Ministry of State
Science and Technology Canada

Ministère d'État
Sciences et Technologie Canada

security classification
cote de sécurité

# THE DEMAND FOR ENGINEERING GRADUATES TO 1985

working paper

document de travail

# THE DEMAND FOR
# ENGINEERING GRADUATES
# TO 1985





MOSST
University Branch
June 1978

(This paper is based on the technological block of the MOSST HQM Data Base and Demand Model)

TABLE OF CONTENTS

# APPENDIX CONTENTS

# THE POTENTIAL DEMAND FOR ENGINEERS TO 1985

## Introduction

This report provides conditional forecasts of the demand for engineering graduates by academic field of study. These forecasts were produced by the Highly Qualified Manpower Demand Model (HQM Model) developed by MOSST, University Branch based on consultations and data provided by Statistics Canada, Manpower and Immigration and other governmental departments and with various professional associations including the Canadian Engineering Manpower Committee (CEMC). The CEMC provided welcome advice and critical comment on the methodology and data distributions associated with the engineering demand forecasts.

The HQM Model is innovative in the sense that it is possible, for the first time, to provide direct forecasts of the demand for university graduates by degree level for some 70 fields of study. Moreover, the Model was designed as a simulation model in order that the various assumptions and data distributions could be readily altered and the impact of these changes assessed. The Model was developed at MOSST as an aid to policy planning at the national level in the Highly Qualified Manpower area and as a back-drop to various studies and issues in science and technology. It is expected, however, that the results of the model will be of interest to many other users including academics, other government departments and professional associations.

Methodology

A comprehensive exposition of the methodology is contained in a separate paper.[1] The following descriptive outline of the methodology provides a brief overview of the content and structure of the model. Persons interested in a more rigorous treatment should consult the above mentioned methodology report.

As previously stated, the objective in developing the model was to prepare conditional forecasts of the demand for university graduates by degree level and by academic field of study for use in policy research work at MOSST and by other interested users.

In order to prepare these educational demand forecasts it was necessary first to prepare forecasts of occupational stocks for some 50 HQM occupations. In general, these forecasts were calculated using occupational employment coefficients for 17 industries based on 1971 census data and applying these coefficients to industry employment forecasts to 1985 provided by the CANDIDE econometric model. With respect to engineering occupations, the stock data were based on adjusted 1971 Census data. Here the contribution of the CEMC was essential in developing estimates that were consistent with Canadian Council

---

[1] Methodology: MOSST HQM Demand Model

of Professional Engineers (CCPE). In the case of health and education occupations, the occupational stocks were prepared using historical data from data bases at Health and Welfare and Statistics Canada and a detailed socio-economic calculation algorithm described in the methodology paper. For selected occupations, largely in the engineering field, the occupation/industry coefficients were adjusted over the forecast period, based on information from the Occupational Employment Survey of Statistics Canada.

Annual attrition estimates were calculated for each occupation starting with the 1971 sex and single year of age distributions, obtained from the census, and applying death and retirement rates and estimates of emigrants from the occupation. The annual replacement demand was added to the change in the stock to produce the number of new entrants required in the occupation each year.

These new entrant estimates were then adjusted, where appropriate, to determine the number of university graduates required in the occupation each year. The number of graduates required by occupation was multiplied by an educational field of study distribution which showed the educational background of entrants to the occupation.

This field of study matrix, as it is called, contains 70 fields of study for some 50 occupations for three degree levels (first professional or bachelor, masters, and doctorates). These data

were obtained from the 1973 Post-Censal Survey of highly qualified manpower and pertain to the census occupations in 1971 for persons under age 35.

The educational demand forecasts were calculated by summation of each of the 70 fields of study across all occupations for the three degree levels.

The model also contains a detailed allocation and attrition sub-system for the occupation "university teacher" to provide detailed estimates for some 71 teaching specialities at universities. This sub-model draws on detailed age and sex data contained in the Statistics Canada Full-time University Teacher File.

Features of the MOSST HQM Model

The HQM Model represents a step forward in projecting the demand for university graduates. In particular, the Model allows for the following considerations:

1. provides for similation of alternative assumptions at every stage in the calculations;

2. provides for occupational forecasts which take account of technological change and inter-industry shift effects;

3. provides occupational forecasts which are based on behavioural and socio-economic trends as in health, law and education;

4. provides a detailed attrition sub-system to calculate replacement demand by occupation based on death and retirement rates and emigration assumptions;

5. takes account of upgrading in educational requirements by occupation;

6. provides for occupational mobility in an innovative way by the use of an occupation/education matrix.

## The Requirements for Engineering Graduates

The statistical appendix to this report provides detailed tables showing the engineering occupational forecasts and the requirements for engineering graduates by field of study. This section of the report provides a summary of the results of a March 22, 1978 simulation and an analysis of these results.

## Summary of Requirements for Engineering Graduates

Figure 1 shows the requirements for engineering graduates for the period 1972 to 1985 and estimates of the supply of graduates for the period 1971-72 to 1975-76. These technical

Figure 1

REQUIREMENTS FOR ENGINEERING GRADUATES AND SUPPLY
(ALL DEGREE LEVELS)

| | Requirements | | | Supply | |
|---|---|---|---|---|---|
| | ENGINEERING GRADUATES FOR ENG OCCS | ENGINEERING GRADUATES OTHR OCCS | TOTAL ENGINEERING GRADUATES | ENGINEERING DEGREES AWARDED | ADJUSTED AVAILABLE SUPPLY |
| 1972 | 3,581 | 2,299 | 5,880 | 5,443 | 4,945 |
| 1973 | 3,729 | 2,462 | 6,191 | 5,416 | 6,349 |
| 1974 | 3,609 | 2,675 | 6,284 | 5,339 | 6,448 |
| 1975 | 4,131 | 2,715 | 6,846 | 4,917 | 5,968 |
| 1976 | 3,099 | 2,180 | 5,279 | 5,252 | 5,930 |
| 1977 | 2,608 | 1,943 | 4,551 | - | - |
| 1978 | 2,519 | 1,942 | 4,461 | - | - |
| 1979 | 2,799 | 2,178 | 4,977 | - | - |
| 1980 | 3,209 | 2,479 | 5,688 | - | - |
| 1981 | 3,350 | 2,579 | 5,929 | - | - |
| 1982 | 3,051 | 2,396 | 5,447 | - | - |
| 1983 | 2,697 | 2,226 | 4,923 | - | - |
| 1984 | 2,542 | 2,170 | 4,712 | - | - |
| 1985 | 2,553 | 2,234 | 4,787 | - | - |

SOURCE: MOSST: HQM MODEL (MARCH 22,1978 SIMULATION)

requirements for graduates are not necessarily reflective of day-to-day labour market conditions. Rather, the "demand" series reflect the particular economic scenario employed in preparing the projections. More specifically, the industry employment forecasts are based on a recent solution of the CANDIDE econometric model and reveal a pronounced business cycle component.

In terms of overall trends, the projection indicates an average annual requirement of about 5,100 graduates over the 10 year period 1976 to 1985. These requirements should not be interpreted as a specific labour market predictions, but rather reflect the assumptions of the particular model solution of March 1978.

The number of engineering degrees awarded and the adjusted supply are also shown in Figure 1. Adjusted supply was estimated by the Forecasting Division on the basis of data provided by Statistics Canada. These estimates attempt to show the number of new graduates available to the domestic labour market and includes immigration. Again, it is of interest to note that the adjusted supply and the total demand for engineering graduates have been in reasonably close balance during the first half of the decade.

Contribution of Replacements - Engineering Occupations

Figure 2 shows the projection of the number of engineers (occupation) from 1971 to 1985, the annual increase in this stock and the number of replacements annually as estimated by the attrition sub-system. The total number of new entrants required annually is calculated as the sum of the annual stock increase and replacement demand.

It should be noted that the new entrants to the engineering occupations will not necessarily have engineering degrees - their education profile is contained in the occupation/ education matrix. This point is underlined by the fact that the level of new entrants to the occupation "engineer" is significantly lower, (about 3,900 per year 1976 to 1985), than the requirements for engineering graduates (5,100 per year).

As shown in Figure 2, replacements represent a significant source of demand for new entrants within the engineering occupations, rising from 22.2 percent of new entrants in 1972 to 41.8 percent in 1985.

In the HQM model solution of March 1978, it was assumed that 90 percent of the new entrants required to fill engineering jobs would have a university degree. This proportion was based on a review of the membership lists of the Ontario, Quebec and Manitoba engineering associations.

Figure 2

OCCUPATION: TOTAL ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | TOTAL ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 46,079 | - | - | - |
| 1972 | 49,892 | 3,813 | 1,085 | 4,898 |
| 1973 | 53,875 | 3,983 | 1,108 | 5,091 |
| 1974 | 57,621 | 3,746 | 1,128 | 4,874 |
| 1975 | 62,008 | 4,387 | 1,154 | 5,541 |
| 1976 | 65,010 | 3,002 | 1,182 | 4,184 |
| 1977 | 67,398 | 2,388 | 1,209 | 3,597 |
| 1978 | 69,652 | 2,254 | 1,242 | 3,496 |
| 1979 | 72,278 | 2,626 | 1,277 | 3,903 |
| 1980 | 75,448 | 3,170 | 1,306 | 4,476 |
| 1981 | 78,776 | 3,328 | 1,341 | 4,669 |
| 1982 | 81,646 | 2,870 | 1,379 | 4,249 |
| 1983 | 83,994 | 2,348 | 1,417 | 3,765 |
| 1984 | 86,092 | 2,098 | 1,459 | 3,557 |
| 1985 | 88,175 | 2,083 | 1,499 | 3,582 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

## Engineering Graduates' Share of Total Demand for Graduates

Figure 3, below, shows the total demand for university graduates to fill all HQM jobs for the period 1976 to 1985. As can be seen in this table, engineering graduates required for all HQM occupations represent 17.5 percent of the total demand for graduates. In comparison, between 1971-72 and 1975-76, engineering degrees awarded represented about 5.9 percent of the total degrees awarded.

Figure 3

DEMAND FOR UNIVERSITY GRADUATES 1976 - 1985

| | |
|---|---|
| Total university graduates required | 290,000 |
| Engineering graduates required | 50,800 |
| Share of the total | 17.5 percent |

## The Occupational Source of Demand for Engineering Graduates

Figure 4, below, shows the occupational groups requiring engineering graduates during the 1976 to 1985 period. Engineering occupations are expected to generate 56.0 percent of the total demand and other HQM occupations, 42.8 percent. University teaching is expected to provide about 1.2 percent of the employment opportunities for future graduates.

Figure 4

DEMAND FOR ENGINEERING GRADUATES BY OCCUPATIONAL GROUP

1976-1985

| Occupational Group | Number of Graduates | Percent of Total |
|---|---|---|
| Engineering occupations | 28,427 | 56.0 |
| University Teaching | 624 | 1.2 |
| Other HQM Occupations | 21,703 | 42.8 |
| TOTAL | 50,754 | 100.0 |

Engineering Occupations and Total Employment*

The relationship between total employment, HQM employment and the number of engineers (occupational stock) is shown in Figure 5 for the years 1976 and 1985. It is projected that total employment will increase by 23.9 percent over this period of time. In comparison, the stock of HQM jobs is expected to increase by 18.6 percent and the number of engineers by 35.7 percent. It should be noted that the growth in the stock of HQM jobs is affected substantially by the depressed outlook for education jobs. If education occupations are excluded, HQM occupations are projected to increase by 28.9 percent between 1976 and 1985.

---

* It should be noted that these data represent the stock of jobs (occupations) and not the requirements for engineering graduates

Figure 5

GROWTH IN EMPLOYMENT AND THE NUMBER OF ENGINEERS

1976 and 1985

(thousands of jobs)

| | 1976 | 1985 | Growth |
|---|---|---|---|
| Total Employment | 9,558.0 | 11,847.0 | 2,289.0 |
| HQM Occupations | 1,439.8 | 1,707.0 | 267.2 |
| Number of Engineers (stock) | 65.0 | 88.2 | 23.2 |

## Analysis of Supply of Engineering Graduates

The HQM model does not provide forecasts of the supply of universities graduates. Such forecasting is a difficult theoretical problem due, in part, to possible switching between fields of study, and to the difficulty of projecting enrolment participation rates and forecasting immigration by intended occupation and field of study. At the same time, there are considerable practical problems in securing historical estimates and distributions that are required for such forecasts. However, an attempt has been made to estimate "adjusted supply" which is intended to represent the number of graduates available to the labour market during the period 1971-72 to 1975-76. Figure 6 shows the composition of the adjusted supply of engineers during this period of time.

As the Figure shows, the number of engineering degrees awarded is the base figure from which is subtracted those students who

were part-time graduates*, foreign students returning home, and graduates who are continuing their studies on a full-time basis. The result of these calculations yield an estimate of the available domestic supply. To this supply must be added the Canadians who are returning from abroad with an engineering degree and immigrants who have entered Canada with engineering degrees.

