Report of

Committee 9

Textiles and Natural Leather

Chairman - M.L. Staples

Members - C.H. Bayley

- H.C. Mercereau

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220 ORGANIC CHEMISTRY

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C.H. Bayley and H.C. Mercereau

INTRODUCTION

The term textiles is applied broadly to the products of the knitter and the weaver and to the various raw materials and processes that are used in the manufacture, dyeing and finishing of such products. Included also are ropes, twines, felts and non-woven materials whose construction does not depend upon either weaving or knitting. The leather industry is concerned primarily with the tanning of hides and the utilization of leathers thus produced. The origins of both industries date from antiquity and until the present century the techniques which they employed were more of an art than a science. In this respect, these industries differ markedly from the chemical industry which owes its origin and development to science. The traditional background of the textile and leather industries has also influenced the rate at which scientific methods have been accepted by these industries and introduced into their operations. However, since the beginning of the present century, much progress has been made and to-day the application of science is beginning to be recognized as of fundamental importance to the future of both industries.

DEFINITION OF THE FIELD

In relation to the basic scientific disciplines, the fields of textiles and leather embrace chemistry, physics, mathematics and various branches of engineering. In addition, both fields rely on technologies that are more or less uniquely their own. Because research and development in textiles and also in the leather industry, depends upon a knowledge of the basic sciences, and since leather and all textile fibres are high polymers of one type or another, some overlapping of the scope of this Committee with that of other Committees engaged in this survey is unavoidable. In particular, reference should be made to the reports of 220 Organic Chemistry Committee 7 Polymers, etc., Area 071-Elastomers, Plastics and Resins; Committee 5 Fuels, etc., Area 051-Oils, Fats and Waxes, Area 052-Soaps, Detergents, Surfactants, Area 053-Dyestuffs, and perhaps others.

The emphasis in the survey conducted by Committee 9 has been on textiles and leather with particular reference to the application of chemistry. However, because of the contributions which many scientific disciplines make to research and development in these fields, the information gathered during the survey and the various areas proposed for future research in Canada have not been confined to the application of chemistry alone but rather to any area that may broadly be considered of interest and importance to textile and leather science. For ease of presentation, the fields of textiles and leather will be dealt with separately.

HISTORY AND PRESENT STATUS OF RESEARCH AND DEVELOPMENT IN CANADA

Textiles

Textile research and development in Canada has been influenced greatly by at least three factors. The first arises from the fact that the textile industry began as a craft concerned only with products made from natural fibres and was for a long time not dependent upon scientific knowledge for its operation. This traditional background delayed acceptance of the benefits that could be gained from the application of scientific methods and it was not until after the commercial production of man-made and synthetic fibres began that much interest was expressed in research and development. Even to-day there are large sections of the textile industry in Canada where little or no research or development is being carried on.

The second factor is due to the presence in Canada of foreign-owned companies. Canadian subsidiaries have had ready access to the results of research and development work that is carried out by their parent companies and, in view of this, there is little incentive for such branch plants to establish their own laboratories to undertake research in Canada. Some parent companies are also reluctant to assign any of their research programs to Canadian subsidiaries and this imposes a further restriction on the amount of research being done by the textile industry in Canada.

The third factor is cost. The establishment of research facilities and staffing with competent personnel is expensive and is becoming more so as science and technology become more sophisticated. It has been said that a team of about ten scientists costing at least a quarter of a million dollars a year

to maintain is about the minimum required for an effective research and development group. Many of the companies that make up the textile industry in Canada are small and consider the cost of providing their own research facilities to be much higher than they can afford. Others are not yet convinced that the return on investment in research is sufficient to justify the expenditure.

It is not surprising, therefore, that the limited amount of textile research and development in Canada has been carried out by comparatively few organizations. Until recently only the National Research Council, the Ontario Research Foundation and a few of the larger synthetic fibre manufacturers have been engaged in research and development in the textile field. The N.R.C. and the O.R.F. have operated textile research laboratories for approximately 35 years and in addition to providing a technical service to the Canadian textile industry, they have conducted research on problems related to cotton, wool, viscose rayon, silk and some synthetic fibres. In recent years the Textile Laboratory at the N.R.C. has been particularly interested in studies of physical and chemical methods for retarding the photodegradation of textile fibres and of the microbiological degradation of cotton. During the past few years, the O.R.F. has been studying methods for the chemical modification of cellulosic fibres with a view to improving those properties in which these fibres are deficient. In addition, research is being conducted on the structural modification of wool and hair to exploit changes in the fibre which can be induced chemically, with particular reference to rigidity and ease of extension.

At the present time the Commercial Products Division of Atomic Energy of Canada Limited is exploring the possibility of utilizing gamma radiation to initiate chemical reactions in the finishing of cotton fabrics. Work on cellulose graft copolymers induced by radiation has also been carried out by International Cellulose Research Limited and by the Department of Chemical Engineering at the University of Toronto. This represents an area of research of potential interest to the textile industry if suitable improvements in fibre properties can be achieved at reasonable cost.

