PN-ABN-441

# LABOR MARKET DEMAND

# AND

# PLACEMENT SERVICES

# FOR RETURNED PARTICIPANTS OF

# THE TECHNOLOGY TRANSFER PROJECT

# (664-0315)

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Study Team:
Jesse J. McCorry
Rosemary Bellew
Paul Hebert
Michel Skapa

Report Preparation:
Jesse J. McCorry
Rosemary Bellew
David E. van Tijn

TvT Associates
503 Capitol Court, N.E., Suite 300
Washington, D.C. 20002
(202) 547-4550

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## PROJECT IDENTIFICATION DATA

1. Country: Tunisia

2. Project Title: Technology Transfer Project

3. Project Number: 664-0315

4. Project Dates:

   a. First Project Agreement: FY 81 (4th quarter)
   b. Final Obligation Date: FY 86 (planned)
   c. Most recent Project Assistance Completion Date (PACD): 8/31/87

5. Project Funding: (amounts obligated to date in dollars or dollar equivalents from the following sources) (Amendment 6)*

| | | |
|---|---|---|
| a. | A.I.D. Bilateral Funding (grant and/or loan) | US$20,150,000 |
| b. | Other Major Donors | - |
| c. | Host Country Counterpart Funds | US$19,969,000 |
| | TOTAL | US$40,119,000 |

6. Mode of Implementation:

   Government of Tunisia
   Academy for Educational Development (A.I.D. Contractor)

7. Project Designers:

   Government of Tunisia -- USAID/Tunis
   PSI Associates, Inc.

8. Responsible Mission Officials:

   a. Mission Directors: Martin V. Dagata, James R. Phippard, C. Fritz Weden
   b. Project Officers: William G. Kaschak, Mark Karns

9. Previous Evaluation: Creative Associates, Inc., January 1986

* Total obligations

## ACRONYMS

| | |
|---|---|
| BAC | Bachelier = High School Diploma |
| BNEC | Bureau National d'Emploi des Cadres<br>National Professional Employment Bureau |
| BRE | Bureau Regional d'Emploi<br>Regional Employment Bureau |
| BSc/BS | Bachelor of Science<br>Bachelier + 4 |
| CERES | Centre d'Etudes et de Recherches Economiques et Sociales<br>The Center for Economic and Social Research |
| CETIME | Centre Technique des Industries Mecaniques et Electriques<br>The Technical Services Center for the Mechanical and Electrical Industries |
| CNEI | Centre National des Etudes Industrielles<br>National Center for Industrial Studies |
| GOT | Le Gouvernement Tunisien<br>The Government of Tunisia |
| IEQ | Institut Economique et Quantitative<br>The Institute of Quantitative Economics |
| INS | Institut National de Statistique<br>The National Institute of Statistics |
| ISG | Institut Superieur de Gestion<br>The Institute of Advanced Management |
| MSc/MS | Master of Science<br>BAC + 6 |
| MESRS | Ministere de l'Enseignement Superieur et de la Recherche Scientifique<br>Ministry of Higher Education and Scientific Research |
| MUST | Mission Universitaire et Scientifique de la Tunisie<br>The University and Scientific Mission of Tunisia |
| PhD | Doctor of Philosophy<br>Doctorat d'Etat |

| | |
|---|---|
| OPETT | Office de la Promotion de l'Emploi des Travailleurs Tunisiens a l'Etranger<br>The Office for the Promotion of Tunisian Workers Abroad |
| PNUD | Programme des Nations Unies Pour le Developpement<br>UNDP - United Nations Development Program |
| USAID | Agence International Pour le Developpement des Etats-Unis<br>United States Agency for International Development |
| USIS | Service d'Information des Etats-Unis<br>United States Information Service |

# EXECUTIVE SUMMARY

The Technology Transfer Project (TTP) originated in 1981 as a modest 1.45 million dollar effort with a focus on institutional development. In the course of time, after six amendments, the emphasis has changed to supporting a major participant training initiative of the Government of Tunisia (GOT), and the USAID/Tunis expenditure has increased to almost 18 million dollars. This sum represents a significant proportion of the Mission's portfolio.

