

Science and the Universities

Claude Fortier

Four years ago, in a brief to the Prime Minister, the Royal Society of Canada emphasized (1) that

At no time in our history have we been confronted with so many problems needing science-based solutions. It is hardly possible to exaggerate the importance of the decisions that confront Canada in such areas as resource management, energy options, health care, food supply, pollution, transportation, and so on. Furthermore, the wisdom of the choices that we, as a nation, make in these areas will be dependent on the maturity, knowledge, versatility and stature of contemporary Canadian science and engineering.

These observations are equally valid today, not only in Canada but in the United States as well. As the principal source of highly qualified manpower, and as the site of a large proportion of all research and development, the universities in our two countries clearly have a key role to play. Their ability to play this role will depend largely on the financial support provided to the universities for teaching and research. However, even if this support were judged to be adequate according to current criteria, the university system could find itself severely impaired in its ability to serve national needs unless proper cognizance is taken of the demographic challenge facing our universities today.

The decline in the number of young people of university age that will take place during the present decade is not confined to the United States and Canada. It will also occur in other western industrial countries such as Germany,

France, Great Britain, the Netherlands, Denmark, Norway, and Sweden. The timing and the magnitude of the decline may vary from one country to another, although in the United States and Canada these two factors will be similar. The peak in the 18- to 24-year age group will occur in 1981 in the United States, 1982 in Canada; in the United States the de-

Summary. The university system in Canada, as well as its method of funding, was built on the expectation of growth. It is now necessary to consider what effect the expected decline in enrollment may have on the ability of the university system to serve national needs. Neither the government nor the universities have had any experience that would fit them for carrying out effectively, humanely, and economically the kind of contraction that may be required, while still maintaining the quality of education. Such an adjustment is going to require the best efforts of the universities and the two senior levels of government working in concert, as well as the support of the public. Parallels are drawn with the situation in the United States.

cline will be 23 percent, with the minimum occurring in 1997; in Canada the decline will be 21 percent, with the minimum in 1996. However, in both countries there will be wide variations in these factors. In Quebec, for instance, the peak year was 1980, and the decrease is estimated to be more than 32 percent, whereas in Alberta the peak will occur in 1983 and the drop is likely to be only about 11 percent.

Although migration within each country introduces considerable uncertainty in making demographic predictions for the states and the provinces, projections at the national level are likely to turn out to be essentially correct. Most of the 18- to 24-year-olds of 1998 are with us now. Any errors made in estimating immigration, emigration, and mortality are not likely to affect the national figures very much.

Effects of Declining Enrollment on Our Universities and Scientific Capability

What impact will these inevitable decreases in the 18-24 age cohort have on our universities? And more specifically, what will be the impact on our scientific capability? At this point we move from the realm of relative certainty to one of speculation, and even controversy. The divergence of views in the United States is typified in the July/August 1980 issue of the magazine *Change*, in which the editor has placed, side by side, two articles outlining two entirely different scenarios for the future of academe. One of these (2) supports the views expressed in the recent report of the American Council on Education (3) that there need be *no* decrease in overall enrollment, and there could even be a significant *increase*, if

some 12 schemes to recruit more students are brought into play. The other article (4) insists that university administrators must avoid hiding their heads in the sand and admit that there *will* be a substantial decline in enrollment, so that they can then get on with the business of learning how to cope with it.

The different views expressed in these two articles provide ample evidence of the difficulty of predicting the future. If further evidence is needed, all we have to do is look back at the predictions that were being made in the early 1960's as to what the enrollments would be today. In some cases these turned out to be in error by as much as 100 percent.

Instead of trying to predict the future, it would seem wiser to rephrase our questions and ask what impact the inevitable decreases in the 18-24 age cohort *could* have on our universities, and what

The author is chairman of the Science Council of Canada, 100 Metcalfe Street, Ottawa, Ontario K1P 5M1 and head, Department of Physiology, Faculty of Medicine, Laval University, Quebec G1K 7P4. This article is adapted from a paper presented at a symposium on "The Other Frontiers of Science," held at the AAAS annual meeting in Toronto, 3 to 8 January 1981.

could the impact be on our scientific capability. If, in answering these questions we try to be as objective as possible and avoid indulging in wishful thinking, we should be able to see more clearly the steps that need to be taken to ensure that our universities will be able to fulfill their true role in society.

The onset of the decline in the number of young people of university age occurs at a time when, for over a decade, our universities have been displaced from the high pedestal they occupied during the post-Sputnik era of the 1960's and have been contending with budgets that were less than adequate to keep up with the ravages of inflation. Under the circumstances, it is not surprising that the academic community has become preoccupied with the purely financial aspect of their situation. In Canada, private universities are a phenomenon of the past. Today all universities depend for their existence on operating grants provided by the provincial governments, and these are determined, in large measure, by student enrollment. One observer, commenting (5) on the academic scene in Ontario writes:

Desperate to conserve both jobs and money in the face of an apprehended decline in enrollment, some universities have already resorted to lowering admission standards and debasing the quality of their undergraduate programs.

