Precision optical components —
The windows of research

Precision optical components, with a wide variety of research applications are provided for NRC by the Optical Components Laboratory of the Division of Physics. Its techniques, developed originally for working with glass, have proven versatile enough for use on other materials such as metals, ceramics or plastics. As a result, the Laboratory is now capable of finishing diverse custom-designed components to a precision otherwise unattainable.

"Physical phenomena consist always of the interaction of energy with matter. We see matter by light; we are aware of the presence of light by the interruption of matter. And that thought makes up the world of every great physicist, who finds that he cannot deepen his understanding of one without the other."

— Jacob Bronowski, from The Ascent of Man —

Consider the scientist's realm without the microscope lens, the telescope mirror, the spectrometer prism or, indeed, without the far-sighted researcher's spectacles. Each component is vital to his analysis of the physical world, and each, for its use, depends on the interaction of light with optical materials.

Interactions of light with optical materials (such as magnification, reflection, diffraction and focussing) are all well known, but to use them best, a scientist requires the highest quality optical components.

Such components, with a wide variety of research applications, are provided for the National Research Council of Canada and other laboratories by the Optical Components Laboratory of NRC's Division of Physics.

It is described by Mr. J. Norton Cairns, laboratory coordinator, as "a place where the difficult has become routine."

The Optical Components Laboratory began operation in 1940, concentrating initially on the manufacture of optical parts for military purposes. Over the years, its activities diversified as new demands arose for optical components in many areas of research.

Its early years involved much experimentation and the development of optical techniques. The techniques and materials employed by existing optical laboratories in other countries proved to be as valued and guarded as the recipes of a master chef. Thus, since these could not be copied or adapted, it became necessary to develop an entire new system of techniques and operations.

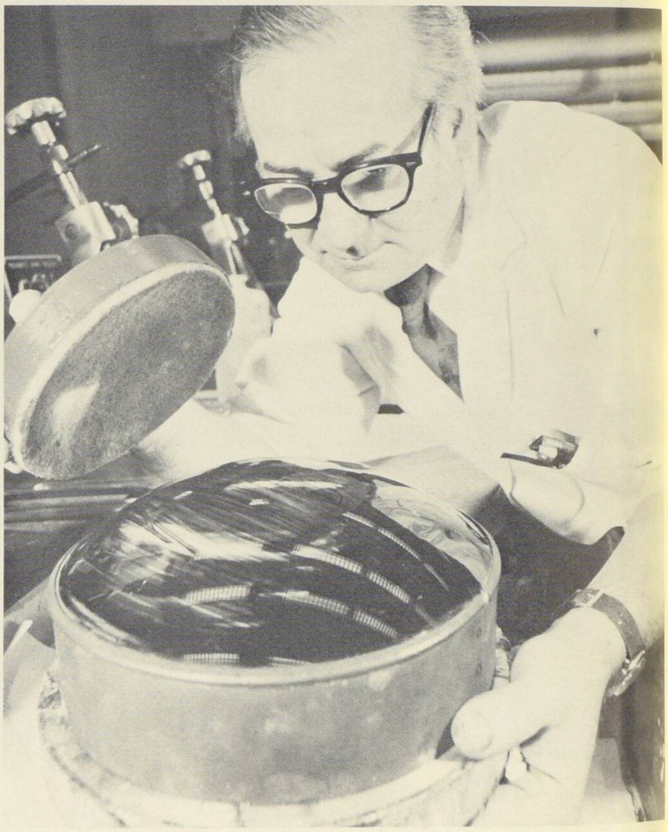
Fortunately, the new techniques for working with glass proved versatile enough to be used with other materials. This faculty has since emerged as a unique feature of the laboratory's operation.

For example, adaptations of glass polishing techniques are now applied to metals, ceramics, plastics and a variety of other materials. Using optical methods, the laboratory has fabricated diverse components of diamond, ruby and sapphire designed for use with lasers. Metal components range from polished clips for use in delicate surgical operations, to precision parts for nuclear reactors. In these cases, optical polishing produces near-perfect surfaces, unattainable otherwise.

Although much of its work is done for the Division of Physics, the laboratory has also produced numerous components for outside customers. In most cases, these components either could not be purchased commercially or needed a higher degree of precision than any available commercial product.

What skills does the optical technician need to transform raw materials into a crystal-clear, finely-polished lens?

The stages in the manufacture of any optical component are not unlike the steps artists take in producing their finest creations. Like sculptors, optical technicians must know their materials intimately. From a selection of glasses such as crown (boron containing), flint (high lead content) or fused quartz, they must chose the one with the appropriate physical properties. In their selection they must also bear in mind the purpose intended for the finished product. Will it be used to transmit light (for example a focussing lens) or will it act merely as a substrate for a mirror such as in a telescope?



Optical technician, Mr. Sy Bourgault inspects the polished surface of a large convex lens. The polishing material on the tool (top left) is critical and varies with the type of optical material as well as its hardness. For optimum polishing, each type of glass requires a tool surface of different hardness. In most cases, pine resin is chosen and either hardened or softened with castor oil. The same composition is unsuitable for polishing other optical materials such as salt crystals which are prone to scratch. For these, softer polishing materials such as paraffin are used.

M. Sy Bourgault, technicien de l'optique, examine la surface polie d'une lentille convexe de grande dimension. Le matériau de polissage sur l'outil (en haut à gauche) est critique et varie avec le type de matériau optique et aussi avec sa dureté. Pour avoir un polissage optimal, chaque type de verre exige une surface d'outil de dureté différente. Dans la plupart des cas la résine de pin est choisie et on lui donne ensuite la consistance recherchée en y ajoutant de l'huile de ricin. La même composition ne convient pas pour le polissage d'autres matériaux optiques comme les cristaux de sel qui ont tendance à se rayer. Pour eux, des matériaux plus doux de polissage tel que la paraffine sont utilisés.