As the estimates in Figure 6 show, the adjusted supply of engineers exceeds the number of degrees awarded in every year and, on average, by some 16.2 per cent.

Figure 6

ANALYSIS OF SUPPLY OF ENGINEERING GRADUATES
(1972 - 1976)

| | | 1972 | 1973 | 1974 | 1975 | 1976 |
|---|---|---|---|---|---|---|
| | DEGREES AWARDED | 5,443 | 5,416 | 5,339 | 4,917 | 5,252 |
| | PART-TIME GRADUATES | 184 | 217 | 245 | 239 | 253 |
| LESS | FOREIGN STUDENTS RETURNING HOME | 427 | 408 | 368 | 315 | 319 |
| | GRADUATES CONTINUING EDUCATION | 979 | 902 | 841 | 782 | 858 |
| EQUALS | AVAILABLE DOMESTIC SUPPLY | 3,853 | 3,889 | 3,885 | 3,581 | 3,822 |
| ADD | CANADIANS RETURNING FROM ABROAD | 392 | 390 | 379 | 331 | 362 |
| | IMMIGRANTS | 1,700 | 2,070 | 2,184 | 2,056 | 1,746 |
| EQUALS | ADJUSTED SUPPLY | 5,945 | 6,349 | 6,448 | 5,968 | 5,930 |

SOURCE: STATISTICS CANADA AND ESTIMATES BY UNIVERSITY BRANCH, MOSST

* It was assumed that part-time graduates were already employed.

Sensitivity Analysis of the Engineering Occupation Forecasts

Since the HQM Demand Model is a simulation model, it is possible to vary certain key assumptions and examine the impact of these changes. Of particular interest is the extent of the inter-industry shift effect and the effect of technological change on the occupational projections. The shift effect occurs because all industries do not experience the same rate of employment growth. Technological change is reflected in changes in the occupation/industryt coefficients in particular industries. The results of changes made to the rates of employment growth and the coefficients are shown in Figure 7.

As can be seen in Figure 7, Assumption I represents the Control Forecast of March 1978, with a changing industrial structure and some rising occupation/industry coefficients. Assumption IV represents the number of engineers that would be required if the industrial structure and the occupation/industry coefficients were held constant at the 1975 level. The difference between Assumption II and Assumption IV represents the effect of an inter-industry shift (the number of engineers required due to disparate growth by various industries as forecasted by the CANDIDE model) which amounts to some 6,800 engineers, by 1985. Similarly, the effect of technological change can be calculated by comparing Assumption III to IV, which indicates that the changes in the occupation/industry coefficients contributed some 1,800 engineers to the forecasts. The interaction of these two effects, as revealed in the Control Forecast contributes a further 1,100 for a total range of 9,700 by 1985.

Figure 7

ESTIMATE OF NUMBER OF PERSONS IN THE OCCUPATION ENGINEERING UNDER ALTERNATIVE ASSUMPTIONS

| | I | II | III | IV |
|---|---|---|---|---|
| | (thousands of persons) | | | |
| 1975 | 62.0 | 62.0 | 62.0 | 62.0 |
| 1976 | 65.0 | 64.2 | 64.1 | 63.3 |
| 1977 | 67.4 | 66.1 | 65.7 | 64.6 |
| 1978 | 69.7 | 68.0 | 67.2 | 65.9 |
| 1979 | 72.3 | 70.4 | 69.1 | 67.7 |
| 1980 | 75.4 | 73.2 | 71.4 | 69.7 |
| 1981 | 78.8 | 76.5 | 73.9 | 72.0 |
| 1982 | 81.6 | 79.1 | 75.9 | 73.9 |
| 1983 | 84.0 | 81.4 | 77.5 | 75.5 |
| 1984 | 86.1 | 83.3 | 78.8 | 77.0 |
| 1985 | 88.2 | 85.3 | 80.3 | 78.5 |

ASSUMPTIONS

I changing industrial structure some rising occupation/ industry coefficients (control forecasts)

II changing industrial structure, constant (1975) occupation/ industry coefficients

III constant (1975) industrial structure, some rising occupation/ industry coefficients

IV constant (1975) industrial structure, constant (1975) occupation/industry coefficients

SOURCE: MOSST, Highly Qualified Manpower Demand Model (March 1978 Solution)

One could conclude from this analysis that the HQM Model occupational forecasts are sensitive to the particular assumptions made about employment growth by industry and that the adjustment of the occupation/industry coefficients has had a significant impact on the occupational requirements forecasts. It is also clearly apparent that these assumptions have an increasing impact on the projections as one moves further into the future. Since the requirements for university graduates are a function of these stock forecasts, it is important therefore that the occupational projections be monitored closely and the key assumptions of industry employment and occupation/industry coefficients be revised periodically.

## Statistical Appendix

The statistical appendix to this report contains a large number of tables and charts taken from the March 1978 simulation.

# APPENDIX

# TABLE 1

## NUMBER OF ENGINEERS & OTHER OCCUPATIONS BY INDUSTRY - 1971
(ADJUSTED CENSUS DATA)

| OCCUPATIONS | INDUSTRY | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MINING | DUR-ABLES | NON-DUR ABLES | CONSTR-UCTION | UTIL-ITIES | TRANSP/ COMM. | TRADE | EDUCA-TION | SERVICES TO BUSINESS | FED. ADMIN | OTHER PUBLIC ADMIN. | OTHER INDUSTRY | TOTAL |
| CHEMICAL ENGINEERS | 180 | 393 | 1,798 | 69 | 65 | 65 | 69 | 83 | 227 | 88 | 88 | 42 | 3,157 |
| CIVIL ENGINEERS | 330 | 1,086 | 599 | 2,466 | 755 | 1,177 | 174 | 312 | 4,314 | 995 | 2,676 | 589 | 15,473 |
| ELECTRICAL ENGINEERS | 98 | 2,563 | 462 | 257 | 1,643 | 2,157 | 286 | 176 | 1,194 | 537 | 198 | 153 | 9,724 |
| MECHANICAL ENGINEERS | 223 | 2,482 | 1,200 | 267 | 267 | 278 | 280 | 139 | 1,091 | 302 | 182 | 239 | 6,950 |
| METALLURGICAL ENGINEERS | 87 | 437 | 17 | 8 | 0 | 4 | 8 | 8 | 78 | 21 | 4 | 4 | 676 |
| AERONAUTICAL ENGINEERS | 2 | 319 | 10 | 0 | 0 | 143 | 17 | 6 | 21 | 101 | 10 | 22 | 651 |
| MINING ENGINEERS | 888 | 79 | 14 | 20 | 3 | 3 | 10 | 14 | 222 | 24 | 65 | 33 | 1,375 |
| PETROLEUM ENGINEERS | 616 | 16 | 109 | 16 | 16 | 39 | 66 | 0 | 117 | 31 | 47 | 8 | 1,081 |
| INDUSTRIAL ENGINEERS | 151 | 1,924 | 964 | 63 | 77 | 249 | 148 | 18 | 322 | 189 | 110 | 193 | 4,408 |
| OTHER ENGINEERS | 68 | 291 | 241 | 65 | 108 | 65 | 68 | 47 | 643 | 219 | 650 | 119 | 2,584 |
| SUB-TOTAL ENGINEERS | 2,643 | 9,590 | 5,414 | 3,231 | 2,934 | 4,170 | 1,126 | 803 | 8,229 | 2,507 | 4,030 | 1,402 | 46,079 |
| GEOLOGISTS | 2,781 | 50 | 81 | 10 | 65 | 25 | 10 | 96 | 806 | 403 | 348 | 30 | 4,705 |
| CHEMISTS | 528 | 740 | 2,501 | 40 | 106 | 35 | 116 | 956 | 523 | 825 | 362 | 408 | 7,140 |
| COMPUTER PRGMRS | 578 | 3,844 | 2,462 | 95 | 688 | 2,135 | 1,357 | 2,191 | 2,156 | 2,100 | 1,362 | 3,517 | 22,485 |
| COMMISSIONED OFFICERS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16,410 | 0 | 0 | 16,410 |
| TECHNICAL SALES | 86 | 1,845 | 728 | 152 | 76 | 101 | 2,346 | 20 | 227 | 15 | 20 | 329 | 5,945 |
| UNIVERSITY PROFESSORS | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24,733 | 0 | 0 | 0 | 0 | 24,733 |
| ADMINISTRATORS | 4,431 | 24,322 | 29,132 | 11,641 | 3,042 | 18,734 | 28,647 | 7,168 | 12,919 | 31,378 | 24,039 | 40,012 | 235,465 |
| OTHER HQM | 2,192 | 12,765 | 24,747 | 6,350 | 1,845 | 12,069 | 27,672 | 347,526 | 46,828 | 20,117 | 26,431 | 291,723 | 820,265 |
| NON-HQM | 124,070 | 752,831 | 822,127 | 512,879 | 77,551 | 542,770 | 1,202,392 | 179,301 | 135,718 | 251,098 | 251,825 | 1,853,906 | 6,706,469 |
| TOTAL L. F. | 137,309 | 805,987 | 887,192 | 534,398 | 86,367 | 580,039 | 1,263,666 | 562,794 | 207,406 | 324,853 | 308,418 | 2,191,327 | 7,889,696 |

SOURCE: MOSST: ESTIMATES BASED ON 1971 CENSUS

TABLE 2

NUMBER OF ENGINEERS BY FIELD OF STUDY
1971

| OCCUPATIONS | FIELD OF STUDY | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CHEM ENG. | CIVIL ENG. | ELECT. ENG. | MECH ENG. | METAL ENG. | AERO ENG. | MINING ENG. | PETRO ENG. | INDUS ENG. | AGRI ENG. | OTHER ENG | PHYS SCI/MATH | OTHER FOS | NO DEGREE | TOTAL |
| CHEM ENG. | 1,828 | 58 | 86 | 199 | 21 | 2 | 23 | 31 | 10 | 4 | 41 | 237 | 123 | 494 | 3,157 |
| CIVIL ENG. | 272 | 9,106 | 459 | 846 | 54 | 45 | 289 | 16 | 62 | 61 | 524 | 225 | 1,030 | 2,484 | 15,473 |
| ELECT ENG. | 68 | 280 | 5,975 | 582 | 25 | 3 | 49 | 3 | 53 | 0 | 240 | 482 | 362 | 1,602 | 9,724 |
| MECH ENG. | 156 | 289 | 234 | 4,064 | 33 | 89 | 59 | 15 | 56 | 52 | 133 | 110 | 176 | 1,484 | 6,950 |
| METAL ENG. | 59 | 25 | 36 | 48 | 309 | 0 | 29 | 5 | 0 | 0 | 4 | 41 | 24 | 96 | 676 |
| AERO ENG. | 0 | 11 | 25 | 230 | 4 | 195 | 0 | 0 | 4 | 0 | 19 | 34 | 38 | 91 | 651 |
| MINING ENG. | 39 | 60 | 12 | 56 | 28 | 0 | 620 | 7 | 2 | 4 | 11 | 182 | 89 | 265 | 1,375 |
| PETRO ENG. | 152 | 95 | 30 | 159 | 4 | 2 | 91 | 204 | 0 | 2 | 29 | 31 | 23 | 259 | 1,081 |
| INDUS ENG. | 291 | 282 | 393 | 718 | 64 | 50 | 100 | 27 | 297 | 11 | 125 | 370 | 995 | 685 | 4,408 |
| OTHER ENG. | 157 | 285 | 203 | 209 | 30 | 21 | 30 | 2 | 37 | 99 | 150 | 153 | 687 | 521 | 2,584 |
| GEOLOGIST | 5 | 44 | 28 | 10 | 4 | 0 | 493 | 8 | 0 | 6 | 25 | 2,536 | 126 | 1,420 | 4,705 |
| CHEMISTS | 341 | 39 | 14 | 6 | 14 | 4 | 0 | 0 | 5 | 11 | 15 | 2,784 | 1,011 | 2,896 | 7,140 |
| COMP PRGM | 119 | 134 | 574 | 195 | 21 | 45 | 6 | 0 | 127 | 8 | 133 | 2,978 | 2,242 | 15,903 | 22,485 |
| COMM OFF. | 129 | 262 | 363 | 234 | 0 | 48 | 22 | 0 | 32 | 12 | 114 | 657 | 1,669 | 12,868 | 16,410 |
| TECH SALES | 131 | 81 | 214 | 259 | 21 | 18 | 9 | 11 | 3 | 5 | 9 | 115 | 282 | 4,787 | 5,945 |
| PROFESSOR | 224 | 325 | 513 | 301 | 91 | 54 | 66 | 3 | 51 | 28 | 143 | 4,257 | 18,677 | 0 | 24,733 |
| ADMINISTRATOR | 1,414 | 2,238 | 1,804 | 2,303 | 335 | 112 | 701 | 162 | 294 | 70 | 734 | 3,787 | 30,138 | 191,373 | 235,465 |
| OTHER HQM | 531 | 759 | 1,025 | 811 | 137 | 79 | 288 | 18 | 191 | 219 | 680 | 12,569 | 250,043 | 552,915 | 820,265 |
| NON-HQM OCCS | 2,026 | 2,505 | 2,903 | 2,998 | 748 | 148 | 688 | 113 | 365 | 281 | 933 | 12,844 | 99,545 | 6,580,372 | 6,706,469 |
| TOTAL | 7,942 | 16,878 | 14,891 | 14,228 | 1,943 | 915 | 3,563 | 625 | 1,589 | 873 | 4,062 | 44,392 | 407,280 | 7,370,515 | 7,889,696 |