About a year ago, Textile Sections were established under the Home Economics Department at Guelph University and under the Faculty of Food Sciences at the University of Toronto. Both of these educational facilities are now

offering instruction in textiles to graduate students and plan to conduct research on textiles, but to date there has not been time to make much progress. At Guelph University, however, in addition to instruction in textiles, work has been started on six projects. These are concerned with studies of the factors involved in the production and discharge of static electricity from textiles, phosphorus-nitrogen polymers, effects of radiation on fibres, torsional rigidity of fibres under high rates of stress, yarn irregularity and the shrinkproofing of wool. At the University of Manitoba plans are being laid to offer training in textile research, at the graduate level, and courses are to begin there in the Fall of 1968.

Perhaps reference should also be made to the work at the Pulp and Paper Research Institute and at the Division of Polymer Chemistry of the Department of Chemistry at McGill University. Some of the activities at these two research centres have a bearing on the science and technology of the textile industry.

For obvious reasons, no detailed information is available on the nature of the research and development work being carried on by the textile industry at the present time. It is known, however, that certain synthetic fibre manufacturers and other companies whose activities are closely related have been conducting research on the production and dyeing of polyolefin fibres, on improvements in high tenacity viscose rayon and on developing non-woven fabrics. Where research and development is being carried on by the textile industry, it is directed primarily toward either improving the properties of the fibres in which they are particularly interested, or their methods of production.

Leather

The history of research and development in Canada in the field of leather is similar in many respects to that of textiles. Until just after the Second World War, a laboratory was maintained at the National Research Council where work was carried out on such projects as the development of a new type of tannage for white leathers, a study of the deterioration of shoe leather and a variety of problems related to the production and utilization of materials used in leather manufacture. The work of this laboratory was discontinued in 1946.

A research laboratory for leather was set up at the Ontario Research Foundation in 1930. Among its early projects were studies of methods for improving the process of finishing patent leather, the relationship of fibre structure to the wearing properties of sole leather, grain thickness of vegetable tanned leather, the cause of fatty acid spew on chrome retanned shoe leather, and short-term problems of immediate concern to individual manufacturers. Owing to the lack of industrial support, this laboratory has also been discontinued.

A few laboratories are operated privately by various companies in the leather industry but, with perhaps one or two exceptions, their work is concerned chiefly with supervision and production control. One industrial laboratory is engaged in a well planned research program dealing with the use of enzymes in tanning. Recently some exploratory work has been undertaken on the possibility of utilizing ultrasonic energy as an aid in tanning.

STATISTICAL DATA

Some indication of the volume of research and development work that is being carried on by the textile industry in Canada is provided by the information obtained from the Dominion Bureau of Statistics and from the C.I.C. survey questionnaires. Such statistics, of course, give no clue as to the type of work being done, but they do enable comparisons to be made with other yardsticks such as volume of sales within the industry or the relationships with similar types of work in other industries. Since the number of companies in the leather industry that are conducting research and development is very small, no corresponding information can be reported separately for this industry.

Textiles

The tabulations given in Appendix A summarize the statistical data on textile research and development in Canada for the year 1965. Where figures are available for 1966, these have been included and in some cases the data for the three years prior to 1966 are also recorded.

Where corresponding data are reported from both the Dominion Bureau of Statistics and the results of the C.I.C. questionnaires, some differences will be observed. Most of these differences may be attributed to the fact that in the C.I.C. survey an attempt was made to record the R & D of the textile

industry by a selected group of scientific disciplines within each company whereas the D.B.S. used the principal product of the company as the basis for classifying the R & D of that company. For example, the total current intramural expenditures of the textile industry for the year 1966 was reported by the D.B.S. to be $3,220,000 (Table I) whereas the corresponding total from the results of the C.I.C. survey was $2,605,000 (Table XVIII). If the data from the C.I.C. survey are tabulated according to the principal product of each reporting company, a total of $2,929,000 is obtained (Table XIX). The difference between the latter total and the D.B.S. total can be accounted for, at least in part, by the fact that R & D expenditures by the textile industry in certain fields of engineering were included in the D.B.S. total but were not included in the C.I.C. total.

In spite of these discrepancies, some interesting general conclusions are indicated by the data in Appendix A and brief reference will be made to some of them. It appears that the textile companies

engaged in research and development in Canada spent, on the average, approximately 1% of their total sales on research and development during 1966. If the calculation is based upon the total value of goods manufactured by all companies in the Canadian textile industry, a little over 0.2% is spent on research and development. These figures are, of course, only approximate, but they do serve to indicate an order of magnitude. Comparative figures which refer to the United States, show that the American textile industry spends approximately three times the percentage of sales on research and development that is spent by the textile industry in Canada and this is from one-fifth to one-tenth the percentage of sales that the American chemical industry spends annually on research and development.