And lest anyone should think that the phenomenon is confined to this side of the border, George W. Bonham, president of the Council on Learning in the United States, has recently commented (6) that,

It must surely be recognized by the clear-minded that the number of academic institutions that now carry on any selective admissions policy is rapidly diminishing.

The lowering of admission standards is not the only way in which the quality of university education is being jeopardized. To quote again from our commentator (5) on the Ontario scene,

Spending restraint is not centrally coordinated, but left up to each university acting alone. Within each institution, the administration is largely beholden to the university senate, which is dominated by faculty, and the last place the faculty will look for budget cutbacks is in reduced teaching posts and lower salaries. Instead, they will first loot the libraries, plunder scientific equipment, and allow physical plant to deteriorate. The inevitable results will be poor teaching and worse research.

To substantiate this indictment, he quotes from the annual *Report of the Ontario Council on University Affairs* to show that in the last 4 years the value of books and periodicals purchased by

Ontario universities out of their operating income has dropped by more than 18 percent in current dollars and that these universities are spending only slightly more than half of the money that would be required to maintain their existing inventories of equipment and furniture.

If this is the situation that exists while the university-age cohort is still growing, what could the consequences be if enrollment were to decline by, say, 20 percent or more, in parallel with the decline in the age group? I will leave this to your imagination.

If we try to come to grips with this situation, it soon becomes apparent that over the last 20 years, during which university enrollment in Canada has increased dramatically, the whole university system has been built on the expectation of growth, and that the various arrangements that have been made with government to provide financing have been based on this assumption. It is therefore imperative to recognize that neither our governments nor our universities have had any experience that would fit them for carrying out effectively, humanely, and economically, the kind of contraction that could arise, while still maintaining the quality of university education. It is evident that the universities would not be able to manage such a contraction on their own. It is going to require the best efforts of the universities and the two senior levels of government, working in concert, as well as the support of the public. Unless the methods of financing and administering our universities are adapted to the 1980's, instead of the 1960's, the decline in the quality of so-called higher education may lead our young people to turn to other forms of postsecondary education or to seek a university education elsewhere. This could then result in declines in enrollment even greater than the decline in the size of the age cohort. We could, in fact, have the makings of a chain reaction, leading to a situation in which our universities would no longer be able to serve the needs of the nation. Insofar as science and engineering are concerned, it must be recognized that the complex scientific, technological, and economic problems of the present and the future cannot be met by using second-rate institutions to generate new concepts and to train the highly qualified manpower required.

It was these concerns that led the Science Council of Canada, nearly 4 years ago, to undertake an examination of the implication of the passage of the

"baby boom" on the quality of university research and the training of scientists and engineers. This culminated in the publication, about a year ago, of the report *University Research in Jeopardy: The Threat of Declining Enrolment* (7). In this article I draw on this report from time to time.

The thesis behind the report is that if excellence in teaching and research is to be preserved and enhanced, a threefold approach must be used. First of all, we must ensure a steady influx of talented young investigators into academic research. Second, steps must be taken to eliminate some of the weaknesses that were allowed to develop in our university system during the period of essentially uncontrolled growth in the 1960's. Finally, we must be able to convince our young people that if they graduate, whether it be with a B.Sc. or a Ph.D., they will be able to play a role in our society that is in keeping with their education.

The Need for Young Investigators

With regard to the first point—the need for young investigators—it is interesting to note that this was the principal theme of the report *Research Excellence Through the Year 2000* (8), published a little over a year ago by the National Academy of Sciences. The subtitle of that report is *The Importance of Maintaining a Flow of New Faculty into Academic Research*.

The main recommendation of the Academy's report was that the National Science Foundation should establish a program of Research Excellence Awards tenable for a maximum of 5 years. These would be open to existing faculty members on condition that the universities concerned would utilize the funds so released to hire additional staff in the recipients' departments.

A recommendation of similar intent, but visualizing a somewhat different mechanism, was made by the Science Council of Canada, namely, that the awards be made, not to an existing faculty member but to a young person who would have all the qualifications, and most of the privileges, of an assistant professor, but who would not be an actual member of the faculty. It was gratifying to us that when our report was in press the Natural Sciences and Engineering Research Council released its *Five-Year Plan* (9) which, among other things, proposed a similar scheme. The first awards in its *University Research*

Fellowships program have already been made.