SOURCE: MOSST: BASED ON 1971 CENSUS, 1973 POST-CENSAL SURVEY AND MEMBERSHIP LISTS OF THE CCPE

TABLE 3

NUMBER OF ENGINEERS - PROJECTION 1971 TO 1985
(NUMBER)

| YEARS | OCCUPATIONS | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | CHEMICAL ENGINEERS | CIVIL ENGINEERS | ELECTRICAL ENGINEERS | MECHANICAL ENGINEERS | METALLURGICAL ENGINEERS | AERONAUTICAL ENGINEERS | MINING ENGINEERS | PETROLEUM ENGINEERS | INDUSTRIAL ENGINEERS | OTHER ENGINEERS | TOTAL ENGINEERS |
| 1971 | 3,157 | 15,473 | 9,724 | 6,950 | 676 | 651 | 1,375 | 1,081 | 4,408 | 2,584 | 46,079 |
| 1972 | 3,271 | 16,868 | 10,729 | 7,555 | 716 | 704 | 1,452 | 1,158 | 4,630 | 2,809 | 49,892 |
| 1973 | 3,391 | 18,189 | 11,855 | 8,237 | 761 | 767 | 1,530 | 1,242 | 4,882 | 3,021 | 53,875 |
| 1974 | 3,463 | 19,466 | 12,991 | 8,831 | 786 | 817 | 1,652 | 1,365 | 5,023 | 3,227 | 57,621 |
| 1975 | 3,526 | 20,976 | 14,301 | 9,567 | 814 | 865 | 1,817 | 1,524 | 5,152 | 3,466 | 62,008 |
| 1976 | 3,573 | 21,924 | 15,266 | 10,055 | 828 | 893 | 1,955 | 1,656 | 5,227 | 3,633 | 65,010 |
| 1977 | 3,670 | 22,545 | 16,025 | 10,501 | 852 | 928 | 2,025 | 1,729 | 5,375 | 3,748 | 67,398 |
| 1978 | 3,770 | 23,175 | 16,716 | 10,898 | 874 | 962 | 2,075 | 1,782 | 5,528 | 3,872 | 69,652 |
| 1979 | 3,900 | 24,039 | 17,410 | 11,330 | 903 | 998 | 2,123 | 1,829 | 5,722 | 4,024 | 72,278 |
| 1980 | 4,054 | 25,180 | 18,146 | 11,823 | 938 | 1,036 | 2,207 | 1,905 | 5,945 | 4,214 | 75,448 |
| 1981 | 4,212 | 26,397 | 18,890 | 12,351 | 975 | 1,074 | 2,298 | 1,984 | 6,177 | 4,418 | 78,776 |
| 1982 | 4,341 | 27,452 | 19,546 | 12,807 | 1,006 | 1,105 | 2,374 | 2,048 | 6,369 | 4,598 | 81,646 |
| 1983 | 4,450 | 28,297 | 20,094 | 13,186 | 1,031 | 1,132 | 2,428 | 2,094 | 6,534 | 4,748 | 83,994 |
| 1984 | 4,552 | 29,061 | 20,568 | 13,515 | 1,054 | 1,156 | 2,479 | 2,138 | 6,686 | 4,883 | 86,092 |
| 1985 | 4,659 | 29,827 | 21,022 | 13,835 | 1,078 | 1,181 | 2,530 | 2,181 | 6,843 | 5,019 | 88,175 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

TABLE 4

OCCUPATION: CHEMICAL ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | CHEMICAL ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 3,157 | - | - | - |
| 1972 | 3,271 | 114 | 65 | 179 |
| 1973 | 3,391 | 120 | 66 | 186 |
| 1974 | 3,463 | 72 | 67 | 139 |
| 1975 | 3,526 | 63 | 68 | 131 |
| 1976 | 3,573 | 47 | 70 | 117 |
| 1977 | 3,670 | 97 | 71 | 168 |
| 1978 | 3,770 | 100 | 73 | 173 |
| 1979 | 3,900 | 130 | 76 | 206 |
| 1980 | 4,054 | 154 | 78 | 232 |
| 1981 | 4,212 | 158 | 79 | 237 |
| 1982 | 4,341 | 129 | 82 | 211 |
| 1983 | 4,450 | 109 | 84 | 193 |
| 1984 | 4,552 | 102 | 87 | 189 |
| 1985 | 4,659 | 107 | 89 | 196 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22, 1978 SIMULATION)

TABLE 5

OCCUPATION: CIVIL ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | CIVIL ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 15,473 | - | - | - |
| 1972 | 16,868 | 1,395 | 367 | 1,762 |
| 1973 | 18,189 | 1,321 | 373 | 1,694 |
| 1974 | 19,466 | 1,277 | 378 | 1,655 |
| 1975 | 20,976 | 1,510 | 384 | 1,894 |
| 1976 | 21,924 | 948 | 390 | 1,338 |
| 1977 | 22,545 | 621 | 397 | 1,018 |
| 1978 | 23,175 | 630 | 406 | 1,036 |
| 1979 | 24,039 | 864 | 417 | 1,281 |
| 1980 | 25,180 | 1,141 | 426 | 1,567 |
| 1981 | 26,397 | 1,217 | 439 | 1,656 |
| 1982 | 27,452 | 1,055 | 452 | 1,507 |
| 1983 | 28,297 | 845 | 466 | 1,311 |
| 1984 | 29,061 | 764 | 480 | 1,244 |
| 1985 | 29,827 | 766 | 495 | 1,261 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

TABLE 6

OCCUPATION: ELECTRICAL ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | ELECTRICAL ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 9,724 | - | - | - |
| 1972 | 10,729 | 1,005 | 211 | 1,216 |
| 1973 | 11,855 | 1,126 | 217 | 1,343 |
| 1974 | 12,991 | 1,136 | 222 | 1,358 |
| 1975 | 14,301 | 1,310 | 229 | 1,539 |
| 1976 | 15,266 | 965 | 236 | 1,201 |
| 1977 | 16,025 | 759 | 244 | 1,003 |
| 1978 | 16,716 | 691 | 253 | 944 |
| 1979 | 17,410 | 694 | 262 | 956 |
| 1980 | 18,146 | 736 | 270 | 1,006 |
| 1981 | 18,890 | 744 | 278 | 1,022 |
| 1982 | 19,546 | 656 | 287 | 943 |
| 1983 | 20,094 | 548 | 295 | 843 |
| 1984 | 20,568 | 474 | 305 | 779 |
| 1985 | 21,022 | 454 | 315 | 769 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22, 1978 SIMULATION)

TABLE 7

OCCUPATION: MECHANICAL ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | MECHANICAL ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 6,950 | - | - | - |
| 1972 | 7,555 | 605 | 176 | 781 |
| 1973 | 8,237 | 682 | 180 | 862 |
| 1974 | 8,831 | 594 | 184 | 778 |
| 1975 | 9,567 | 736 | 190 | 926 |
| 1976 | 10,055 | 488 | 194 | 682 |
| 1977 | 10,501 | 446 | 199 | 645 |
| 1978 | 10,898 | 397 | 204 | 601 |
| 1979 | 11,330 | 432 | 209 | 641 |
| 1980 | 11,823 | 493 | 214 | 707 |
| 1981 | 12,351 | 528 | 219 | 747 |
| 1982 | 12,807 | 456 | 225 | 681 |
| 1983 | 13,186 | 379 | 232 | 611 |
| 1984 | 13,515 | 329 | 239 | 568 |
| 1985 | 13,835 | 320 | 244 | 564 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

TABLE 8

OCCUPATION: METALLURGICAL ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | METALLURGICAL ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 676 | - | - | - |
| 1972 | 716 | 40 | 14 | 54 |
| 1973 | 761 | 45 | 14 | 59 |
| 1974 | 786 | 25 | 15 | 40 |
| 1975 | 814 | 28 | 16 | 44 |
| 1976 | 828 | 14 | 17 | 31 |
| 1977 | 852 | 24 | 18 | 42 |
| 1978 | 874 | 22 | 18 | 40 |
| 1979 | 903 | 29 | 18 | 47 |
| 1980 | 938 | 35 | 18 | 53 |
| 1981 | 975 | 37 | 19 | 56 |
| 1982 | 1,006 | 31 | 20 | 51 |
| 1983 | 1,031 | 25 | 20 | 45 |
| 1984 | 1,054 | 23 | 21 | 44 |
| 1985 | 1,078 | 24 | 22 | 46 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

TABLE 9

OCCUPATION: AERONAUTICAL ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | AERONAUTICAL ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 651 | - | - | - |
| 1972 | 704 | 53 | 15 | 68 |
| 1973 | 767 | 63 | 16 | 79 |
| 1974 | 817 | 50 | 16 | 66 |
| 1975 | 865 | 48 | 17 | 65 |
| 1976 | 893 | 28 | 18 | 46 |
| 1977 | 928 | 35 | 19 | 54 |
| 1978 | 962 | 34 | 20 | 54 |
| 1979 | 998 | 36 | 21 | 57 |
| 1980 | 1,036 | 38 | 22 | 60 |
| 1981 | 1,074 | 38 | 22 | 60 |
| 1982 | 1,105 | 31 | 23 | 54 |
| 1983 | 1,132 | 27 | 24 | 51 |
| 1984 | 1,156 | 24 | 24 | 48 |
| 1985 | 1,181 | 25 | 25 | 50 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22, 1978 SIMULATION)

TABLE 10

OCCUPATION: MINING ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | MINING ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 1,375 | - | - | - |
| 1972 | 1,452 | 77 | 41 | 118 |
| 1973 | 1,530 | 78 | 42 | 120 |
| 1974 | 1,652 | 122 | 43 | 165 |
| 1975 | 1,817 | 165 | 43 | 208 |
| 1976 | 1,955 | 138 | 44 | 182 |
| 1977 | 2,025 | 70 | 44 | 114 |
| 1978 | 2,075 | 50 | 44 | 94 |
| 1979 | 2,123 | 48 | 44 | 92 |
| 1980 | 2,207 | 84 | 44 | 128 |
| 1981 | 2,298 | 91 | 44 | 135 |
| 1982 | 2,374 | 76 | 44 | 120 |
| 1983 | 2,428 | 54 | 44 | 98 |
| 1984 | 2,479 | 51 | 44 | 95 |
| 1985 | 2,530 | 51 | 44 | 95 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

TABLE 11

OCCUPATION: PETROLEUM ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | PETROLEUM ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 1,081 | - | - | - |
| 1972 | 1,158 | 77 | 20 | 97 |
| 1973 | 1,242 | 84 | 21 | 105 |
| 1974 | 1,365 | 123 | 22 | 145 |
| 1975 | 1,524 | 159 | 22 | 181 |
| 1976 | 1,656 | 132 | 23 | 155 |
| 1977 | 1,729 | 73 | 24 | 97 |
| 1978 | 1,782 | 53 | 25 | 78 |
| 1979 | 1,829 | 47 | 26 | 73 |
| 1980 | 1,905 | 76 | 26 | 102 |
| 1981 | 1,984 | 79 | 27 | 106 |
| 1982 | 2,048 | 64 | 28 | 92 |
| 1983 | 2,094 | 46 | 29 | 75 |
| 1984 | 2,138 | 44 | 30 | 74 |
| 1985 | 2,181 | 43 | 31 | 74 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

TABLE 12

OCCUPATION: INDUSTRIAL ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | INDUSTRIAL ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 4,408 | - | - | - |
| 1972 | 4,630 | 222 | 110 | 332 |
| 1973 | 4,882 | 252 | 113 | 365 |
| 1974 | 5,023 | 141 | 116 | 257 |
| 1975 | 5,152 | 129 | 119 | 248 |
| 1976 | 5,227 | 75 | 123 | 198 |
| 1977 | 5,375 | 148 | 126 | 274 |
| 1978 | 5,528 | 153 | 129 | 282 |
| 1979 | 5,722 | 194 | 134 | 328 |
| 1980 | 5,945 | 223 | 137 | 360 |
| 1981 | 6,177 | 232 | 141 | 373 |
| 1982 | 6,369 | 192 | 144 | 336 |
| 1983 | 6,534 | 165 | 147 | 312 |
| 1984 | 6,686 | 152 | 151 | 303 |
| 1985 | 6,843 | 157 | 154 | 311 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

