries and external visitors. They provide tremendous added value, and stimulate students and staff alike to build on our history to create exciting new developments in optics and photonic science. Moreover, our program has contributed to the emergence of a national initiative to preserve the intangible heritage of French optics, led by the Société Française d'Optique. The teaching of science through the inclusion of historical elements stresses to students that they themselves are part of a broader university community that has worked together over many years (or even centuries in older universities) to extend human knowledge. In a world that seems increasingly to focus only on the short-term, we believe that adding this historical dimension to our teaching is essential.

REFERENCES

[1] See for example E. Hecht, *Optics*, Fifth Edition, Pearson (2017), F. L. Pedrotti, L. M. Pedrotti, and L. S. Pedrotti *Introduction to Optics*, Third Edition, Cambridge University Press (2018).

[2] For example, both Optica and SPIE post obituaries of prominent scientists; Optica hosts a dedicated webpage on *Living History* https://www.optica.org/en-us/history ; SPIE has published a valuable historical monograph: D. J. Lovell, Optical Anecdotes, SPIE (1981). There are many other examples from these and other societies.

[3] https://www.aip.org/history-programs/niels-bohr-library

[4] Articles of a historical nature regularly appear in the Société Française d'Optique publication *Photoniques.* https://www.photoniques.com

[5] G. Tribillon, J.M. Fournier. *Large-sized Holographic Interferometry in Real Image.* Optica Acta: International Journal of Optics, **24**, 893-896 (1977); C. Bainier, G. Tribillon. *Holography and Art in a Research Laboratory: A Retrospective*, Leonardo (MIT Press) **22**, 349-352 (1989).

[6] See for example the local report https://actu.univ-fcomte.fr/article/voyage-dans-la-troisieme-dimension-002470#.ZE_taoTP2Uk and recorded interviews https://www.radiofrance.fr/franceculture/podcasts/creation-on-air/holos-gramma-4772056

[7] La Mission nationale de sauvegarde et de valorisation du patrimoine scientifique et technique contemporain (PATSTEC). https://www.patstec.fr

[8] https://projects.femto-st.fr/patrimoine-scientifique

[9] F. Gires (ed.) *Encyclopédie des instruments de l'enseignement de la physique du XVIIIe au milieu du XXe siècle,* Association de Sauvegarde et d'Etude des Instruments Scientifiques et Techniques de l'Enseignement ASEISTE (2016). See also http://www.aseiste.org

[10] P. M. Duffieux. *L'intégrale de Fourier et ses Applications à l'Optique*. Faculté des Sciences, Besançon; Société Anonyme des Imprimeries Oberthur, Rennes (1946).

[11] M. Born & E. Wolf. Principles of Optics. Pergamon, Oxford, 1959

[12] P. Hawkes and N. Bonnet, *A symposium in honour of Pierre-Michel Duffieux*, Microscopy, Microanalysis, Microstructures, **8** 9-14 (1997)

[13] J.-C. Viénot. The LOBE in Optics. Optica Acta: International Journal of Optics, **24**, 789-793 (1997)

[14] L. Froehly, F. Courvoisier, D. Brunner, L. Larger, F. Devaux, E. Lantz, J. M. Dudley, and M. Jacquot, *Advancing Fourier: space–time concepts in ultrafast optics, imaging, and photonic neural networks*, J. Opt. Soc. Am. A **36**, C69-C77 (2019)