In preparation for developing the next set of program amendments, USAID and the GOT decided that it would be useful to determine if the project was continuing to be responsive to, and supportive of, the development needs of the country. The Government's seventh five-year plan (1987-91 and its economic adjustment policies suggested that development priorities may have changed, and it was unclear if the project in its present form was consistent with those new priorities.

TvT Associates was given the assignment to respond to these concerns. A four-person team conducted a six-week field study in Tunisia, followed by additional data analysis in Washington, DC. The assignment may be paraphrased as requiring a response to the following questions:

(1) Is the Technology Transfer Project still meeting the development needs of Tunisia?

(2) Is there a need for a program redesign that would address the employment needs of its graduates?

(3) Is the program likely to contribute to an oversupply of engineers in view of the changed economic environment of Tunisia?

The complete work statement is provided in Appendix 3. In addition to the tasks in the statement of work, a number of related questions were examined:

(1) An investigation was made of the status of TTP graduates since their return to Tunisia, and 30 returnees were interviewed.

(2) A complete accounting (as of August 1987) was made of:

- degrees granted under the TTP program,
- individuals graduated from the program, with the number of their (program) degrees,
- individuals currently enrolled in the program with the number of (program) degrees.

This reconciliation allows a complete accounting of the project's output and current load in both individuals and degrees.

## MAJOR FINDINGS

The findings of this study are given in detail in Chapter 4. We summarize below the major findings.

### Supply and Demand for Engineers

There will be a bifurcated labor market, with

- an oversupply of engineers in the fields of mechanical, electrical, civil, and mining engineering, especially at the "engineer" (BAC+4) level; and
- a continuing need for personnel in most other fields, especially the higher-technology fields and at the "principal engineer" levels.

### Strengthening Tunisian Institutions

- The Technology Transfer Project has been shifting participants into areas of need, and continuing participants to higher degrees.
- In addition, the Technology Transfer Project is training selected participants to the PhD level, with a view to strengthening the faculties of Tunisian institutions.

### Policy Analysis and Management Training

- Though no quantitative analysis of the demand and supply for these fields was performed, a qualitative analysis showed that a need in these areas will develop, due to:
  - increased use of computers in administration and for information systems,
  - increased emphasis on financial services,
  - privatization and increased emphasis on the private sector,
  - decentralization, and
  - increased emphasis on export marketing and foreign exchange earnings.

- Tunisian insitutions are producing personnel in the policy analysis and management areas, but mainly at the BAC+4 level. The programs are limited.

- The Technology Transfer Project has already shifted toward these areas. While 21 percent of Master's degrees and 17 percent of PhDs who have completed the program were in policy/business fields, among current enrollees the proportions are 29 percent of Master's students and 21 percent of PhD students.

Placement Services

- No need was found for establishment of formal placement services in either the public or private sector. Current search methods for employment and employees are satisfactory to both employers and job seekers. Of thirty returned TTP graduates interviewed, twenty-seven were currently employed, two had severed previous employment to find better jobs, and one was unemployed.

- Provision of secretariat services to the "amicale" of returned foreign students would

  - strengthen returnees' networking efforts

  - provide an unobtrusive method to maintain contact with returned TTP graduates.

- In addition, there is a need for TTP skills in the private sector in the areas of

  - equipment maintenance and repair

  - computer support, and

  - consulting in specialty engineering fields.

  TTP graduates could consider becoming entrepreneurs in these areas. Support from private sector development projects of USAID/Tunis in the form of

  - provision of materials detailing opportunities and sources of support, and

  - business development support

  would help fill this need, and provide additional opportunities for TTP returnees.

Disposition of TTP Graduates

- The team was able to ascertain the status of sixty-seven TTP graduates who had finished prior to January 1987. Of these, 63 were in Tunisia and four were working abroad.

- In toto, 643 students have entered the program and 166 have completed their studies. Of the 477 currently enrolled, 121 already have one American degree and 24 of 105 PhD students have two prior American degrees. The retention of students past their first American degree contributes to the objective of the Technology Transfer Project to transfer American technology and private sector orientation.