Although there are over 1000 firms in the primary textile industry in Canada, many of these are small. In fact, less than 20% of the companies employ more than 100 persons and in many cases the total number on the staff is well below 100. This means that the number of textile companies in Canada with an annual sales volume large enough to support a research program on an individual company basis is small. Conducting research on a group basis for related segments of the textile industry might be explored as a possible solution to this problem.

It is interesting to note that the total amount spent during 1966 (current plus capital expenditures) on research and development by the textile industry in Canada was $3,717,000 and practically all of this sum was derived from Canadian sources, generally speaking from the reporting company. The Government of Canada contributed $50,000 to the total spent by industry in 1965. The amount for 1966 is not yet available. The Canadian textile industry spent $125,000 on extra-mural research and development during 1965 and about half of this sum was spent with Consultants and Commercial Laboratories in Canada. Forty-three thousand dollars were spent with other companies and non-profit organizations and practically all of the remainder - about $23,000 - was used to support research and development work at industrial and Provincial research institutes.

It cost the Canadian textile industry $1,353,000 for patents, licences and technical "know how" in 1965 and this entire sum was spent outside of Canada. No doubt this practice was adopted to obtain some benefit from the results of research carried on outside the country and thereby offset, to some extent at least, the lack of research and development in Canada.

The largest proportion of the total amount spent on research and development by the Canadian textile industry during 1965 was used to support work on synthetic fibres and their products. The total expenditure on synthetic fibre research exceeded by over $500,000 the amount spent by all other branches of the industry. The total expended by the universities on textile research in 1966 was $8,000 and the Federal Government spent $119,000.

In terms of manpower, by far the greatest number engaged by the textile industry in research and development in Canada in 1965 were either chemists or chemical engineers. Of all scientists thus employed, only one was engaged in basic research and seven in applied research. The remaining 87 spent full time working on development. In terms of the research dollar, the textile industry spent approximately 92% on development work, 7% on applied research and 1% on basic research. In government and university laboratories, about five scientists were employed on basic and applied research and development.

FUTURE OF RESEARCH AND DEVELOPMENT IN CANADA

Textiles

Although it is interesting to review the present status of textile research and development in Canada, it is of far greater importance to consider the areas of study toward which future research should be directed. During the course of this survey, opinions and recommendations have been obtained from scientists and technologists in almost every laboratory in which textile research is now being carried out. In presenting this information it is convenient to group the recommendations into the sections which appear below.

The general areas of research of interest to the Canadian textile industry may be classified broadly into three categories. The first is concerned with the development of new products. Some of these are based on the use of raw materials that are native to Canada, such as wood pulp and various chemicals produced by the petroleum industry, whereas others would utilize the waste by-products of present industries, eg. lignin. The second category deals with research aimed at improving existing processes to permit manufacturing operations to be carried out more economically. The third refers to a study of the dyeing

of textiles and the chemical modification of fibres and fabrics to overcome deficiencies in those properties which limit their market potential. The latter includes the broad field commonly referred to as textile finishing.

Not all of the research projects that are mentioned in this report are strictly chemical in nature. However, the line of demarcation between chemistry and other scientific disciplines is so vague that it is not possible to discuss the interests of the textile industry in research unless related areas of science are also included.

Polymer and Fibre-Forming Research

Considerable interest has been expressed in the development of new fibre forming polymers. In particular, reference is made to the production of additional cheap, high tenacity, chemically resistant fibres from olefins. It was also suggested that new methods of polymerization might be investigated. In view of the large resources of petroleum in the Western provinces, this area of study seems to be well suited to textile research in Canada.

A closely related field of investigation is concerned with a fundamental study of block and graft copolymerization and the relationship between the structure of multi-component polymer melts and the rheological and chemical properties of the fibres thus produced. Modifications in the characteristics of textile fabrics which are now being accomplished by the application of specific finishes might be achieved more economically if the fibre-forming polymer could be suitably altered prior to or during the spinning operation. Polymers containing internal lubricants thus obviating the need for lubrication of yarns during processing, and modification of existing polymers to secure better dyeability, abrasion resistance, soil resistance, etc., are but a few examples.

Interest has been expressed in the development of improved high wet modulus regenerated cellulosic fibres to replace cotton. Such fibres could be made either from wood pulp alone or in blends with synthetic polymers. In view of the vast supply of pulp wood available in Canada, research in this area would seem to be justified. If a satisfactory fibre could be developed, it would not only provide a better final product for the consumer, but would also save millions of dollars of Canadian exchange. A closely related field of research would have as its objective the production of cellulosic fibres from trees by a new process.

