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MOSST

HIGHLY QUALIFIED MANPOWER

PROJECT

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PROJECT

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The Ministry's efforts of monitoring federal science expenditures is often rendered difficult due to the lack of appropriate information against which to assess requests for funding. In an age where growing numbers of priorities tend to compete for limited public funds, it has become essential to improve the documentation of funding requests. The HQM model project was undertaken to help MOSST personnel to carry out their evaluation function more effectively.

The key objective was to come to grips with information on the demand for scientific personnel, their qualifications, age structure and replacement needs, on the demand for university graduates and many other related aspects. To serve this requirement,

the HQM project was started in the fall of 1976.

The objectives of the project have now been met: the Ministry has a fully computerized HQM data bank and projection model, the first and only of its kind in Canada. The model provides annual information from 1971 to 1985 on the demand for some 70 HQM occupations, and on the demand for university graduates, by degree level and some 70 fields of study. In addition, it contains a university sub-model, which provides similar information on about 60 different teaching specialities.

The system was conceived and developed as an on-going simulation tool, rather than merely a one-shot effort. It does not produce "predictions", but projections that are conditional on specifically articulated assumptions. Policy simulations can be carried out by posing different assumptions for the economic, technological, demographic or several other technical variables.

To a certain extent, this model was made possible by the availability of certain surveys and data systems that had not existed before. Reference is made to the HQM post-censal survey that was initiated and sponsored by MOSST, and to the administrative records of the educational system kept by the Education Division of Statistics Canada. In the occupational area, the new occupational classification system used in the 1971 Census was of crucial importance. The occupational employment surveys (OES) of Statistics Canada have also been of some help. The availability of material that is basically of a "cross-sectional" (as opposed to "time series") nature dictated the use of an input/output type of approach for the basic model method. However, the coefficients, or in this case, the relationships between HQM and other manpower within a given industry, are not assumed to be constant, but are varied whenever quantifiable information is available.

Another innovative feature of the model is its attrition method. This is a sophisticated perpetual inventory approach, with retirement rates estimated from census data rather than explicitly assumed, as is traditionally the case.

Without going into any details of the method, the model is based on other innovative approaches, such as the conversion of occupational demand into demand for university graduates, by use of a probability table indicating the inter-disciplinary shifts (e.g. an engineer entering the occupation "government official").

Two of the basic inputs into the model are solutions of the CANDIDE model (with MOSST specifications), yielding employment growth by industry; and demographic projections, supplied by Statistics Canada. Special projections were developed by MOSST Forecasting Division to estimate university student enrolment (taking account of the growing importance of part-time students, who come from rapidly expanding

age cohorts); and health personnel requirements (which are affected by the progressive aging of the population, needing relatively more health care).

The first set of model solutions indicates a number of interesting trends in the demand for highly qualified manpower. From now to 1985, the demand for health occupations is estimated to rise by some 17 per cent as compared with 20 per cent for total employment in all occupations and all industries. It should be remembered that the health sector growth in the future is likely to be governed by demographic requirements and constrained funding. The level of health services has shifted to a significantly higher plane over the past decade, with the introduction of health schemes and other improvements. It would not be reasonable to expect the high growth rates of the past decade to persist. The only additional source of demand strength is the anticipated aging factor of the population, and some persisting shortages in some areas (e.g. dentistry, rehabilitation medicine).

As far as education is concerned, the picture is a familiar one. The demand for teaching personnel is expected to decline by some 12 per cent from 1975 to 1985, mostly due to the declining demand for secondary teachers. The demand for elementary teachers will grow again by the beginning 1980's (as a consequence of births which have begun to increase again). The demand for university teachers will begin to fall by the mid-1980's, although the demand picture varies significantly by field of teaching.

Demand growth in the applied sciences, in commerce and administration, and in the life sciences will be relatively high to 1985. These are occupations where demand is basically affected by technological factors and changes in the industrial structure that favour their employment.