TABLE 13

OCCUPATION: OTHER ENGINEER - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | OTHER ENGINEER | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 2,584 | - | - | - |
| 1972 | 2,809 | 225 | 66 | 291 |
| 1973 | 3,021 | 212 | 66 | 278 |
| 1974 | 3,227 | 206 | 65 | 271 |
| 1975 | 3,466 | 239 | 66 | 305 |
| 1976 | 3,633 | 167 | 67 | 234 |
| 1977 | 3,748 | 115 | 67 | 182 |
| 1978 | 3,872 | 124 | 70 | 194 |
| 1979 | 4,024 | 152 | 70 | 222 |
| 1980 | 4,214 | 190 | 71 | 261 |
| 1981 | 4,418 | 204 | 73 | 277 |
| 1982 | 4,598 | 180 | 74 | 254 |
| 1983 | 4,748 | 150 | 76 | 226 |
| 1984 | 4,883 | 135 | 78 | 213 |
| 1985 | 5,019 | 136 | 80 | 216 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

TABLE 14

OCCUPATION: TOTAL ENGINEERS - DEMAND GROWTH
1972 TO 1985

| YEARS | (NUMBER OF PERSONS) | | | |
|---|---|---|---|---|
| | TOTAL ENGINEERS | ANNUAL INCREASE | REPLACEMENT DEMAND | NEW ENTRANTS REQUIRED |
| 1971 | 46,079 | - | - | - |
| 1972 | 49,892 | 3,813 | 1,085 | 4,898 |
| 1973 | 53,875 | 3,983 | 1,108 | 5,091 |
| 1974 | 57,621 | 3,746 | 1,128 | 4,874 |
| 1975 | 62,008 | 4,387 | 1,154 | 5,541 |
| 1976 | 65,010 | 3,002 | 1,182 | 4,184 |
| 1977 | 67,398 | 2,388 | 1,209 | 3,597 |
| 1978 | 69,652 | 2,254 | 1,242 | 3,496 |
| 1979 | 72,278 | 2,626 | 1,277 | 3,903 |
| 1980 | 75,448 | 3,170 | 1,306 | 4,476 |
| 1981 | 78,776 | 3,328 | 1,341 | 4,669 |
| 1982 | 81,646 | 2,870 | 1,379 | 4,249 |
| 1983 | 83,994 | 2,348 | 1,417 | 3,765 |
| 1984 | 86,092 | 2,098 | 1,459 | 3,557 |
| 1985 | 88,175 | 2,083 | 1,499 | 3,582 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22, 1978 SIMULATION)

TABLE 15

ENGINEERING GRADUATES REQUIRED FOR ENGINEERING OCCUPATIONS
(NUMBER OF GRADUATES - ALL DEGREE LEVELS)

| OCCUPATIONS | 1972 - 1985 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| CHEMICAL ENGINEER | 23 | 24 | 18 | 17 | 14 | 21 | 22 | 26 | 29 | 30 | 26 | 24 | 24 | 25 |
| CIVIL ENGINEER | 1,389 | 1,334 | 1,304 | 1,492 | 1,055 | 802 | 816 | 1,009 | 1,234 | 1,304 | 1,187 | 1,033 | 980 | 993 |
| ELECTRICAL ENGINEER | 977 | 1,080 | 1,092 | 1,237 | 966 | 806 | 759 | 769 | 809 | 822 | 758 | 678 | 626 | 618 |
| MECHANICAL ENGINEER | 649 | 716 | 647 | 769 | 566 | 536 | 499 | 532 | 588 | 621 | 566 | 507 | 472 | 469 |
| METALLURGICAL ENGINEER | 38 | 43 | 28 | 32 | 23 | 30 | 28 | 34 | 38 | 41 | 37 | 33 | 32 | 33 |
| AERONAUTICAL ENGINEER | 56 | 65 | 54 | 53 | 38 | 44 | 44 | 46 | 49 | 49 | 44 | 41 | 39 | 41 |
| MINING ENGINEER | 83 | 85 | 117 | 147 | 129 | 81 | 66 | 65 | 91 | 96 | 85 | 69 | 67 | 67 |
| PETROLEUM ENGINEER | 63 | 68 | 94 | 118 | 100 | 63 | 51 | 47 | 66 | 69 | 59 | 49 | 48 | 48 |
| INDUSTRIAL ENGINEER | 173 | 190 | 134 | 129 | 103 | 143 | 147 | 171 | 188 | 194 | 175 | 162 | 158 | 162 |
| OTHER ENGINEERS | 130 | 124 | 121 | 137 | 105 | 82 | 87 | 100 | 117 | 124 | 114 | 101 | 96 | 97 |
| TOTAL ENGINEERS | 3,581 | 3,729 | 3,609 | 4,131 | 3,099 | 2,608 | 2,519 | 2,799 | 3,209 | 3,350 | 3,051 | 2,697 | 2,542 | 2,553 |
| OTHER HQM OCCUPATIONS | 2,299 | 2,462 | 2,675 | 2,715 | 2,180 | 1,943 | 1,942 | 2,178 | 2,479 | 2,579 | 2,396 | 2,226 | 2,170 | 2,234 |
| TOTAL GRADUATES REQUIRED | 5,880 | 6,191 | 6,284 | 6,846 | 5,279 | 4,551 | 4,461 | 4,977 | 5,688 | 5,929 | 5,447 | 4,923 | 4,712 | 4,787 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER MODEL (MARCH 22, 1978 SIMULATION)

TABLE 16

ENGINEERING GRADUATES REQUIRED FOR ENGINEERING OCCUPATIONS
(PERCENTAGE DISTRIBUTION - ALL DEGREE LEVELS)

| OCCUPATIONS | 1972 - 1985 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| CHEMICAL ENGINEER | 0.4 | 0.4 | 0.3 | 0.2 | 0.3 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| CIVIL ENGINEER | 23.6 | 21.5 | 20.8 | 21.8 | 20.0 | 17.6 | 18.3 | 20.3 | 21.7 | 22.0 | 21.8 | 21.0 | 20.8 | 20.7 |
| ELECTRICAL ENGINEER | 16.6 | 17.4 | 17.4 | 18.1 | 18.3 | 17.7 | 17.0 | 15.5 | 14.2 | 13.9 | 13.9 | 13.8 | 13.3 | 12.9 |
| MECHANICAL ENGINEER | 11.0 | 11.6 | 10.3 | 11.2 | 10.7 | 11.8 | 11.2 | 10.7 | 10.3 | 10.5 | 10.4 | 10.3 | 10.0 | 9.8 |
| METALLURGICAL ENGINEER | 0.6 | 0.7 | 0.4 | 0.5 | 0.4 | 0.7 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| AERONAUTICAL ENGINEER | 1.0 | 1.0 | 0.9 | 0.8 | 0.7 | 1.0 | 1.0 | 0.9 | 0.9 | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 |
| MINING ENGINEER | 1.4 | 1.4 | 1.9 | 2.1 | 2.4 | 1.8 | 1.5 | 1.3 | 1.6 | 1.6 | 1.6 | 1.4 | 1.4 | 1.4 |
| PETROLEUM ENGINEER | 1.1 | 1.1 | 1.5 | 1.7 | 1.9 | 1.4 | 1.1 | 0.9 | 1.2 | 1.2 | 1.1 | 1.0 | 1.0 | 1.0 |
| INDUSTRIAL ENGINEER | 2.9 | 3.1 | 2.1 | 1.9 | 2.0 | 3.1 | 3.3 | 3.4 | 3.3 | 3.3 | 3.2 | 3.3 | 3.4 | 3.4 |
| OTHER ENGINEERS | 2.2 | 2.0 | 1.9 | 2.0 | 2.0 | 1.8 | 2.0 | 2.0 | 2.1 | 2.1 | 2.1 | 2.1 | 2.0 | 2.0 |
| TOTAL ENGINEERS | 60.9 | 60.2 | 57.4 | 60.3 | 58.7 | 57.3 | 56.5 | 56.2 | 56.4 | 56.5 | 56.0 | 54.8 | 53.9 | 53.3 |
| OTHER HQM OCCUPATIONS | 39.1 | 39.8 | 42.6 | 39.7 | 41.3 | 42.7 | 43.5 | 43.8 | 43.6 | 43.5 | 44.0 | 45.2 | 46.1 | 46.7 |
| TOTAL GRADUATES REQUIRED | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER MODEL (MARCH 22, 1978 SIMULATION)

TABLE 17

ENGINEERING GRADUATES REQUIRED FOR ENGINEERING OCCUPATIONS
(PERCENTAGE DISTRIBUTION - GRADUATE DEGREE LEVEL)

| OCCUPATIONS | 1972 - 1985 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| CHEMICAL ENGINEER | 0.4 | 0.4 | 0.3 | 0.3 | 0.2 | 0.4 | 0.6 | 0.5 | 0.6 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 |
| CIVIL ENGINEER | 24.8 | 23.2 | 21.1 | 23.2 | 21.1 | 19.6 | 20.2 | 22.6 | 23.8 | 24.3 | 24.1 | 23.4 | 23.4 | 23.9 |
| ELECTRICAL ENGINEER | 15.5 | 16.8 | 15.8 | 17.1 | 17.2 | 17.5 | 16.7 | 15.4 | 13.9 | 13.7 | 13.7 | 13.7 | 13.3 | 13.3 |
| MECHANICAL ENGINEER | 8.0 | 8.7 | 7.3 | 8.3 | 7.8 | 9.2 | 8.6 | 8.3 | 7.9 | 8.1 | 8.0 | 8.0 | 7.8 | 7.9 |
| METALLURGICAL ENGINEER | 0.4 | 0.5 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 |
| AERONAUTICAL ENGINEER | 2.2 | 2.5 | 1.9 | 1.8 | 1.6 | 2.3 | 2.3 | 2.2 | 2.0 | 2.0 | 1.9 | 2.0 | 2.0 | 2.1 |
| MINING ENGINEER | 1.6 | 1.6 | 2.1 | 2.5 | 2.8 | 2.1 | 1.7 | 1.6 | 1.9 | 2.0 | 1.9 | 1.7 | 1.7 | 1.7 |
| PETROLEUM ENGINEER | 0.5 | 0.5 | 0.7 | 0.8 | 0.8 | 0.7 | 0.6 | 0.4 | 0.6 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 |
| INDUSTRIAL ENGINEER | 1.3 | 1.3 | 0.9 | 0.8 | 0.8 | 1.4 | 1.5 | 1.6 | 1.5 | 1.4 | 1.4 | 1.5 | 1.5 | 1.6 |
| OTHER ENGINEERS | 4.5 | 4.2 | 3.8 | 4.1 | 4.1 | 3.9 | 4.2 | 4.3 | 4.4 | 4.5 | 4.5 | 4.4 | 4.5 | 4.5 |
| TOTAL ENGINEERS | 59.1 | 59.7 | 54.2 | 59.3 | 56.8 | 57.6 | 56.9 | 57.4 | 57.0 | 57.7 | 57.0 | 56.2 | 55.7 | 56.7 |
| OTHER HQM OCCUPATIONS | 40.9 | 40.3 | 45.8 | 40.7 | 43.2 | 42.4 | 43.1 | 42.6 | 43.0 | 42.3 | 43.0 | 43.8 | 44.3 | 43.3 |
| TOTAL GRADUATES REQUIRED | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER MODEL (MARCH 22, 1978 SIMULATION)

TABLE 18

REQUIREMENTS FOR ENGINEERING GRADUATES
(ALL DEGREE LEVELS - ALL HQM OCCUPATIONS)

| FIELDS OF STUDY | YEARS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| CHEMICAL ENGINEERING | 477 | 506 | 486 | 499 | 412 | 413 | 413 | 470 | 537 | 557 | 508 | 469 | 458 | 477 |
| CIVIL ENGINEERING | 1,693 | 1,685 | 1,718 | 1,892 | 1,391 | 1,110 | 1,123 | 1,336 | 1,590 | 1,672 | 1,537 | 1,364 | 1,307 | 1,329 |
| ELECTRICAL ENGINEERING | 1,422 | 1,557 | 1,606 | 1,742 | 1,359 | 1,159 | 1,120 | 1,183 | 1,285 | 1,318 | 1,216 | 1,104 | 1,038 | 1,039 |
| MECHANICAL ENGINEERING | 1,237 | 1,341 | 1,298 | 1,428 | 1,101 | 1,017 | 983 | 1,078 | 1,207 | 1,266 | 1,163 | 1,059 | 1,009 | 1,022 |
| METALLURGICAL ENGINEERING | 118 | 127 | 119 | 120 | 97 | 95 | 92 | 105 | 118 | 124 | 113 | 103 | 100 | 102 |
| AERONAUTICAL ENGINEERING | 71 | 78 | 77 | 83 | 63 | 59 | 60 | 65 | 73 | 77 | 71 | 66 | 65 | 65 |
| MINING + GEOLOGICAL ENGINEERING | 271 | 285 | 344 | 401 | 323 | 226 | 201 | 209 | 267 | 277 | 249 | 215 | 207 | 211 |
| PETROLEUM ENGINEERING | 34 | 37 | 41 | 46 | 39 | 31 | 29 | 31 | 38 | 40 | 36 | 32 | 31 | 32 |
| INDUSTRIAL ENGINEERING | 137 | 147 | 141 | 143 | 116 | 116 | 116 | 128 | 146 | 155 | 144 | 135 | 130 | 132 |
| AGRICULTURAL ENGINEERING | 71 | 62 | 73 | 86 | 71 | 62 | 59 | 71 | 78 | 81 | 76 | 71 | 70 | 72 |
| OTHER ENGINEERING | 349 | 366 | 381 | 406 | 307 | 263 | 265 | 301 | 349 | 362 | 334 | 305 | 297 | 306 |
| TOTAL ENGINEERING | 5,880 | 6,191 | 6,284 | 6,846 | 5,279 | 4,551 | 4,461 | 4,977 | 5,688 | 5,929 | 5,447 | 4,923 | 4,712 | 4,787 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22, 1978 SIMULATION)