Project Administration and Management

- The selection and management of TTP students is well organized and effective.

- The observed reorientation of degree and field objectives of participants conforms to the needs found in this study.

- Employers and returned participants expressed the opinion that employability of TTP graduates would be enhanced if their programs included summer cooperative work experience in the U.S. or Tunisia.

- USAID/Tunis has difficulty obtaining a satisfactory accounting of students and degrees from the Project. This problem could be alleviated by expanding the student tracking system used by MUST to manage individual students and their programs to a data base system.

## MAJOR RECOMMENDATIONS

Project Continuation and Reorientation

The Technology Transfer Project is fulfilling its intended objective of transferring American technology and orientation toward technological, management and economic challenges to Tunisia. It should be continued at approximately its current level.

Flexible program goals should be formulated in the areas of:

- the distribution of Project output among degree levels, and the distribution of the number of degrees earned with Project support,

- the distribution (by degree level) of degrees among
  - various engineering and other technology fields,
  - policy analysis, and
  - management;

and a modality, involving MESRS, MUST and USAID/Tunis should be developed to continue to adjust these goals to GOT development needs.

Project Administration and Information

Support should be provided to MUST to convert the present student tracking system to a data base system which will routinely deliver information on:

- the number of graduates at each level and the number of American degrees for each,
- the number of students studying for each degree and the source (American or Tunisian) of their previous degrees, and
- field of study.

This information will allow a complete accounting of Project output in both individuals and in degrees.

Placement Service

We recommend that no formal placement service be initiated for Technology Transfer graduates; however, other support should be provided (see below).

Networking Support

An effort should be made to provide support in the form of a secretariat to the "amicale" of returned foreign students and/or the Order of Engineers. This secretariat could provide help in

- registration,
- preparation and mailing of resumes, and
- networking, and

it would furnish a method of maintaining contact with and supporting returned graduates.

A local company might provide these services under contract. The contractor could also supply support to local employers in locating personnel with scarce skills. At a small fee for such service the secretariat might become self-supporting.

Private Enterprise Support

An effort should be made to support returned TTP graduates who want to go into business for themselves, either as a service business or as manufacturers. This support could consist of

- material identifying
  - the need (potential clients) for such businesses, especially service businesses, in the Tunisian economy, and
  - the support available for entrepreneurs;
- distribution of such material, to
  - MUST, for inclusion in a "return kit," and
  - to returned graduates; and
- perhaps, financial and business development advisory support for aspiring entrepreneurs who are TTP graduates.

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# CHAPTER 1

# INTRODUCTION

This study of labor demand and supply in the engineering sectors was undertaken to assist the USAID mission in Tunisia to assess the need, if any, for modifications to its on-going Technology Transfer Project with the Government of Tunisia (GOT). This project has been amended six times since its inception in 1981.

Between 1981 and 1987 the Technology Transfer Project (TTP) changed its focus from institutional development to long-term participant training with an emphasis upon degrees in the engineering disciplines. During this same time period, USAID/Tunis has seen its financial participation increase from a modest 1.45 million dollars to almost 18 million dollars by 1987. This sum represents a significant proportion of the Mission's portfolio.

In preparation for developing the next set of program amendments, USAID and the GOT decided that it would be useful to determine if the project was continuing to be responsive to, and supportive of, the development needs of the country. The Government's seventh five-year plan (1987-91) and its economic adjustment policies suggested that development priorities may have changed, and it was unclear if the project in its present form was consistent with those new priorities.

Decline in the economic circumstances of the country also gave rise to some concern at USAID that graduates of the project might be encountering difficulties in finding employment upon their return to Tunisia. Associated with this concern was an uncertainty about the strength of demand for trained engineers and the supply of such personnel through 1992. For USAID/Tunis, then, this labor market study was seen as a way to help answer three major questions:

(1) Is the Technology Transfer Project still meeting the development needs of Tunisia?

(2) Is there a need for a program redesign that would address the employment needs of its graduates?

(3) Is the program likely to contribute to an oversupply of engineers in view of the changed economic environment of Tunisia?