The model converts these occupational trends into requirements for university graduates. The model

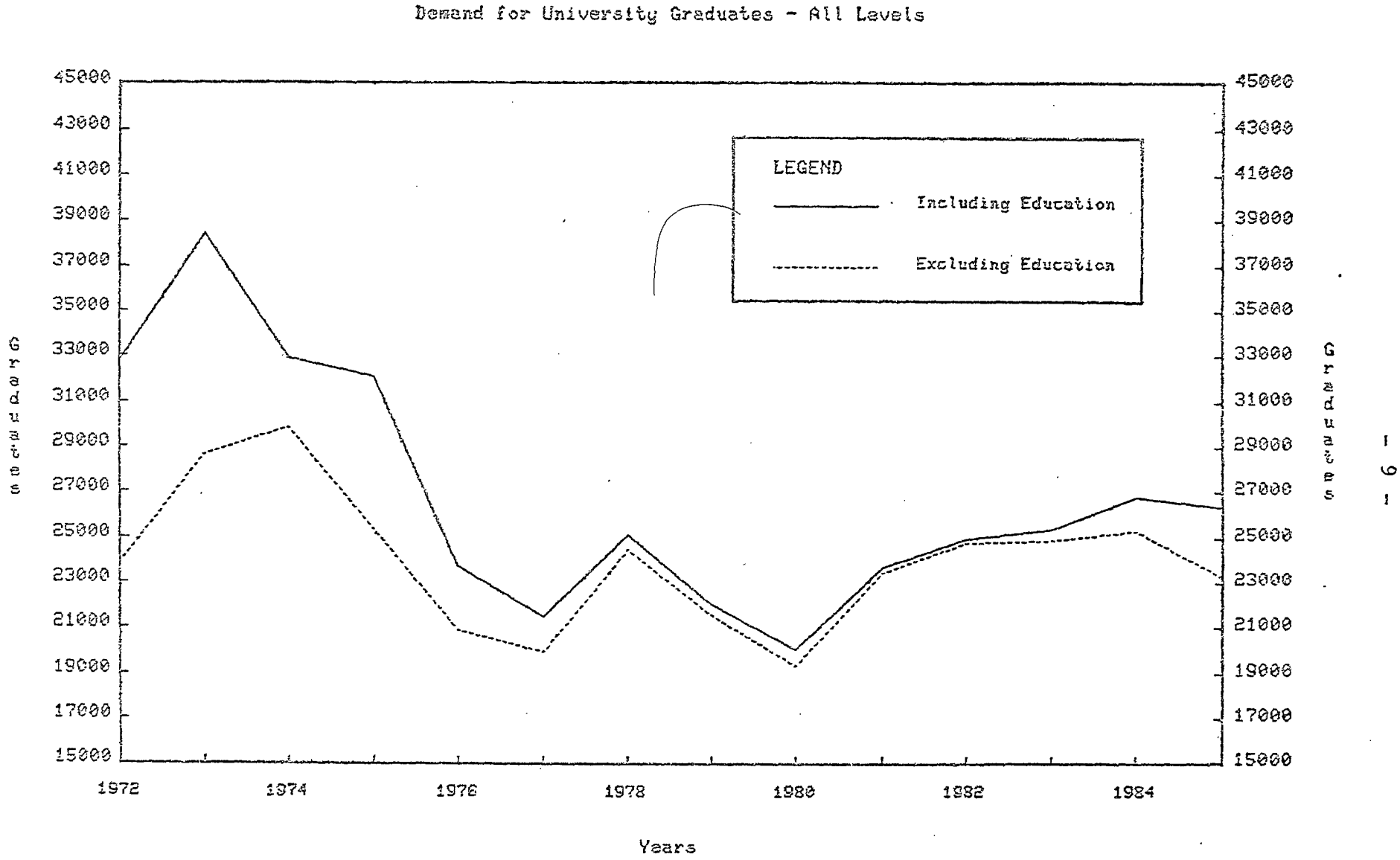
solutions show that there are two overriding influences that seem to govern the demand for university graduates in the various fields of study. The first is the pervasive effect of what happens to manpower requirements in the education sector. The largest single block of Canada's highly qualified manpower is concentrated in this sector, but this is the sector that is most directly and most severely affected by demographic changes, especially at the elementary and secondary levels. While the total number of births has already begun to rise again (in fact, at an earlier point and at a substantially higher rate than was predicted in the latest population projections), the full effect of this increase will not be felt on the demand for elementary teachers until the early 1980's. Secondary enrolment is still declining, causing major adjustments in the requirements for teachers. Demand for graduates from occupations other than teaching in the education sector is also weak. Traditionally, these teaching and non-teaching occupations in the education sector

