Conservation

The Laby X-ray spectrograph

Dianne Whittle

The Laby X-ray spectrograph was in manufacture by 1930 by Adam Hilger Ltd of London to the design of Professor Thomas Howell Laby. The instrument used the principle of single crystal Bragg X-ray diffraction to record wavelengths for spectrum analysis. An example is on permanent display in the University of Melbourne's Physics Museum.[1] In 2007 the conservation treatment of the instrument was undertaken as part of the University's Cultural Collections Renewal Project, which was funded by the Miegunyah Trust.

Thomas Howell Laby (1880–1946) was appointed Professor of Natural Philosophy, as Physics was then called, at the University of Melbourne in 1915, and held this position until his retirement in 1944. From 1926 to 1929 he was also Dean of the Faculty of Science.[2] At the University, he placed great importance on research, exploring areas such as precision physics, radio physics, X-rays, and atomic and nuclear physics.[3] In the process he was involved in the design of a number of instruments including a string electrometer and this X-ray spectrograph. One version of the spectrograph was exhibited by Adam Hilger Ltd at the 1928 Exhibition of the Physical and Optical Societies in London.[4] The Physics Museum also

holds a prototype of the spectrograph (reg. no. 275), constructed in the Natural Philosophy workshop at the University and now displayed alongside the final version. It has recently undergone conservation cleaning .

The finished instrument now displayed in the Physics Museum (reg. no. 274) is a complex assembly of brass, lead, aluminium, and iron-based components, with a rock salt or calcite crystal held in position by wax, and a range of surface coatings including enamel paint and shellac. The oscillating components were driven by a clockwork mechanism mounted under the base plate below the collimator.

When in use during the 1930s, an X-ray beam would be directed at an oscillating crystal, which diffracted the beam at various angles depending on the elements present. The reflected beam was then selectively passed through an aperture in a synchronised oscillating lead screen, and onto a curved photographic plate. The wavelengths of unknown lines on the spectra image produced were then determined by interpolation from known standard lines.[5]

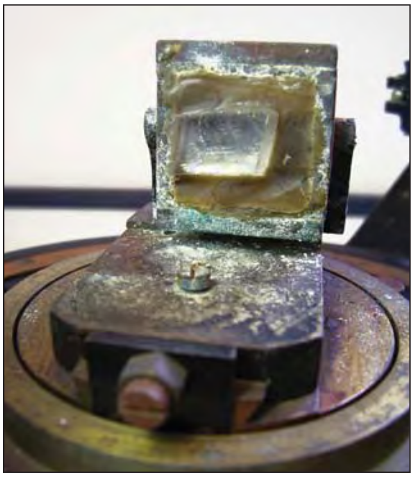
More than 60 years later, and after many years of static display in the Physics Museum display cases, the veteran instrument was showing signs of deterioration including corrosion, surface coating abrasion and loss, contamination of lubricated surfaces, and otherwise the general rigours of dust, oxidation and handling over time.

The challenge in developing the conservation treatment was to improve the appearance of the object, as well as ensuring its long-term stability, without losing evidence of use, provenance or historical record. Conservation ethics ideally require minimal intervention, the preservation of original material and the use of reversible treatments. In application however, there often needs to be a compromise between the expectations of the owners or managers of a collection, technical

Opposite: *Professor Laby optical munitions 1943*, photographic print, 25.0 x 19.5 cm. Reg. no. 72, Physics Museum, University of Melbourne.

Below: X-ray spectrograph, designed by Thomas Howell Laby, Melbourne, manufactured by Adam Hilger Ltd, London, c.1928–1930, various materials including brass, lead, aluminium, iron, enamel paint and shellac, height: 43.0 cm. Reg. no. 274, Physics Museum, University of Melbourne.

Elements of the spectrograph before treatment: front and rear of crystal holder, and partially disassembled crystal mount slide adjustment and turntable, showing corrosion, dirt and other damage.



and resource limitations, and ethical considerations. For the collection managers, it was important that the instrument's appearance reflect its significance as the 'best preserved instrument surviving from Professor Laby's research',[6] and that its function and use should be readable. In particular, it was felt that the severely corroded graduated scales associated with the crystal table oscillation should be legible.