The present report is the result of a six-week field study, followed by data analysis and report preparation by TvT Associates in Washington, DC. This report provides findings and recommended actions in each of the three principal issue areas

just noted. In addition, the TvT study team has sought to address a number of related questions that arose during its field investigations, including information on the situation of program graduates since their return to Tunisia. We have also included an analysis of the project's degree output since its inception. While this information was not required by the scope of work, TvT believes that it will be of value to USAID as it plans for the upcoming five-year period.

From the information that the team was able to gather, the Technology Transfer Project has been successful in meeting the objectives set by the GOT and USAID/Tunis. Students selected for the project are completing their original degree objectives at a very high rate. In addition, we found that substantial numbers of these degree recipients then continue their studies for advanced degrees. This report discusses the kinds of adjustments in fields of study and of participants that the GOT has made in response to changing economic circumstances and development priorities.

Tunisia has and will continue to have a surplus of engineers at the "Engineer" level (BAC+4) in selected fields through 1992. However, TTP graduates are entering the Tunisian labor market with higher degrees and with specializations that are in limited supply, and needed to fulfill the VIIth Plan goals. Thus, the economy appears to have the absorptive capacity to accommodate this cohort. It should be noted in this context that the GOT has already taken some steps to restrict entry in Tunisian institutions to the most congested disciplines.

Our overall assessment of the Technology Transfer Project is that there is no evidence to support the initiation of a major program redesign effort. The modifications which this report does recommend are aimed at improvements in management efficiencies and responsiveness, a process that will require close cooperation by both the GOT and USAID/Tunis.

Chapter 2 of this report discusses briefly some of the background information for this study including project history, an overview of the labor market, the terms of reference for and the TvT approach to the investigation. Chapter 3 contains the results of the study, including a largely descriptive analysis of the demand for and supply of engineers in Tunisia. The TvT study team's findings are presented in Chapter 4. Chapter 5 contains the team's recommendations based on their findings. A list of persons contacted in connection with the study is attached as Appendix 1. Appendix 2 contains sources; Appendix 3 the Statement of Work for the study. The procedures used for estimating demand and supply are described in detail in Appendix 4 and several alternate scenarios for projected labor market balance are presented.

# CHAPTER 2

# BACKGROUND OF THIS STUDY

## 2.1 Project History

The Technology Transfer Project (TTP) (664-0315) originated in 1981 as a relatively small project to support the Government of Tunisia (GOT) in a major initiative to transfer American technology to Tunisia. The GOT proposed at that time to train approximately 1,000 Tunisian students in engineering disciplines in the United States. The project also supported limited initiatives in faculty exchange and development and strengthening of Tunisian academic institutions. These initiatives were accomplished by the original PACD of December 31, 1984.

The GOT continued the major initiative of training students in the United States. Owing to its deteriorating foreign exchange position, the GOT requested that ESF funds be used to cover some of the costs of maintaining this effort. These requests were granted; in the fourth amendment the PACD was extended to August 31, 1987 and 41 percent of the total cost of the training effort was met from AID funds.

The Technology Transfer Project represents a major portion of the USAID/Tunis portfolio, and the Mission has, therefore, a need for the kind of feedback on:

- the number of students who complete their programs of study
- the number of students who return to Tunisia
- the number of students who proceed to the next higher degree, e.g., BSc to MSc, MSc to PhD, etc.
- the employment status of students who have returned to Tunisia, and the extent to which they are using the training they have received and transferring technology in their own right.

At the same time, the training effort is managed by the GOT, who still contribute more than half the cost of the program. The original project funds were in part used to establish an office in the Tunisian Embassy in Washington to manage and administer the training effort in the United States. This office, the "Mission Universitaire et Scientifique de Tunisie" (MUST), maintains project-related information for its own purposes. USAID/Tunis is dependent on this source for program feedback.