absorbed significant number of university graduates, but this source of demand has completely disappeared, for the time being (see Chart I).

The demand for Ph.D's is basically governed by the demand for university teaching. While enrolment growth and the derived demand for professors is much less dependent on demographic factors, a slowdown in the demand for professors and thus for PhD's in many fields of study has emerged. This slowdown in growth can be ascribed to several factors, such as the extremely high recent rates of growth in the professoriate; the slowdown in the growth of enrolments; and the tightening of the budgets of the universities.

The other set of influences that govern the demand for university graduates are more general, more pervasive, and less drastic than the demographic effects. Chart I indicates that the demand for graduates arising from occupational growth other than in the education sectors displays a more orderly

CHART I


Demand for University Graduates - All Levels
LEGEND
Including Education
Excluding Education
Graduates
45000
43000
41000
39000
37000
35000
33000
31000
29000
27000
25000
23000
21000
19000
17000
15000
1972
1974
1976
1978
1980
1982
1984
Years

growth path, with much less volatility. The main influences on this demand are the growth of the economy, the changes in the industrial structure, technological development, changes in the age structure of the total population, etc. Depending on the particular economic growth assumptions, the model also indicates that the demand for graduates is sensitive to business cycle conditions.

The demand estimates for university graduates are also affected by rising requirements for educational qualifications. In the work underlying the model, the trends in degree requirements were examined in each occupation, and it was found that in those HQM occupations where not every incumbent already has a degree, or even needs a degree, the proportion of degree holders is rising. Applying this behaviour of the recent past to the projections, the demand for university graduates is raised considerably. While there is no hard evidence to support this phenomenon of educational upgrading in a precise manner, it is felt that, in practice, it

might even be more pervasive than has been assumed in the model. The solution displayed in chart I indicates an annual demand for graduates (all levels, all fields), arising out of HQM occupations only, of some 28,000. The upgrading factors used in this estimate contributes about 4,000 graduates to this demand. The potential for educational upgrading of several HQM jobs is, however, substantially higher, particularly in such fields as computer science, general business administration, management occupations, accounting, technical sales, farm management, and many others. These are all HQM occupations (i.e. occupations needing a high level of formal education and vocational preparation) that currently have large proportions of incumbents without university education. The demand potential for graduates in these occupations is probably substantially larger than estimated in the current model solution, but the upgrading factors are difficult to quantify. The extent of upgrading in these occupations is probably as much a function of business conditions as it is a function of replacement and growth demand trends.

In 1975, the latest year for which there are data, it appears that the university system turned out some 74,000 BA's, some 10,000 MA's, and some 1,700 Ph.D's. However, these are not all potential job seekers, since many have jobs already (having obtained their degrees on a part-time basis); also, large numbers go on to further studies, and foreign students leave the country. Excluding those categories, and adding Canadians returning from studies abroad, the figures for 1975 are estimated as 55,000 BA's, 6,000 MA's, and 1,500 Ph.D's. These are still sizeable numbers in relation to HQM demand, but a number of factors should be considered:

- the demand potential is probably higher than indicated in the current solutions. A test solution, assuming a much more rapid upgrading of educational standards than is perhaps likely to occur, indicates that there could be from 35,000 to 40,000 HQM jobs for graduates.