This would consist of devising a means for by-passing the present cumbersome and time-consuming pulping and/or rayon process. As an example of how waste products might be used to commercial advantage, there is the possibility of producing very low cost polymers from a by-product of the paper industry - lignin.

It has been suggested that there is a need for fibres having good textile properties, that will not fuse, melt or burn. Fibres that will resist very high temperatures are of interest for space travel. Such a development might overcome some disadvantages shown by present day thermoplastic fibres. In this area reference might be made to research on so-called inorganic fibres with which should be included metallic fibres. There is also a possibility of combining organic and inorganic systems in the production of new and interesting textile fibres.

Two other ideas were suggested. For a number of years the Armed Services have been interested in using chicken feathers in place of down in sleeping bags. If a very fine mist of plastic particles could be deposited electrostatically on a skeleton made from an extremely fine wire spring, a product might be produced containing the fine branches that give down its characteristics. Artificial down could find a market for use in many types of insulation as well as in cold weather clothing and in sleeping bags. Another need is for an ultra fine fibre having a diameter of the order of 0.1 microns. At this level of fineness, it appears possible to develop a virus filter. High strength fibres that will retain an electrostatic charge would also be useful for this purpose.

As an aid in polymer research, it is useful to know something about the mechanisms by which polymers are degraded when exposed to actual service conditions. Some knowledge is already available, but it is felt that considerably more can be learned from a fundamental study of the mechanisms of polymer degradation by such agencies as micro-organisms, and various forms of radiation, especially light and heat.

Dyeing and Finishing Research

Since the characteristics of a finished fabric or other textile article determine to a large extent its usefulness for a particular purpose and its

consumer appeal, a tremendous effort has been made during the past decade or so to improve those properties in which fibres are deficient. Attention has been directed toward the application of finishes to obtain a wide variety of properties such as flame, rot, water, soil and abrasion resistance, dimensional stability to laundering, anti-static properties, resistance to pilling and improvement in the ability of a fabric to recover from deformation. Some of the finishes that have been developed involve a chemical modification of the structure of the fibre. Not all of these desirable characteristics, however, can be imparted to fabrics by presently known methods without introducing other defects. For this reason there is still plenty of scope for worthwhile research on textile finishing.

A number of areas of research on textile finishing have been suggested. Among these are, the development of a treatment for preventing the shrinkage or stretch of knitted fabrics during laundering, the development of a low cost flame retardant finish for cellulosic and hydrophobic fibres, the development of an anti-static finish that is compatible with water repellency, the development of water and oil repellent finishes that may be coupled with a durable press finish, and the development of a finish that will repel mosquitoes and biting insects.

Most finishes that are applied to textile fabrics to-day are cured and fixed to the fabric by means of heat. The possibility of using other forms of energy such as beta and gamma radiation are now being explored and this field of research is another one that warrants intensive study.

The production of durable fabrics that will transmit water vapour but not liquid water is extremely important to the comfort of clothing used as rain-wear. Such fabrics could also find applications in tentage. This problem is of particular concern to the Armed Services and its solution may involve a combination of finishing research with suitable fabric construction. A good deal has been accomplished on this problem to date but it is necessary to obtain much better performance before the fabrics thus far developed can be put to practical use. In addition to the above essential properties, it would be desirable to have such materials flame resistant and static-free.

In the area of research on textile dyeing, some rather novel recommendations were made. It was suggested that not only is there interest in the development of improved dyes and dyeing methods, but the possibility of producing a dye precursor that could be included in fibres perhaps together with other compounds, and which could be activated to give various hues by selective treatments, for example, exposure to radiation, would represent a new approach to textile dyeing. Useful investigations might also be carried out on photosensitized reactions involving dyestuffs. A practical problem that has plagued dyers for years has been the consistent production of dyed fabrics that are free from shade variation within a piece, from piece to piece in the same dyelot or between repeat dyelots. A solution to this problem would represent a distinct advance in dyeing technology.

New Methods of Forming Textile Structures

This section includes recommended research projects that are not strictly chemical in nature but in many of them the application of chemistry may assist in finding a solution to the problem. The first group of projects deals with the production of textile yarns.

There is considerable interest in the development of new equipment and techniques for forming yarns to eliminate the expensive processes of carding, drawing, twisting, etc. In this connection some progress has already been made in producing fibres or yarns directly from films and it is believed that a thorough investigation of film extrusion methods as a basis for the production of textile-like structures might be rewarding. The treatment of textile yarns, generally made from synthetic fibres, to produce bulk yarns, that is, to increase the apparent specific volume of the yarn, is a very important commercial operation. Although various techniques are now being employed to do this, there is room for further improvement. It is felt that the development of new economic methods of imparting bulk to textile structures, not necessarily yarns, could result in the production of interesting and novel effects.