## 2.2 Overview of the Tunisian Labor Market for Engineers*

The past five years (1982-1987) has been a difficult period for the Tunisian economy. Growth in Gross Domestic Product (GDP) slipped to -0.2 percent and -1.2 percent in 1982 and 1986 respectively, bringing the average real growth in GDP for the period to 2.9 percent annually. Prices on the world market for Tunisia's primary exports also fell while imports grew faster than exports. As a result, terms of trade dropped on average two points per year, and the balance of payments deficit rose significantly.

These conditions, together with a decline in the "guest worker" market in Western Europe and the Gulf States, a decrease in tourism and the closing of the Libyan labor market have led to an increase in unemployment to 264,000 (13.8 percent of the active population) in 1986. This unemployment has begun to affect some of the engineering categories.

The current use of engineering manpower is heavily influenced by past demand. Tunisia has traditionally drawn upon the engineering professions to fill managerial and policy-making positions in its public and private sectors. This probably represents a rational use of technically trained manpower in the areas of greatest national need. Nevertheless, continuation of this practice could lead to some under-utilization of the skills acquired by the graduates of the Technology Transfer Project.

In addition, heavy investment in infrastructure development during the Vth and VIth Plans created many positions in the more traditional engineering fields of civil, mechanical and electrical engineering. The current distribution of engineers across engineering fields and economic sectors reflects this history and is therefore not necessarily a good guide to the future need for engineers.

The Technology Transfer Project is less concerned with the current distribution of engineers in the labor force than with the prospective distribution of and the level of demand for additional trained manpower in the Tunisian economy. This demand will be generated on the basis of a number of factors:

- The VIIth Development Plan emphasizes growth in the relatively higher-technology sectors of manufacturing, agriculture, food processing, commerce and services.
- Within these sectors, emphasis on technology applications in such areas as
  - use of materials,

*Details of the estimation of demand for and supply of engineers, as well as sources are provided in Appendix 4. This section gives a qualitative overview of the background situation.

- production management and process control for greater efficiency, and

- quality control

will require high levels of technical expertise in selected engineering fields related to the manufacturing operations being improved.

- The increased use of computers in technical processes will also require high levels of technical expertise to develop specifications for new computer programs or to choose and adapt available packages.

- Finally, all these engineering improvements, as well as increased applications of computers in administration will require personnnel trained in the management and policy sciences to enable the Tunisian private sector to fully exploit its high-technology opportunities.

## 2.3. Statement of Work for this Study

The Statement of Work for the TvT study (Appendix 3) reflects the situation described above. It does not call for a project evaluation, but for a labor market study of the engineering professions, including an investigation of existing placement methods and the possible need for developing placement services.

In particular, the SOW called for:

- a demand study

  - describing the existing structure and distribution of engineering employment

  - examining the suitability of the current trained stock of engineers to Tunisia's development needs

- a supply study

  - estimating in what fields of specialization, at what degree levels, and at what output levels Tunisian students should be trained by the U.S. Technology Transfer program, based on

    - estimated annual demand for engineers by degree level and field of specialization in the 1988 to 1992 time period, and

- the estimated annual output of trained engineers by degree level and field of specialization of
    - Tunisian institutions
    - other foreign donor programs

- a study of current placement methods

  to examine current methods of locating employment for engineering graduates, including activities by the Scientific Mission for Tunisia in Washington (MUST), by the Ministry of Higher Education and Scientific Research (MESRS), and of other institutions; of the effectiveness of these organizations in finding employment for university graduates in general and the Technology Transfer Project graduates in particular, and to make recommendations regarding the methods for securing job placement for Technology Transfer graduates, including possible methods of

  - coordination of MESRS and MUST for job placement
  - active involvement of other GOT organizations and private sector organizations
  - strengthening of the system by
    - additional staff
    - technical assistance and training of current and/or additional staff
  - establishment and operation of a job placement service, again possibly with additional staff and training.

## 2.4 Approach to this Study

The TvT team's method of approach to this study has been to rely to the maximum extent possible on quantitative sources, supplemented with interviews for those aspects of the study which were not susceptible to quantitative analysis.