The proposal for the establishment of such awards was only one of several recommendations in the Science Council report that were directed at bringing about the entry of talented young people into careers of teaching and research, even when, in terms of the number of students to be taught, there might be no demand for their services. Indeed, because we had placed so much emphasis on this, some of our readers gained the impression that the Science Council believed that older scientists and engineers are less competent than younger ones. Of course, the idea that competence decreases with age is pure heresy, particularly in the United States at present. Actually, that view had been pretty well discredited long before the outcome of the recent presidential campaign.

But we do not have to assume that older researchers are less competent than younger ones to see that provision must be made for the entry of young people into the system.

A few years ago the National Research Council of Canada made a study of its successful grantees over a period extending back to 1970 (10). It was found that at the beginning of the period the dropout rate for older grantees was more than twice that of the younger ones, but toward the end of the decade the dropout rates for the two groups were about the same. While the system was growing, dropouts, for whatever cause, were replaced by young researchers. But if faculty appointments should be frozen, so that dropouts from active participation in research are not replaced, our university research capabilities are bound to deteriorate.

Although the Natural Sciences and Engineering Research Council has accepted some of the responsibility for putting young people into university research, through the agency of its University Research Fellowships program, the universities too, must accept some of this responsibility. One method at their disposal is to remove obstacles to the turnover of faculty, particularly of faculty having the rank of assistant professor and higher. Unfortunately, the subject of faculty turnover has been somewhat confused as the result of Statistics Canada using the term "replacement demand" to mean the sum of the projections of retirement rates and mortality rates. This practice gives a very incomplete and distorted view of the number of faculty positions vacated or likely to be vacated each year, and is certain to

cause more anxiety than need be on the part of aspirants to academic appointments. There is reason to believe that the true replacement rate would be considerably greater if cognizance were taken of the number of faculty leaving the academic sector. Unfortunately, the studies that have been made on this are far from satisfactory. We therefore recommended that the universities, through the Association of Universities and Colleges of Canada and the Canadian Association of University Teachers should seek funds from the federal government to make a study of the magnitude and nature of the turnover of university faculty and to uncover the factors that encourage or inhibit it.

No action has been taken on this up to now. One result is that the future financial requirements of programs such as the University Research Fellowships scheme of the Natural Sciences and Engineering Research Council, which are designed to ensure an adequate flow of new blood into academic research, cannot be made with the degree of confidence that should be associated with the expenditure of large amounts of public funds.

But the lack of knowledge of the precise nature of the flux of this type of highly qualified manpower can have other serious consequences. Whereas in some disciplines there is a lack of openings for young faculty because of a decline in the number of students to be taught, in others it is getting difficult to find qualified candidates to fill the faculty openings that are occurring because of the attractions of alternative employment in the private sector. In the absence of reliable data little progress can be made in manpower planning.

Elimination of the Weaknesses of the 1960's

That weaknesses developed in our university system during the 1960's is not surprising. In that 10-year period, full-time university enrollment in Canada increased by a factor of 3.1; in the United States the corresponding figure was 2.0. Full-time graduate enrollment increased by a factor of 5.1, as compared to 2.9 in the United States. But Canada had started the decade well behind, so that in 1970 we still had only 30 percent as many graduate students per capita as the United States. In spite of this, two-thirds of our universities were offering the Ph.D., compared to only one-third in the United States.

In a report on the state of research in Canada, the Organization for Economic Cooperation and Development (OECD) referred to this period as one of "uncontrolled expansion," and went on to observe (11) that,

Such a rapid expansion of university research from such a narrow potential suggests that, in contrast with the United States, the university system was not in a position to . . . produce scientific results commensurate with the investments from which it benefited.

Many of the weaknesses created in the 1960's are still with us. One of the most serious is the absence of a true partnership between the federal government and the provinces in dealing with university education and research. In spite of what, in retrospect, can only be called the generosity of both levels of government, academic research as we know it today was allowed to grow in a *laissez-faire* manner. Although the provinces provided the salaries of the professors and the basic facilities and overhead, they showed little direct interest in research. At the same time, the national granting agencies, which supplied most of the direct support for research, scrupulously avoided any actions that might be interpreted as interference with provincial jurisdiction over education. The anomaly of this situation was easily overlooked during the heyday of post-Sputnik expansion; it cannot be brushed aside today.

In the absence of effective partnership in dealing with the problems that our universities will have to face during the decade of the 1980's, the prospects for the preservation of excellence in teaching and research would be bleak indeed. A hopeful sign is that the provinces have been taking a greater interest in the direct support of university research, as they begin to appreciate how it can contribute to the achievement of provincial objectives and to the carrying out of provincial responsibilities. Provided the two senior levels of government follow the path of consultation, rather than confrontation, there is cause for optimism.