In the field of garment construction, there is a need for some means of attaching fabrics to one another to replace sewing. The use of suitable adhesives or other techniques could be investigated. Coupled with this would be a study of methods for producing moulded or formed garments. This might involve a chemical modification of the fabric to make it suitable for moulding into garment form.

Although much research has been done in the field of non-woven fabrics, and considerable progress has been made, a truly satisfactory material for use in wearing apparel and household fabrics has yet to be produced. The use of paper-base non-woven fabrics reinforced with man-made or synthetic fibres for disposable end uses such as hospital sheets, tablecloths, protective and sterilized apparel, etc. would have obvious economic advantages over conventional knitted and woven structures. It is believed that further research in this field is warranted.

Leather

Although only a very limited amount of research and development is being carried on at the present time by the leather industry in Canada, there are areas of study that would benefit this industry and place it in a stronger competitive position. A number of research projects have been suggested by members of the industry and these are briefly outlined below.

Considerable interest has been expressed in a study of chemical modifications of tanning materials aimed at producing leathers which have certain desirable properties. Among such properties are leathers that are solvent resistant and can be dry cleaned, that are more resistant to water, to perspiration and to soiling, and leathers that possess better insulating characteristics.

It would be of great practical importance if methods could be found for accelerating the tanning process, particularly the tanning of heavy leathers. The use of ultrasonic energy may find an application here. Basic to this investigation would be a fundamental knowledge of the chemistry of the tanning process and closely related is a study of the physical and chemical structure of the constituents of skin.

Other areas of basic research include a study of the chemical structure and biosynthesis of collagen and the application of the resulting knowledge to the development of a method for reconstituting 'native' collagen into sheets; studies would be made of both genetic and environmental (including dietary) factors on the properties of hides and leathers. This should lead to better animal breeding and to better hides, consistent with good meat production.

In the region of applied research there is a need for methods that can be used to determine not only the fundamental chemical and physical properties of hides and leathers but also methods for assessing the performance characteristics of leathers for various applications, eg. in shoes, clothing, luggage, etc. These methods should preferably be non-destructive.

The importance, now widely recognized, of controlling water pollution, has prompted the suggestion of developing a method for eliminating sulphides from sewage and a study of the effects on sewage organisms of the chromium compounds present in waste tannery liquors. Interest has also been expressed in finding improved uses for tannery by-products - trimmings, hair, shavings and buffing dust. High labour costs have led to the recommendation that consideration should be given to the development of rapid mechanized systems for leathermaking. A systematic comparison of the properties of natural leather with those of the various leather substitutes that have appeared on the market would provide information in deciding the future course that the leather industry should follow.

FUTURE REQUIREMENTS

Textiles

Textile Education

A research program in any field can only be undertaken and carried on satisfactorily if adequately trained personnel are available. Training at a recognized university in the basic sciences, chemistry, physics, mathematics and engineering is essential as a background for research work in textiles. It is also advantageous for a person to have received some training in textile science at the post graduate level and until recently no facilities were available in Canada that could provide such training. Up to the present time, this lack has been largely met by employing persons who have received textile training in other countries, principally in Europe, the United Kingdom or the United States.

About two years ago a Department of Textiles, Clothing and Design was established in the Home Economics Department at the University of Guelph. This Department is now offering graduate instruction in textiles and directs the research of students who are working toward M.Sc. and Ph.D. degrees. Somewhat similar facilities are available at the University of Toronto and in the not too distant future it is expected that there will be another university in Canada which will offer graduate training in this area. Reference should also be made

to the instruction and research training now available at the Division of Polymer Chemistry of the Department of Chemistry at McGill University. It is reasonable to expect that some graduates of this school will be interested in opportunities to do textile research.

Since the amount of textile research now being carried on in Canada is less than a quarter of what it should be, there will obviously be a need for more trained scientists during the next five years if the volume of research is to increase. However, any increase will have to take place gradually and an estimated reasonable rate of growth should require from ten to twelve additional chemists or chemical engineers per year over the next five years.

The facilities now available in Canada for providing formal instruction in textiles at the graduate level are all comparatively new, but with proper support to encourage their expansion and development they should be able to supply a sufficient number of graduates trained in textile science to meet the requirements of the industry in the foreseeable future. No need for the establishment in Canada of other centres of specialized instruction in textiles is envisaged at the present time.

There are also available in Canada two post-secondary technological schools - Mohawk College in Hamilton and the St. Hyacinthe Textile Institute at which an adequate supply of textile technologists can be trained to satisfy the requirements of the industry in this area.

It has been pointed out that there is a need in Canada for a school where training in research and development management can be obtained. This is to ensure that when research personnel are advanced to positions of management, they will be adequately trained for the new responsibility. At present, Canada has no such facility and it is felt that the lack of properly trained research managers is a serious obstacle to the continuous growth of a company. This need is, of course, not confined to the textile industry but applies to all industries that are interested in research.