- many students that are potentially available do not enter the labour market.

- included in the above degree output by the universities are some 20,000 degrees in the "education" fields alone! The number of job openings for graduates with degrees in education is, of course, substantially less than that number (estimated at about 1,000 annually to 1985. In fact, the number of "education" degrees granted in recent years has been rising).

Comparing recent supply data with HQM demand estimates leaves the impression that the labour market is in serious imbalance. Some commentators have drawn the conclusions that the universities (a) turn out too many graduates, and (b) train them in the wrong fields. But is there really a mismatch in numbers and skills? Two important factors should be considered before answering this question. First, apart from a general weakness in the overall labour market, due to business conditions, and apart from the special demographic influence on the underlying demand for teachers, the demand for HQM occupations

does not show any fundamental weaknesses. Why should it? The needs of society and of industry have not ceased to exist all of a sudden. Second, as a consequence of past demographic events, the economy is still in a situation where it experiences an extremely high rate of inflow of young people into the labour market. The supply at this end of the labour market would be straining the absorptive capacities of the economy even under normal circumstances. Would this situation be improved if fewer people went to university, and received different skills? Of course, not. On the contrary, in comparison to others, university graduates have a superior chance of getting employment, and have much better opportunities to advance their later careers and their lifetime earnings.

Generally, it is unlikely that enrolment trends can be significantly adjusted by supply - demand conditions for the various fields of study. Should potential students be advised to take up chemistry instead of education, because the over-supply of

chemistry graduates is only 2:1, whereas in education it is 20:1? It is almost impossible to say that the chances of obtaining a job would be any better or any worse.

Analysis of the various trends by field of study shows that the over-supply in the "soft" sciences is substantially higher than in such fields as engineering, medicine and other applied or health sciences. However, it should be noted that these specialized faculties have capacity limitations that are in much closer accord with the demand for the output of their graduates. Many more applicants are usually turned away from these faculties than can be accepted.

Viewed from a different angle, the enrolments, and thus the demand for professors, in several fields of study are not exposed to the same kind of volatility as are the humanities, some of the social sciences, many of the basic natural sciences, and education.

Further, while the necessary adjustments for the university system as a whole are quite severe (and will become more so after the mid-1980's), this will not be the case for all fields to the same extent. Faculties of applied science, health, and portions of some of the others, while likely to experience some slowdown in growth of enrolment and faculty demand, will not be too seriously affected. They are likely to be able to fully maintain their research capacities, and to absorb new researchers and teachers at an adequate rate. Problems regarding research capacity and absorption of new entrants, especially for several years after the mid-1980's, will arise in the "soft" sciences.

At this stage of the project, it has become evident that the HQM model is an extremely useful and versatile tool, aiding in the analysis of HQM problems, and providing valuable assistance in the formulation of policy on the funding of research training. This is a completely new body of knowledge that had never been available in such a comprehensive

and internally consistent form before. The potential usefulness of this framework is considerably enhanced by the simulative and adaptive powers of the system, permitting the virtually instantaneous testing of challenging policy assumptions with complex and far-reaching ramifications in the occupational and educational dimension of the stock of highly qualified manpower.

The following are some of the more important policy areas that can benefit from the use of this model:

1) Research grants. As far as the granting councils are concerned, the estimates of the demand for university graduates by degree level and field of study could help improve the quality of the documentation of the annual budget planning. Also, the detailed information on the professoriate by teaching speciality contained in the

model should help in this process.

MOSST may wish to use this system not only in the assessment of the various annual funding requests by the councils, but also to view overall research funding trends in a longer-run perspective. This would enable the Ministry, for example, to anticipate emerging structural changes in the university system, and to formulate its own view on policy changes. This is preferable to a reactive policy stance, based on imprecise information. For example, MOSST is in a much better position, thanks to the information system, to assess, and comment on, the various submissions made to the Science Council Workshop on Aging.