Although lack of coordination at the federal-provincial level may have contributed to the fragmentation of scholarship and research, the universities themselves have to accept some responsibility for the status quo and have a duty to do something about it. There seems to be little doubt that if excellence is to survive there will have to be some degree of specialization among our universities, even to the extent of arranging, in some cases, for the transfer of staff and resources from one university to another.

This, of course, would not apply to the basic core of courses that have to be offered by any university, but rather to specialized courses and programs which may have been initiated in one university in order to fulfill a need and then are taken up by near-by universities in the hope of attracting a few extra students.

Although competition among universities for the taxpayer's dollar may appear to be an important, if not a dominant, theme in academe today, one also finds, occasionally, examples of real cooperation. Such a case was the decision of the chemistry departments at the University of Waterloo and the University of Guelph, with the blessing and support of the administrations of these two universities, to form a joint graduate department, the Guelph-Waterloo Centre for Graduate Work in Chemistry.

Because of the success of the Guelph-Waterloo experiment, it was referred to in the Science Council report (7) as an example to be emulated. Whether it can be attributed to the influence of our report, or simply to the wisdom of the people concerned, two additional joint graduate departments are now under way: The Guelph-Waterloo Program for Graduate Work in Physics, and the Ottawa-Carleton Institute for Research and Graduate Studies in Chemistry. There is plenty of scope for future initiatives of this type; there are seven cities in Canada where there are two or more universities.

Availability of Careers

The question of career availability remains as the third component of the threefold approach that must be taken if our universities are going to respond successfully to the demographic chal-

lenge. If academic science and engineering are to make a worthwhile contribution to society it must be through the quality and nature of university research and by the entry of well-educated scientists and engineers into effective careers. Most of these careers must be in industry, and so we have to come to grips with the problems, opportunities, and challenges at the university-industry interface.

The essence, and indeed the strength, of academic research lies in the ability of its practitioners to undertake independent fundamental studies that are not restricted by their immediate applicability in a particular situation or context. This does not mean that university research should be conducted in isolation from the outside world. On the contrary, one of the recommendations of the Science Council report is that a major campaign should be undertaken to encourage university faculty, particularly those in engineering and the applied sciences, to spend a year in industry on one of the Senior Industrial Fellowships provided by the Natural Sciences and Engineering Research Council. In this way university researchers can gain a better appreciation of the problems and opportunities that lie in the private sector, and of how university research can be related to them. But, once back in their university laboratories, they must not devote all their time and expertise to tackling the immediate and specific problems of industry. This would sooner or later deplete their intellectual capital, and they could end up simply providing government-subsidized technical services in competition with commercial concerns which make no pretence of doing research.

A crucial problem for academic research is how to maintain and increase

its capital through basic investigations and, at the same time, provide society with the fruits of research.

This is not a new problem, but the importance, indeed the urgency, of finding solutions has never been greater. I say "solutions" in the plural advisedly, because there is no single recipe that can be devised by some central body and then applied successfully across the country. What the central bodies must do, however, is to see to it that, in introducing new programs designed to bring about closer interaction between universities and industry, they do not compromise the long-term health and capabilities of research by using financial rewards to entice university scientists and engineers away from what they can do best. These new schemes must be in addition to, and not instead of, programs for the support of basic research in science and engineering.

References and Notes

1. *Science in Canada: A Brief to the Prime Minister* (Royal Society of Canada, Ottawa, March 1976).
2. C. Frances, *Change* 12 (No. 5), 19 (1980).
3. *College Enrollment Trends: Testing the Conventional Wisdom Against the Facts* (American Council on Education, Division of Policy Analysis and Research, Washington, D.C., 1980).
4. F. E. Crossland, *Change* 12 (No. 5), 18 (1980).
5. R. Leishman, *Report* 3 (No. 9), 9 (1980).
6. G. W. Bonham, *Change* 12 (No. 5), 8 (1980).
7. *University Research in Jeopardy: The Threat of Declining Enrollment* (Science Council of Canada Report No. 31, Ottawa, December 1979).
8. *Research Excellence Through the Year 2000: The Importance of Maintaining a Flow of New Faculty into Academic Research* (Commission of Human Resources, National Academy of Sciences, Washington, D.C., 1979).
9. *A Five-Year Plan for the Programs of the Natural Sciences and Engineering Research Council* (Natural Sciences and Engineering Research Council, Ottawa, 1979).
10. A. L. Derikx, in *Background Papers for a Workshop on Optimization of Age Distribution in University Research* (Science Council of Canada, Ottawa, 1977), p. 1.
11. *The Research System*, vol. 3, *Canada, United States* (Organization for Economic Cooperation and Development, Paris, 1974), p. 51.
12. I thank D. J. LeRoy, Senior Science Adviser, for invaluable assistance. Please send requests for reprints to the Ottawa address.