With the assistance of the Physics Museum technical staff, the instrument was partially disassembled to enable access to the individual components. An interesting consequence of this disassembly process was the identification of several non-original components, which indicated that the clockwork mechanism at some point in the instrument's use had possibly been replaced by a motor driven belt/pulley system, and that the rotating lead slit described in the manufacturer's reference literature was no longer attached to the instrument.

During treatment, the surface coatings were found to vary widely in solubility and integrity, and care was taken to use different cleaning regimens for each surface. All painted surfaces were cleaned and sealed with a microcrystalline wax. Corrosion products on the brass, lead and iron-based components were reduced or removed manually using a fine scalpel under low power magnification. Deep pitting associated with the iron-based corrosion was treated locally with tannic acid. The exposed lead surfaces of the crystal mount were sealed after cleaning with a coating of Paraloid B72 resin to slow future corrosion.

Corrosion pitting of the graduated brass scales associated with the crystal table required the removal of the original—presumably shellac—coating, which had discoloured with age, and mechanical removal of the corrosion beneath it using abrasives. Prior to re-assembly, the original coloration of these components was matched by applying a tinted acrylic spray coating over a reversible, conservation-safe Incralac barrier layer. On the one levelling foot where a similar coating had major areas of loss, transparent pigments in solvent

The spectrograph after treatment.

were applied over a barrier layer, to simulate the original coloration. Both of these coatings can be easily removed and replaced in the future if required.

Degraded and contaminated lubricants on the base of the turntable component, and within the clockwork mechanism, were removed with solvents and replaced by a light machine oil. A decision was made to leave the tube of the collimator, which appeared to be wrapped in discoloured adhesive tape, untouched, apart from a dry surface clean.

In summary, the instrument has been cleaned of surface grime and the majority of disfiguring corrosion products, and stabilised as much as possible for future long-term storage and display. The treatment has improved the overall visual aesthetic, without significantly compromising the historical context or losing evidence of use. As a result, this important instrument, which tells us much about early physics research and development at the University of Melbourne, can be returned to display for many decades to come.

Acknowledgements: I would like to acknowledge the assistance of Nick Nicola and Phil Lyons from the Physics Department in the disassembly of the spectrograph prior to treatment, and Holly Jones-Amin and Kate Shepherdson from the Centre for Cultural Materials Conservation for their feedback and consultation during the conservation process.

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Notes

1 The display area of the Physics Museum is located on level 2 of the School of Physics theatres building. It is open from 9.00 a.m. to 5.00 p.m., Monday to Friday. For further information on the Museum see http://www.ph.unimelb.edu.au/museum.

2 For a biographical outline see 'Laby, Thomas Howell (1880–1946)', *Bright Sparcs*, The University of Melbourne eScholarship Research Centre, 1994–2007, http://www.asap.unimelb.edu.au/bsparcs/biogs/P000553b.htm.

3 Jacqueline Eager, 'Photograph, Optical Munitions & Prof. Laby', website of the University of Melbourne Physics Museum, http://www.ph.unimelb.edu.au/museum/index.php?state=browse&search=search&start_entry=0&num_results=25&search_field=Brief+description&equals_or_contains=Contains&search_string=laby, accessed 8 January 2008.

4 A.F.C. Pollard, 'Notes upon the mechanical design of some instruments shown at the Exhibition of the Physical and Optical Societies, 1928', *Journal of Scientific Instruments*, vol. 5, no. 3, March 1928, pp. 88–92.

5 'New instruments: Professor Laby's X-ray spectrograph', *Journal of Scientific Instruments*, vol. 7, no. 9, September 1930, pp. 296–297.

6 Online catalogue of the collection of the University of Melbourne Physics Museum, entry for 'X-ray spectrograph, Laby/Hilger', http://www.ph.unimelb.edu.au/museum/index.php?state=item_view&pm_item=274, accessed 8 January 2008.