Research Facilities

A list of projects and areas of research that are of interest to the textile industry has been given above. It remains now to consider how research in textiles can be carried on at a level capable of making a worthwhile contribution to the development of the textile industry.

There are in Canada at the present time a number of industrial, university and government laboratories, and laboratories in research institutes for conducting textile research. Many of these laboratories are well equipped and are capable of making a far greater contribution to the output of research than they are now doing. However, to achieve this objective, much more financial support is required so that the volume of research can be expanded to a level that will really make an impact on the progress of the industry. Textile research in Canada is not being unduly restricted from a lack of equipment or adequately trained personnel but from a serious shortage of funds to carry on the work.

The total expenditure (current plus capital) on textile research and development in Canada during 1966 by industry, government and universities was $3,844,000. This represents approximately 0.2 per cent of the total volume of sales of the entire textile industry. In relation to the activity in other countries, the total expenditure by the Canadian textile industry is low. It has been conservatively estimated that to maintain a competitive position over the next ten years, the textile industry in Canada should invest at least one per cent of gross sales in research. This would represent an increase of approximately five-fold over the present level.

There is also an imbalance in the amounts spent on the three types of research. As mentioned previously, about 92 cents out of every research dollar was spent during 1965 on development, 7 cents on applied research and 1 cent on basic research. It has been said of a large American company that more than 40 per cent of its present production and more than 60 per cent of its current profits are derived from products that have been introduced in the past 10 years. If the textile industry in Canada is to maintain an adequate flow of new knowledge and develop new products and processes to keep abreast with competition, a larger proportion of the research and development expenditure should be devoted to applied and basic research which has an applied objective in view.

Survey results show that whilst the total employment in all industrial research in Canada has shown an appreciable increase over the past two years, the employment of research personnel in the textile segment of the industry has decreased slightly. Prospects for the immediate future indicate a further decrease due to reductions in research budgets. This reflects the progressively decreasing profitability of textile manufacturing in Canada due in part to increasing wage

and production costs and to the loss of a greater share of the domestic market for textile products to imports from low-wage countries. No doubt, the long-standing preference of a large section of the industry for depending upon foreign sources for new ideas and processes is also a contributing factor.

In relation to the total amount of government funds being spent on all branches of scientific research in Canada, it appears that a disproportionately small amount is being invested in textile research. This is not entirely the fault of government although more could be done by governments to demonstrate to the textile industry the benefits to be gained from research. A good deal of responsibility for the situation must be borne by industry itself for in spite of schemes such as the Industrial Research and Development Incentives Act and the Program for the Advancement of Industrial Technology (PAIT) of the Department of Industry, the Industrial Research Assistance Program of the National Research Council and Defence Industrial Research grants from the Defence Research Board, only a very few companies in the textile industry appear to be availing themselves of this assistance. A reluctance on the part of industry to disclose to government details of proposed research programs has been stated to be the chief reason why more companies have not taken advantage of the various assistance schemes now offered by the Federal Government. If this situation is to improve, obviously some alternative method that is free from this major objection must be found for encouraging industry to invest in research and development.

Leather

It has already been pointed out that very little research and development work is being undertaken by the leather industry in Canada at the present time. This lack of an adequate research program is undoubtedly having an adverse effect on the progress of the industry. There are a number of reasons why this is so. The comparatively small size of the individual companies that make up the industry is probably one factor. The high cost of research is another. Some manufacturers do not appear to be sufficiently aware of the possible value of research in improving their products or in extending their markets.

To correct this situation there is general agreement that the leather industry needs an independent laboratory where research could be carried on and where other problems of interest to the industry could be dealt with.

At the present time there is no such laboratory in Canada. Furthermore, there are no facilities in Canada for training students in leather research and technology and this is thought to impose a serious limitation on the effectiveness on any research that might be undertaken in the leather field.

In the opinion of the industry, both of these needs could be met by setting up a small group consisting of two or three qualified persons at an educational centre and preferably at a university, where instruction could be provided and research could be carried out on behalf of the leather industry. If such a group could be assured of continuing financial support from government and industry for an initial period of say ten years, it is believed that this would make a tremendous impact on the leather industry in Canada both through the results of its research and by providing trained personnel. Examples of similar groups may be found in a number of other countries of the world such as England (Leeds), France (Lyon), Germany (Munich), Sweden (Stockholm), South Africa (Grahamstown), India (Madras) and the United States (Cincinnati).

SUMMARY

Textiles

Research and development is being carried on in Canada at the present time in the laboratories of some of the larger textile companies, in the textile departments of the National Research Council and the Ontario Research Foundation, by the Commercial Products Division of Atomic Energy of Canada, in some laboratories of the Defence Research Board and at two or three universities. The total volume of research and development in 1966 measured as a percentage of sales of the entire primary textile industry amounted to a little over 0.2%. In relation to similar activities in other countries, this percentage is low. To maintain a competitive position over the next ten years, it has been conservatively estimated that the textile industry in Canada should invest at least one percent of gross sales in research and development.