TABLE 19

REQUIREMENTS FOR ENGINEERING GRADUATES
(FIRST DEGREE LEVEL - ALL HQM OCCUPATIONS)

| FIELDS OF STUDY | YEARS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| CHEMICAL ENGINEERING | 408 | 437 | 415 | 432 | 353 | 356 | 356 | 406 | 462 | 481 | 438 | 405 | 397 | 416 |
| CIVIL ENGINEERING | 1,405 | 1,403 | 1,424 | 1,574 | 1,155 | 928 | 938 | 1,117 | 1,326 | 1,396 | 1,283 | 1,141 | 1,094 | 1,115 |
| ELECTRICAL ENGINEERING | 1,202 | 1,323 | 1,350 | 1,477 | 1,148 | 988 | 956 | 1,011 | 1,097 | 1,127 | 1,040 | 945 | 891 | 899 |
| MECHANICAL ENGINEERING | 1,100 | 1,197 | 1,147 | 1,272 | 980 | 913 | 882 | 970 | 1,085 | 1,139 | 1,048 | 954 | 912 | 927 |
| METALLURGICAL ENGINEERING | 88 | 96 | 86 | 89 | 70 | 72 | 70 | 80 | 90 | 94 | 85 | 78 | 77 | 80 |
| AERONAUTICAL ENGINEERING | 30 | 34 | 31 | 34 | 27 | 26 | 26 | 28 | 32 | 34 | 31 | 29 | 28 | 28 |
| MINING + GEOLOGICAL ENGINEERING | 229 | 242 | 291 | 337 | 271 | 192 | 171 | 178 | 224 | 235 | 211 | 183 | 176 | 179 |
| PETROLEUM ENGINEERING | 29 | 31 | 34 | 38 | 32 | 26 | 24 | 26 | 31 | 33 | 30 | 27 | 26 | 27 |
| INDUSTRIAL ENGINEERING | 109 | 119 | 110 | 116 | 95 | 96 | 96 | 106 | 121 | 129 | 120 | 112 | 108 | 111 |
| AGRICULTURAL ENGINEERING | 59 | 50 | 60 | 70 | 58 | 51 | 49 | 59 | 65 | 67 | 63 | 59 | 58 | 60 |
| OTHER ENGINEERING | 264 | 281 | 286 | 310 | 235 | 205 | 206 | 235 | 271 | 282 | 260 | 237 | 231 | 239 |
| TOTAL ENGINEERING | 4,923 | 5,213 | 5,234 | 5,749 | 4,424 | 3,853 | 3,774 | 4,216 | 4,804 | 5,017 | 4,609 | 4,170 | 3,998 | 4,081 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22, 1978 SIMULATION)

TABLE 20

REQUIREMENTS FOR ENGINEERING GRADUATES
(GRADUATE DEGREE LEVELS - ALL HQM OCCUPATIONS)

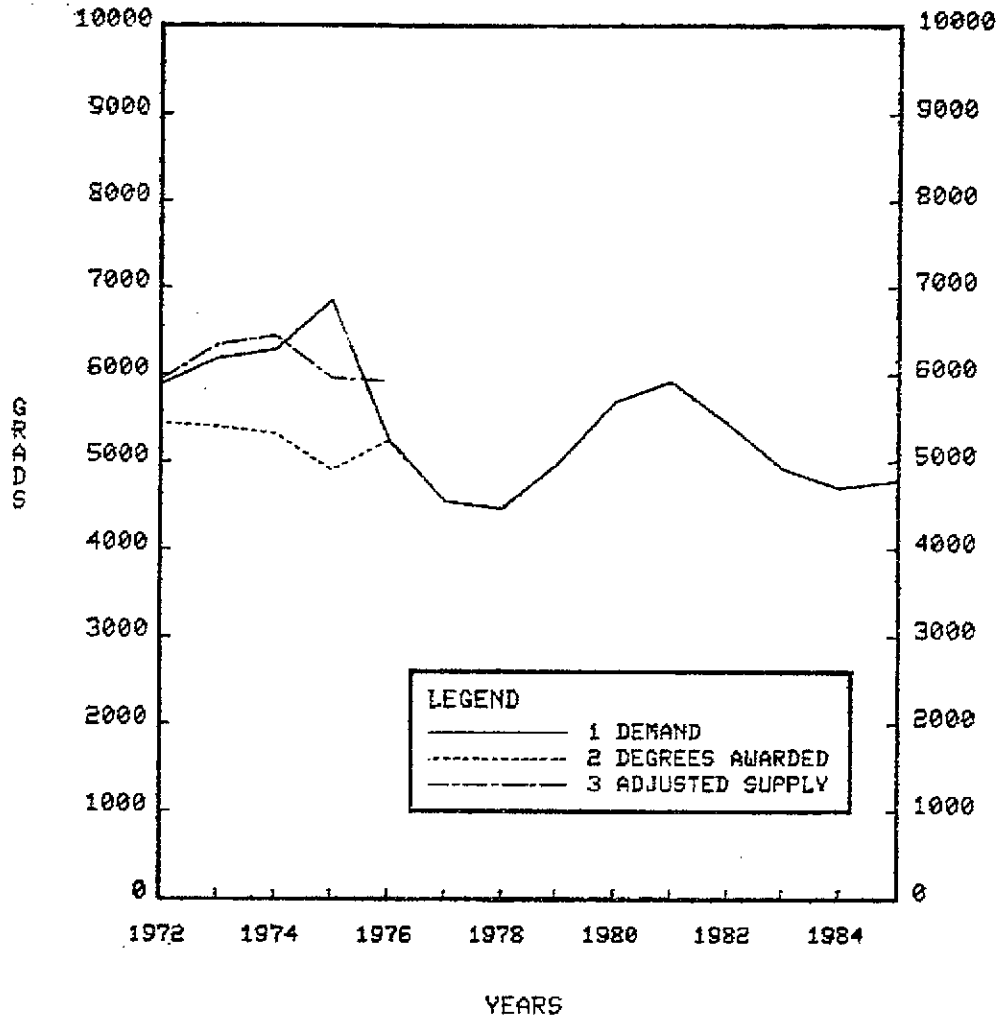
| FIELDS OF STUDY | YEARS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
| CHEMICAL ENGINEERING | 69 | 69 | 71 | 67 | 59 | 57 | 57 | 64 | 75 | 76 | 70 | 64 | 61 | 61 |
| CIVIL ENGINEERING | 288 | 282 | 294 | 318 | 236 | 182 | 185 | 219 | 264 | 276 | 254 | 223 | 213 | 214 |
| ELECTRICAL ENGINEERING | 220 | 234 | 256 | 265 | 211 | 171 | 164 | 172 | 188 | 191 | 176 | 159 | 147 | 140 |
| MECHANICAL ENGINEERING | 137 | 144 | 151 | 156 | 121 | 104 | 101 | 108 | 122 | 127 | 115 | 105 | 97 | 95 |
| METALLURGICAL ENGINEERING | 30 | 31 | 33 | 31 | 27 | 23 | 22 | 25 | 28 | 30 | 28 | 25 | 23 | 22 |
| AERONAUTICAL ENGINEERING | 41 | 44 | 46 | 49 | 36 | 33 | 34 | 37 | 41 | 43 | 40 | 37 | 37 | 37 |
| MINING + GEOLOGICAL ENGINEERING | 42 | 43 | 53 | 64 | 52 | 34 | 30 | 31 | 43 | 42 | 38 | 32 | 31 | 32 |
| PETROLEUM ENGINEERING | 5 | 6 | 7 | 8 | 7 | 5 | 5 | 5 | 7 | 7 | 6 | 5 | 5 | 5 |
| INDUSTRIAL ENGINEERING | 28 | 28 | 31 | 27 | 21 | 20 | 20 | 22 | 25 | 26 | 24 | 23 | 22 | 21 |
| AGRICULTURAL ENGINEERING | 12 | 12 | 13 | 16 | 13 | 11 | 10 | 12 | 13 | 14 | 13 | 12 | 12 | 12 |
| OTHER ENGINEERING | 85 | 85 | 95 | 96 | 72 | 58 | 59 | 66 | 78 | 80 | 74 | 68 | 66 | 67 |
| TOTAL ENGINEERING | 957 | 978 | 1,050 | 1,097 | 855 | 698 | 687 | 761 | 884 | 912 | 838 | 753 | 714 | 706 |

SOURCE: MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22, 1978 SIMULATION)

