technological innovations than larger firms with their more complex organizations and procedures. Examples of such firms are Gandalf Data Ltd., MacDonald Dettwiler & Associates Ltd., and Lumonics Inc.

The Committee believes that even if they do not engage in research and development or technological innovation themselves, small firms — to remain competitive — must adopt those technological innovations in the machinery, equipment and materials they use which can lead to improvements in their productivity. If, as some witnesses anticipate, recent developments in computer-aided manufacturing and robotics make short production runs as productive as long production runs using older production technology, small manufacturing firms may well be able to compete in areas they have been unable to in the past. Speaking of these developments, Mr. Tyaack said, "So we are in the process of loosening that thing up, getting away from the linear flow assembly line and literally freeing ourselves from the old notion that the longer the run the more productive it is. That is going on now. The Japanese have done it. They have done a lot with short production runs to get very high productivity". (1-32-16:22) These developments may be very important to Canada because of the small size of the domestic market.

Research Centres

Technological innovation is an industrial process. Only industry is able to carry out the production and marketing required to transform an invention into a saleable product or process. However, research centres operated by government, universities or non-profit organizations can play an important role in fostering and assisting technological innovation in industry.

First, research centres can undertake fundamental research in technologies of interest to industry such as materials, artificial intelligence, aerodynamics, tribology and bioengineering, and make the results available to industry. Mr. Tyaack noted that research centres in which government, universities and industry co-operate had been particularly successful in producing entrepreneurs and promoting technological innovation. As an example of such a centre, he and other witnesses cited the research in artificial intelligence being conducted at the University of Waterloo.

Second, research centres can undertake applied research and development for industries such as agriculture and fishing which are comprised of enterprises that are too small to undertake research and development on their own. The research institutes and stations that have been established across Canada by Agriculture Canada are examples of such centres.

Third, research centres can provide research and development and other technical services to industry on request. Such services are of particular importance to small firms that cannot afford to establish and maintain their own research and development capability. The Committee noted that a number of Canadian universities, with initial financial assistance from the Department of Regional Industrial Expansion, has established Industrial Research Institutes and Centres of Advanced Technology to provide research and development and other technical services to Canadian industry on a contract basis.