Probably not more than 2% of the companies that make up the textile industry are large enough to finance their own research and development programs. When the restrictions imposed by foreign owners upon Canadian subsidiaries are taken into account, the number is reduced still further. Co-operative or group research, although it has never succeeded in the past, does offer a possible solution to this problem.

Of the total amount spent in Canada during 1966 on textile research and development, approximately 95% of the funds were provided by industry, 4 to 5% by government and about 0.2% by universities.

A little over 100 scientists and engineers were engaged on textile R and D in 1966 and of this number about one-half had bachelors degrees, a third had masters degrees and the remainder held doctors degrees. In past years there has been a shortage of trained personnel, but this is not the case to-day. With the educational facilities at the university level which are now being developed in Canada, it is expected that there will be an adequate supply of scientists and engineers to satisfy the needs in this field of research for at least the next five to ten years.

A number of areas of future textile research are mentioned in this report No serious difficulties seem to have been encountered due to lack of equipment. The greatest need arises from a shortage of sufficient funds to conduct research at a level that is capable of contributing significantly to the progress of the textile industry in Canada. Present Federal Government assistance schemes have not been entirely successful due to the reluctance of industry to disclose details of research ideas and programs to the government. An alternative is required that is free from this objection.

Leather

It is known that only a very limited amount of research and development is being carried on by the leather industry in Canada and for this reason no statistics are available. No Canadian research institutes or universities are engaged in leather research and there are no educational facilities directed toward the leather field at the present time.

It has been recommended that consideration be given to establishing, jointly by government and industry, a small group of qualified persons, preferably at a university, where instruction could be provided and research undertaken on behalf of the leather industry. Similar groups now exist in many countries of the world.

The report outlines areas of research in the leather field which it is believed would be of benefit to the industry as a whole.

APPENDIX A

Statics on Research and Development in the Canadian Textile Industry

Table I:

Current Intra-Mural R & D Expenditures by Textile Industry in Canada Classified by Companies

(thousands of dollars)

	1963	1964	1965	1966
Wages and Salaries	1,670	1,847	2,179	2,148
Other	927	969	1,187	1,072
Total	2,597	2,816	3,366	3,220

Table II:

Capital Expenditures for R & D by Textile Industry in Canada Classified by Companies

(thousands of dollars)

	1963	1964	1965	1966
Land and Buildings	--	31	645	275
Equipment	168	573	410	222
Total	168	604	1,055	497

Table III:

Total Intra-Mural R & D Expenditures by Textile Industry in Canada Classified by Companies

(thousands of dollars)

	1963	1964	1965	1966
Current Expenditures	2,597	2,816	3,366	3,220
Capital Expenditures	168	604	1,055	497
Total	2,765	3,420	4,421	3,717

Table IV:

Canadian Sources of Funds for Intra-Mural R & D by Textile Industry - 1965

(thousands of dollars)

Reporting Company	4,269
Parent Affiliated and Subsidiary Companies	54
Government of Canada	
- R & D prime contracts	3
- R & D portion of procurement contracts	5
- Grants for R & D	42
Contract Work for Other Companies	18
Total	4,391

Table V:

Foreign Sources of Funds for Intra-Mural R & D by Textile Industry - 1965

(thousands of dollars)

Reporting Company	--
Parent, Affiliated and Subsidiary Companies	--
Contract Work for Other Companies	--
Other	30
Total	30

Table VI:

Extra-Mural Expenditures on R & D by Textile Industry

(thousands of dollars)

1963	137
1964	124
1965	128
1966	125

Table VII:

Canadian Recipients of Extra-Mural Payments for R & D by Textile Industry - 1965

(thousands of dollars)

Consultants and Commercial Laboratories	58
Other Companies	19
Non-profit Organizations	24
Industrial Research Institutes	9
Governments	1
Provincial Research Councils	12
Educational Institutions (research payments)	1
Total	124

Table VIII:

Foreign Recipients of Extra-Mural Payments for R & D by Textile Industry - 1965

(thousands of dollars)

Parent, Affiliated and Subsidiary Companies	2
Consultants and Commercial Laboratories	2
Total	4

Table IX:

Sources of Funds for Extra-Mural R & D by Textile Industry - 1965

(thousands of dollars)

Canadian Sources:	
- Reporting Companies	120
- Parent, Affiliated and Subsidiary Companies	8
All Foreign Sources	--
Total	128

Table X:

Payments Made and Received by Reporting Company for Patents, Licences and Technical "Know-How" by Textile Industry - 1965

(thousands of dollars)