CHART 1

ALL DEGREE LEVELS - TOTAL ENGINEERING

DEMAND FOR ENGINEERING GRADUATES
1972 - 1985

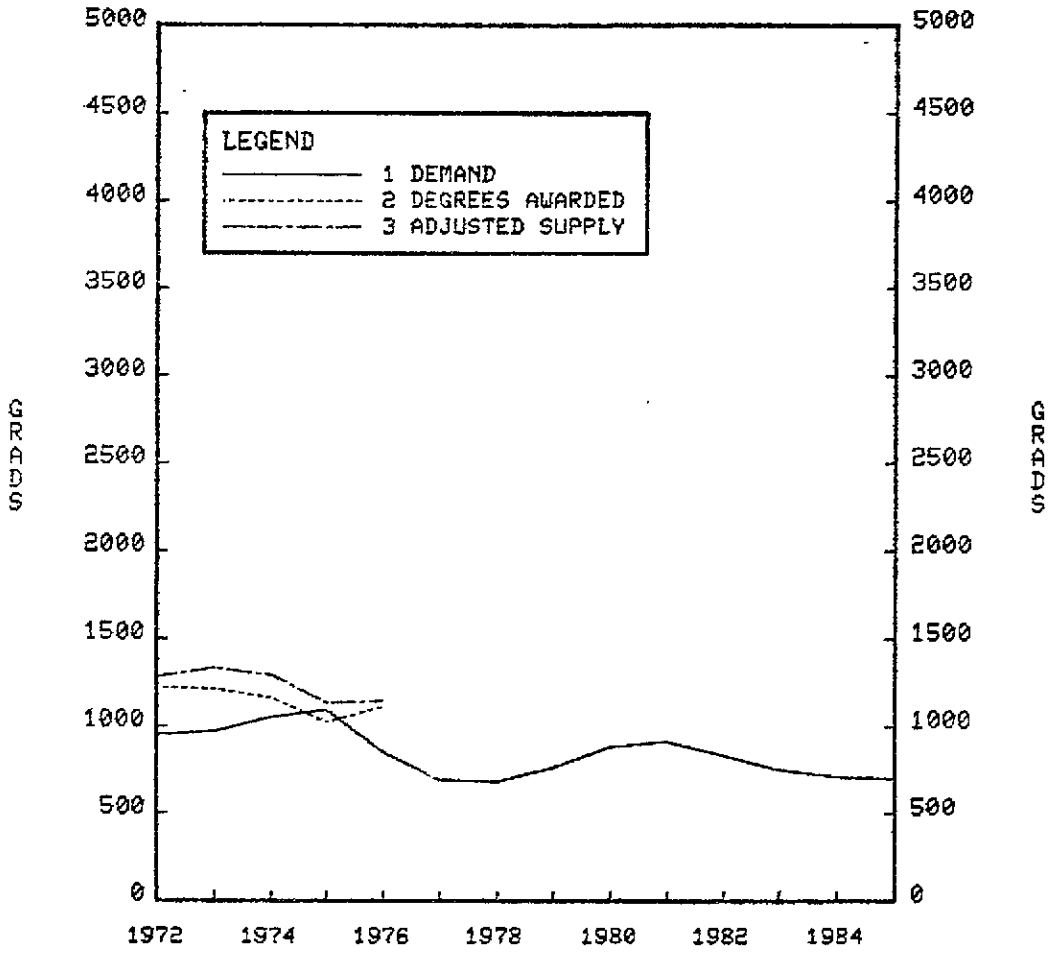



SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 3

GRADUATE DEGREE LEVEL - TOTAL ENGINEERING

DEMAND FOR ENGINEERING GRADUATES
1972 - 1985

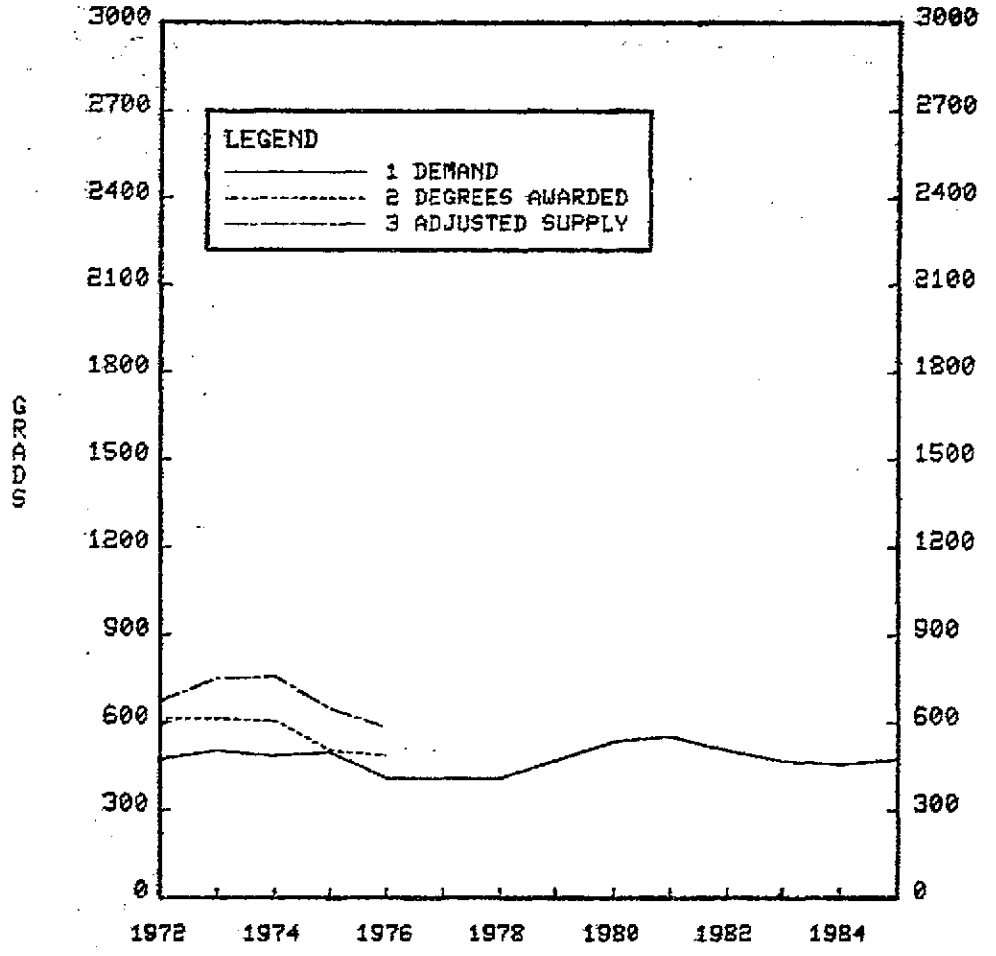



SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 4

ALL DEGREE LEVELS - CHEMICAL ENGINEERING

DEMAND FOR ENGINEERING GRADUATES
1972 - 1985

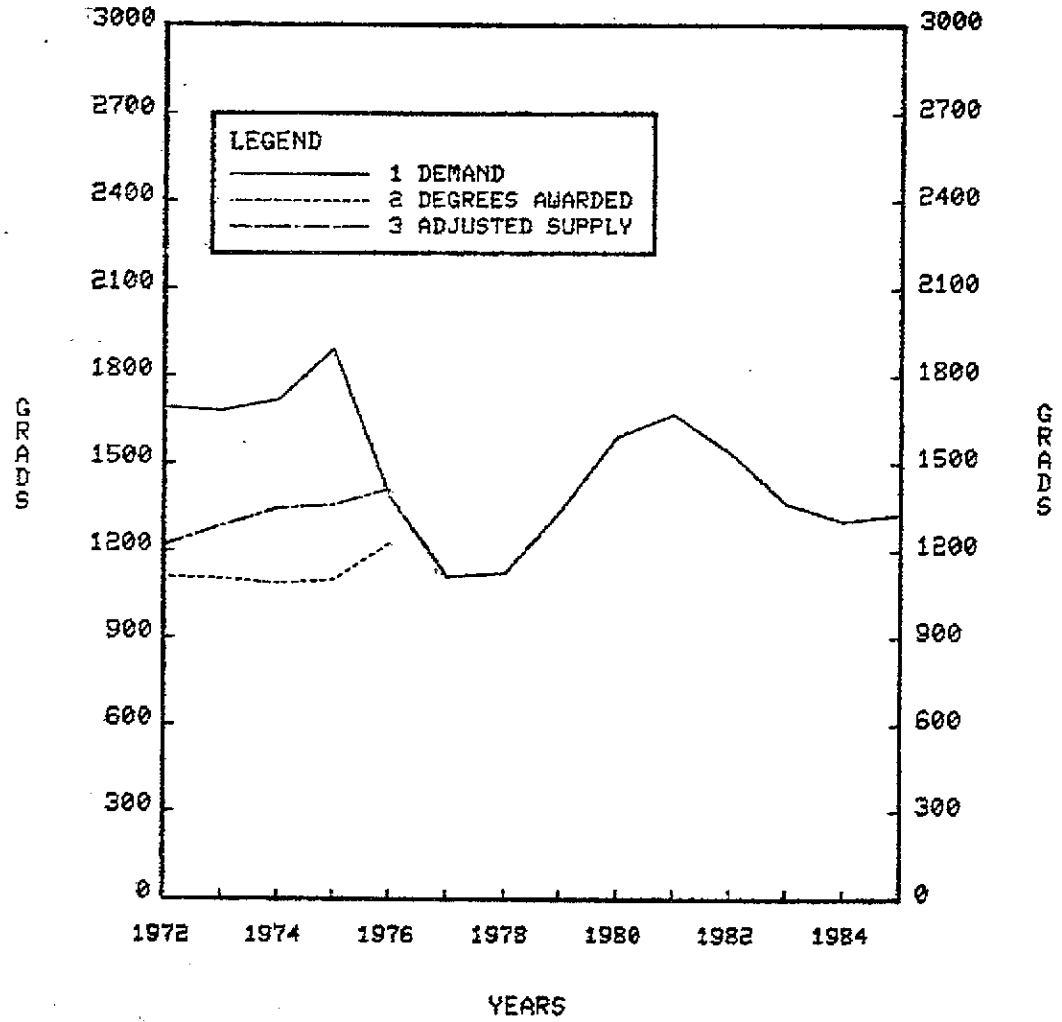



SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 5

ALL DEGREE LEVELS - CIVIL ENGINEERING

DEMAND FOR ENGINEERING GRADUATES
1972 - 1985

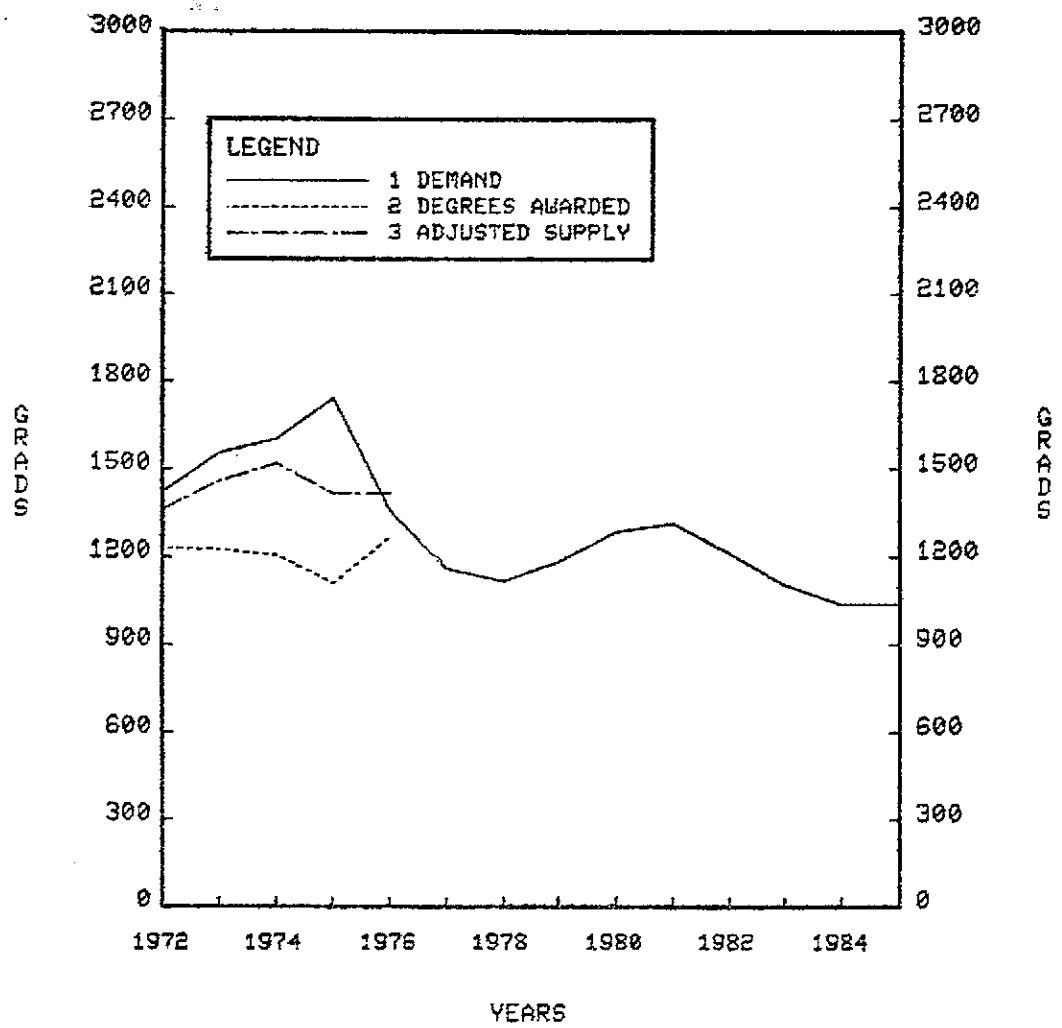



SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 6

ALL DEGREE LEVELS - ELECTRICAL ENGINEERING

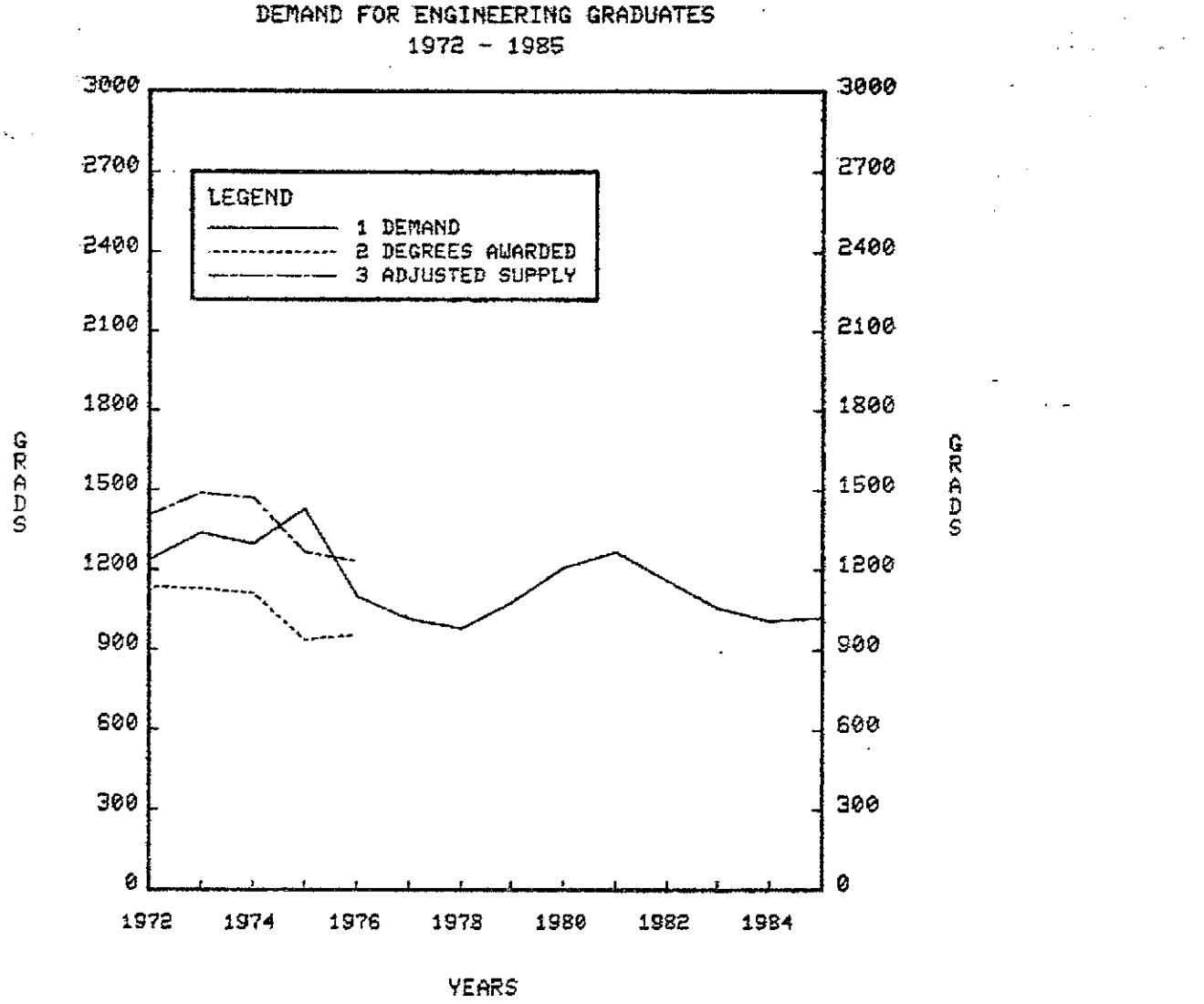
DEMAND FOR ENGINEERING GRADUATES
1972 - 1985




SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 7

ALL DEGREE LEVELS - MECHANICAL ENGINEERING



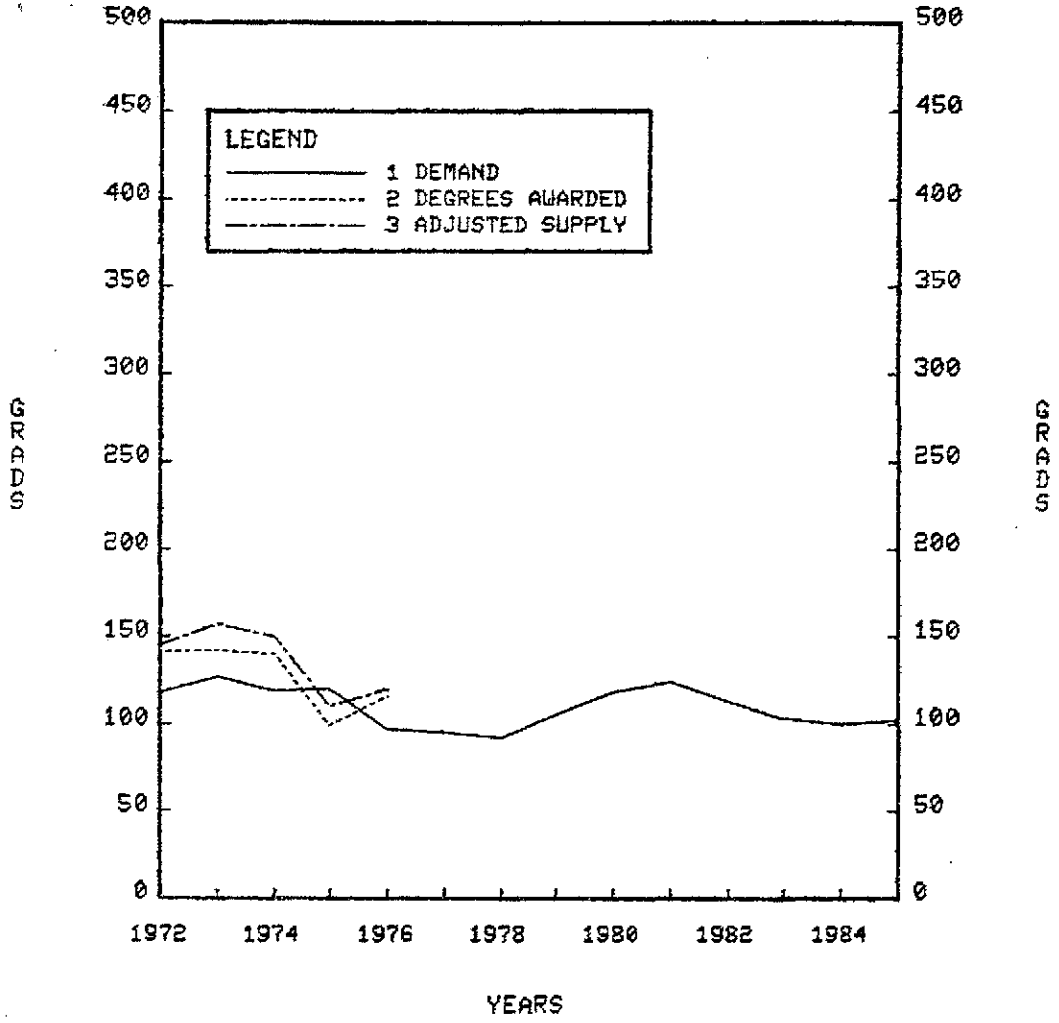

SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 8

ALL DEGREE LEVELS - METALLURGICAL ENGINEERING

DEMAND FOR ENGINEERING GRADUATES

1972 - 1985

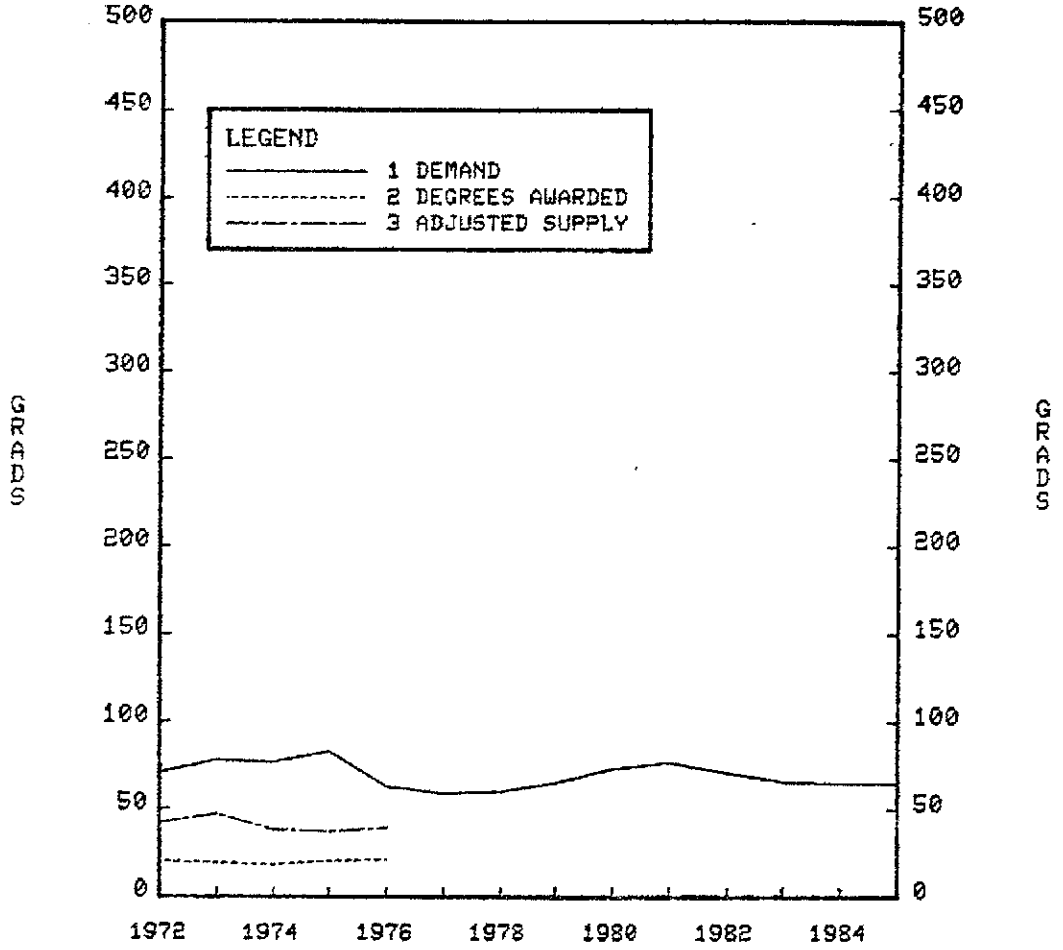



SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 9

ALL DEGREE LEVELS - AERONAUTICAL ENGINEERING

DEMAND FOR ENGINEERING GRADUATES
1972 - 1985

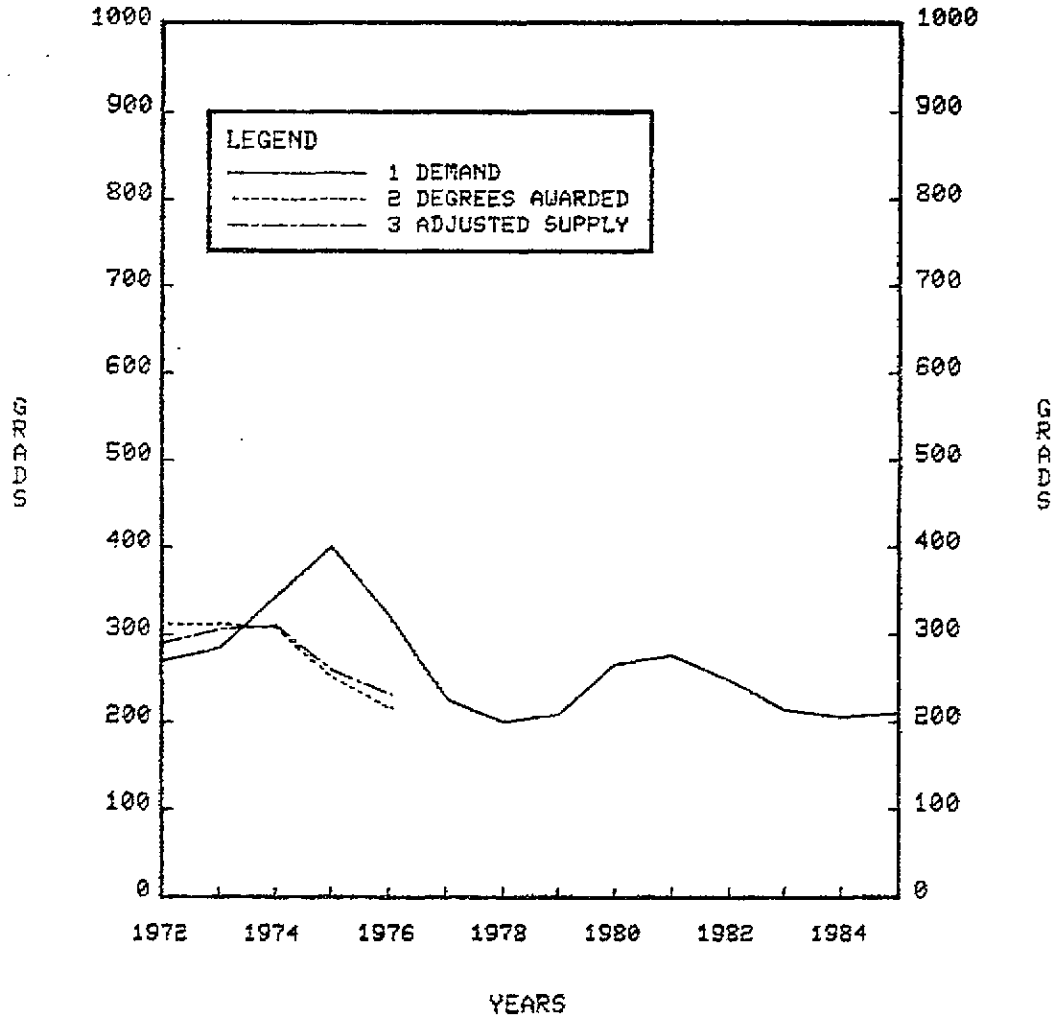



SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 10

ALL DEGREE LEVELS - MINING ENGINEERING

DEMAND FOR ENGINEERING GRADUATES
1972 - 1985

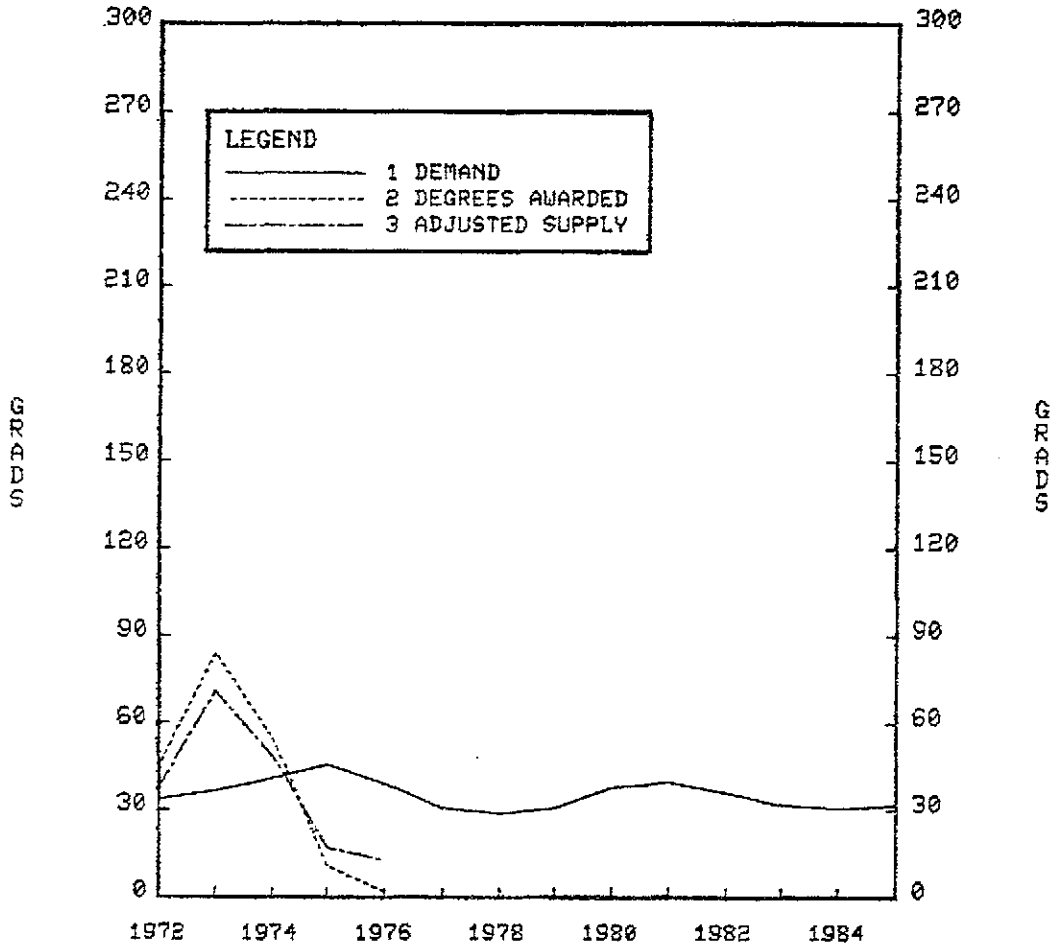



SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 11