2) Manpower planning and related policies. The model provides a framework for the analysis and conduct of manpower planning for the educational sector (universities in particular);

for the various professional associations; and for the government departments which have responsibilities in the areas of professional employment, education, and labour markets. The policy issues which could be evaluated are:

i) immigration policy - both to meet occasional HQM shortages, or skill gaps, and to balance demographic fluctuations which may arise on a cyclical basis due to the aging of the work force, major swings in the birth rate, etc.

ii) Retirement Policy - in view of the demographic lock-up effect in certain occupational groups, the model could provide measures of the effect of alternative retirement strategies, in terms of jobs made available through changes in attrition and in terms of

the effects of these policies on educational demands. It is foreseeable that to maintain a viable employment market in certain occupations, retirement policies may need to be altered over time, initially to make room for new entrants, and in the longer term to maintain a stock in the face of a decline in the number of new entrants available due to a decline in the birth rate.

Professional associations may wish to use the model to assess the effect of changing educational requirements for entry to their field, with regard to the available supply of university graduates. Finally, the federal government, and other levels of government, could benefit from the occupational and educational demand forecasts which set certain basic parameters for their conduct and approach to dealing with professional associations, the

labour market and the educational system. For example, the following departments will have a direct interest in the capabilities of the model:

- Health and Welfare
- Public Service Commission
- Statistics Canada
- Manpower and Immigration
- Agriculture Canada
- Secretary of State

One immediate issue which can be quantified by the model is the impact of various rates of employment growth in the federal government and other levels of government on occupational and educational trends. For example, the implications of the recent low growth posture by the federal government can be directly assessed in terms of occupational demand and educational demand.

3) Public Information Function. The HQM model provides timely and valuable information which can be of interest to the public at large and to business, labour and educators. The implication of the demand forecasts by occupation and by field of study are far-reaching in terms of the impact on Canadian society and should be made available for public discussion and consideration. The fact that the model is amenable to simulation, and because it is open-ended in that revised estimates, forecasts and distributions can be easily inserted, means that various professional groups and organizations can provide inputs to the model. This open-endedness, in turn, suggests that the model has the potential to grow in credibility and usefulness to a wider audience and for a wider range of applications. The outputs of the model are of immediate benefit to officers of

MOSST in replying to public enquiries concerning specific HQM occupations, the composition of demand and the outlook for university graduates in the various fields of study. Several such enquiries have already been received and answered in recent weeks (c.f. Canadian Geosciences Council; Canadian Association of Physicists; Royal Chemical Institute). Other groups have indicated special interest in the simulation powers of the model, and plan to supply additional information from their own data banks for further refinement of the projections (Canadian Medical Association; Canadian Nursing Association).

Viewed from a different angle, this project constitutes an integrated and internally consistent socio-demographic system. It systematically links together the various data sources and surveys, and traces the causal relationships of the different key variables. For this reason, the model can and

should serve as a vehicle for adapting future data collection, and for improving the relevance of some of the survey details, by the responsible departments, such as Statistics Canada, and Manpower and Immigration.

The results of the HQM model work should be published by the Ministry. The Forecasting Division has already carried out several simulations, and a document relating to the method of the model has already been written (see attached). Numerous requests for information on specific occupations and fields of study have already been made available, at the technical level, with the appropriate qualifications. A document dealing with the major results of the projections (including some alternative simulations) is in the process of preparation. A report on attrition of HQM to 1985 has also been prepared for the Workshop on Aging (Science Council) (see "Highly Qualified Manpower Attrition Estimates to 1985", attached).

One final recommendation is that the model work, for the time being, should be carried on at MOSST, on an ongoing basis (which should consume considerably less resources than were expended during the development phase). It should be noted in this connection that another (post-1981 Census) HQM survey will be needed in order to provide meaningful information for updating the model. The Forecasting Division chairs an Interdepartmental Committee on HQM forecasting which has recently met to consider recommending such a survey, but with the qualification that it should be simpler, more timely, and less expensive than the last one.