Payments Made	
- Inside Canada	8
- Outside Canada	1,353
Payments Received from	
- Inside Canada	--
- Outside Canada	30

Table XI:

Current Intra-Mural R & D Expenditures in Textile Industry by Product Field - 1965

(thousands of dollars)

Food and Beverages	
- Beverages	76
Textiles	
- Synthetic	1,776
- Other	1,208
Paper Products (other than newsprint)	114
Machinery (other than agricultural)	132
Transportation	
-Guided missiles and Space vehicles	7
Chemicals and Chemical Products	
- Industrial chemicals	4
- Other	48
Other	1
Total	3,366

Table XII:

Current Intra-Mural R & D Expenditures by Field of Science, in Textile Industry - 1965

(thousands of dollars)

Engineering		
- Chemical	919	
- Electrical	13	
- Electronic	31	
- Mechanical	246	
- Other	1,295	
Total		2,504
Chemistry		777
Physics		47
Pharmacy		38
Total		3,366

Table XIII:

Current Intra-Mural R & D Expenditures in Textile Industry by General Field of Application - 1965

(thousands of dollars)

Space Travel and Communications	4
War and Defence	38
Other	3,324
Total	3,366

Table XIV:

Wages and Salaries and Current Intra-Mural R & D Expenditures per Employee Engaged in R & D in Textile Industry - 1965

(thousands of dollars)

Wages and Salaries per Employee	5.8
Current Intra-Mural Expenditures per Employee	11.0

Table XV:

Number of Persons Engaged in R & D in Textile Industry by Training - 1965

Scientists and Engineers		
- Bachelors	49	
- Masters	27	
- Doctors	19	
Total		95
Supporting Personnel		
- Technician	120	
- Other	154	
Total		274
Total Scientists, Engineers and Supporting Personnel		369

Table XVI:

Scientific Discipline of Employment of Scientists and Engineers Engaged in R & D by Textile Industry - 1965

Engineers and Technologists		
- Chemical and Food	15	
- Mechanical	8	
- Others	14	
Total		37
Scientists		
- Chemists	40	
- Physicists	2	
- Biological Scientists	1	
- Administrators	11	
- Others	4	
Total		58
Total		95

Table XVII:

Scientists and Engineers Engaged in R & D in Textile Industry by Type of Activity

Basic Research	1
Applied Research	7
Development	87
Total	95

Table XVIII:

Current Intra-Mural R & D Expenditures of Textile Industry by Type of Activity

	Expenditures		% of Total	
	1965	1966	1965	1966
Basic Research	$ 26,000	$ 83,000	1%	3%
Applied Research	244,000	341,000	7	13
Development	3,096,000	2,181,000	92	84
Total	$3,366,000	$2,605,000	100%	100%

* Section 18 - Table 2a

Table XIX:

Intra-Mural R & D Expenditures by Textile Industry in Canada Classified by Companies
(thousands of dollars)

	1966
Current Intra-Mural Expenditures	2,929
Capital Expenditures	1,087
Total	4,016

* Section 13 Table 31a

Table XX:

Employment and Sales of Textile Companies with R & D Expenditures - 1965

(number of employees & thousands of dollars of sales)

Employment	22,933
Sales	354,370

Table XXI:

Number of Establishments and Manufacturing Activity of Primary Textile Industry - 1965

	Value of Shipments of Goods of Own Manufacture	Number of Establishments
Cotton Yarn and Cloth Mills	$305,660,000	35
Wool Yarn and Cloth Mills	131,525,000	78
Synthetic Textile Mills	373,842,000	64
Knitting Mills	308,961,000	361
Other Primary Textiles	189,244,000	192
Miscellaneous Textiles Industry	208,125,000	283
Total	$1,517,357,000	1013

Table XXII:

Textile R & D Expenditures of Universities and Institutes - 1966-7

	Expenditures (etc)*
Basic Research	$8,000
Applied Research	nil
Development	nil
Total	$8,000

* Section 14, Table 34

Table XXIII:

Operating Expenditures of Federal Government on Textile Research - 1966

	Expenditures (etc)*
Basic Research	$23,800
Applied Research	35,700
Development	59,500
Total	$119,000

* [illegible] Table 11a

Table XXIV:

Manpower Effort on Textile Research Supported by Federal Government - 1966

(etc. man yrs)*

Doctors	2
Masters	1
Bachelors	1
Technicians	5

Source of Data:

Tables I to XVII inclusive, Table XVIII (1965 data) and Table XX, from Dominion Bureau of Statistics Catalogue No. 13-527, Industrial Research and Development Expenditures in Canada, 1965.

Table XXI from Canadian Textile Journal, Vol. 84, p. 36-37, September 15, 1967.

Table XVIII (1966 data), Table XIX and Tables XXII to XXIV inclusive from Company, Government and University Questionnaires, C.I.C. Survey.