ALL DEGREE LEVELS - PETROLEUM ENGINEERING

DEMAND FOR ENGINEERING GRADUATES
1972 - 1985



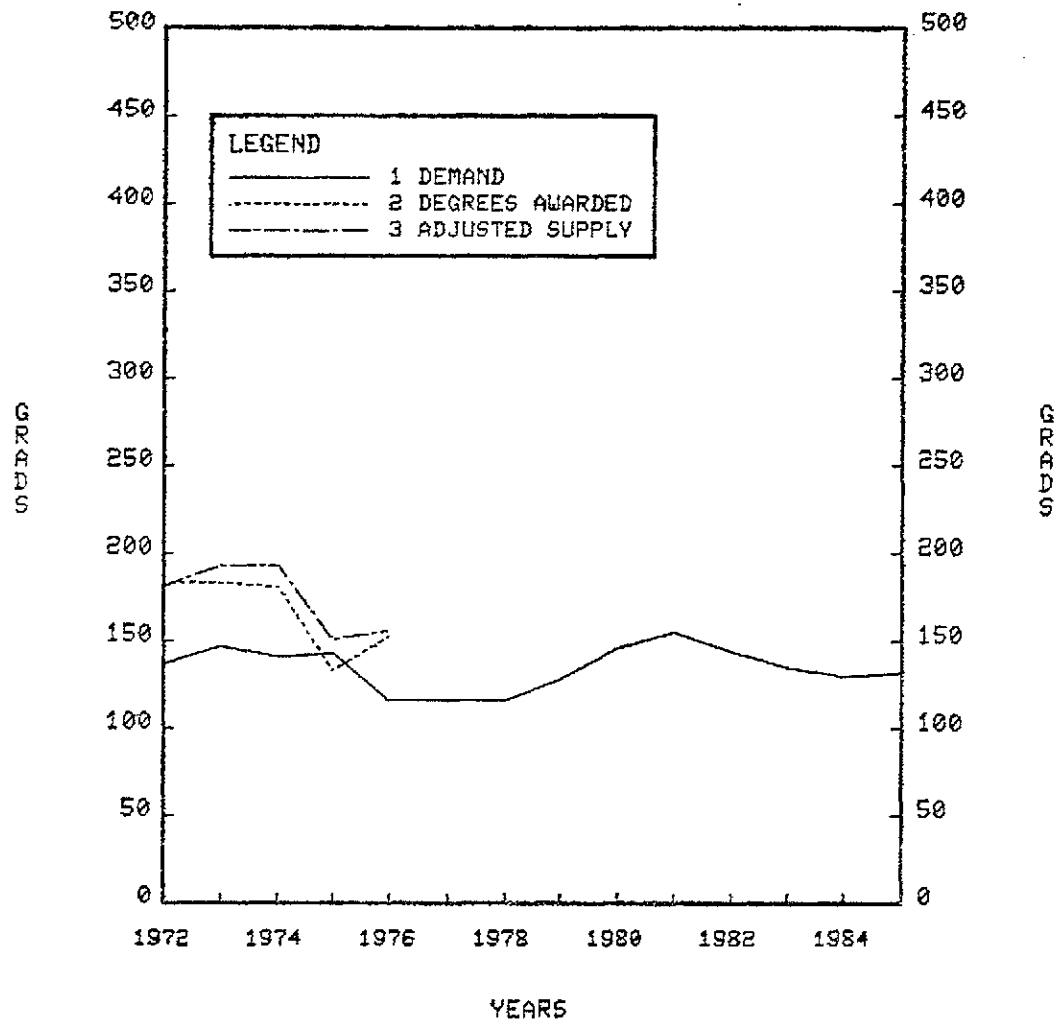

SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 12

ALL DEGREE LEVELS - INDUSTRIAL ENGINEERING

DEMAND FOR ENGINEERING GRADUATES

1972 - 1985



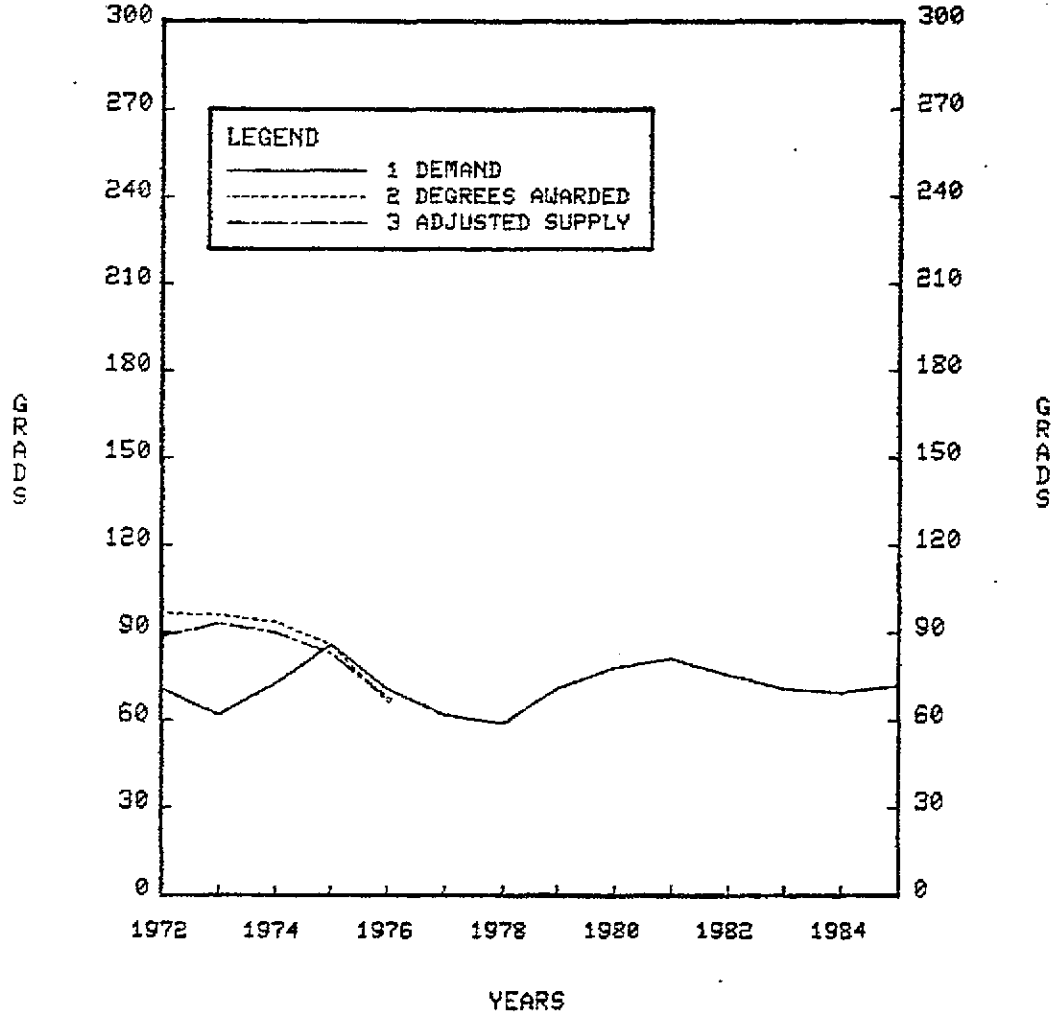

SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 13

ALL DEGREE LEVELS - AGRICULTURAL ENGINEERING

DEMAND FOR ENGINEERING GRADUATES

1972 - 1985



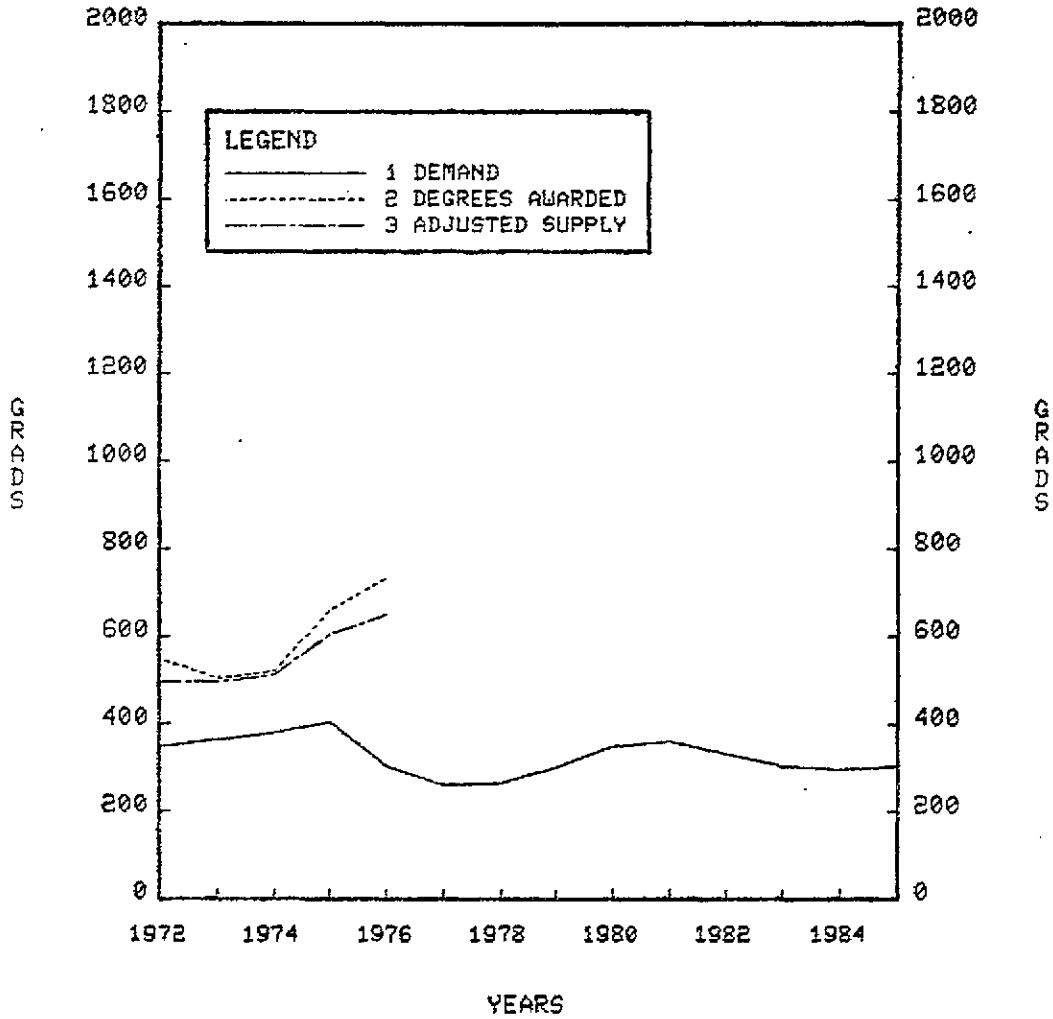

SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)

CHART 14

ALL DEGREE LEVELS - OTHER ENGINEERING

DEMAND FOR ENGINEERING GRADUATES

1972 - 1985




SOURCE : MOSST: HIGHLY QUALIFIED MANPOWER DEMAND MODEL (MARCH 22,1978 SIMULATION)