The team was able to find sources to quantitatively estimate:

- the current (1987) stock of engineers by engineering field and level of training (Principal Engineer, Engineer)

- the additional supply of engineers (by level and field) required to implement the VIIth Plan under the assumption that in each economic sector the use of engineers by level and field as a proportion of the labor force remains the same as current use.

- the additional supply of engineers by field and level of training required to implement the VIIth Plan under a number of different assumptions regarding the shift in the demand for engineers by field and level given the VIIth Plan's emphasis on increasing the technological content of the economy.

A detailed description of the methodology used and of the sources of data for these estimates is given in Appendix 4.

In addition, quantitative estimates were obtained on the prospective supply of engineers from

- Tunisian institutions, from the Ministry of Higher Education and Scientific Research (MESRS), the Ministry of Planning and the Ministry of Agriculture;

- French institutions, from the Office of Cultural and Cooperation Services, the Embassy of France;

- Canadian institutions, from the International Development Agency, the Embassy of Canada;

- other donors institutions, from the international cooperation agencies or cultural affairs offices in the embassies of Sweden, the Federal Republic of Germany, and Japan. For some of the smaller bilateral programs the team utilized data from U.N. documents and MESRS; and

- for the Technology Transfer Project, from USAID/Tunis, MESRS and the MUST office in Washington.

In order to obtain information on hiring practices, and also on employers' current expressions of interest in hiring additional personnel, more than twenty employers in the private, public and parastatal sectors were interviewed. Their names are included in the list of persons interviewed in Appendix 1.

A number of interviews were conducted with Ministry officials and senior university personnel in order to obtain information on

- the organization of and plans for the training of engineers

- the organization of job placement services

- the officials' estimates of the prospective need for additional engineering and management personnel.

Finally, though not a part of the Statement of Work, team members interviewed thirty returned Technology Transfer Project graduates, in order to obtain information on

- employment status
- means of obtaining employment.

At the specific request of the students with whom we spoke in preparing this report, we agreed to treat our conversations as confidential. However, published research in this area by Tunisian scholars tends to support the information which the graduates provided [see reference 5]. The information obtained from all these sources was then synthesized to respond to the questions posed in the Statement of Work.

# CHAPTER 3

# STUDY RESULTS

This section contains a brief description of the conduct of the study and, in narrative form, some of the observations and responses that were obtained during the study; findings, summarizing these observations and results are formulated in Chapter 4.

## 3.1 The Demand for Engineers

### 3.1.1 Quantitative Estimates

Estimating the demand for engineers in the 1988-1992 period requires a number of steps, each of which requires the assembly of such data as are available, and estimation and extrapolation on the basis of these data.

One difficulty in estimation is the fact that economic extrapolation and planning is done by economic sector: the VIIth Plan governs projected (capital) investment by economic sector and predicts growth in employment by economic sector. However, engineering training is by engineering field and degree. It is therefore necessary to estimate the employment of engineers by degree and field separately for each economic sector in order to convert projected economic growth into an estimate of demand for trained engineering manpower.

The steps actually followed in the estimation procedure are described in Appendix 4, together with the sources on which the estimations were based. The steps are as follows:

- The 1987 stock of engineers for two levels of training (principal engineer and engineer (MSc/BAC+6 and BSc/BAC+4)) and by engineering field was estimated, separately, for each economic sector.

- This distribution was then applied to the sectoral growth projected in the VIIth plan to obtain the required engineering labor force in 1992 if the use of engineers by sector does not change.

- The difference between the 1987 stock and the 1992 requirements represents the demand for engineers in the period, if the requirement for engineers by field and level do not change.

Finally, several different assumptions were formulated regarding changes in the requirements for engineers by field and level, to obtain demand estimates under a variety of possible conditions. The method of projection chosen, by postulating increases in the use of selected engineering fields and degree levels, rather than by projecting proportional increases in the current distribution of engineers was chosen for a number of reasons:

- The current field of specialization of engineers in the workforce is heavily influenced by past history and practices. In particular,
    - earlier heavy infrastructure development required a large number of civil, mechanical and electrical (power) engineers. The VIIth Plan does not show a major increase in these activities.
    - in the past, many engineers have been hired into supervisory and management positions without much actual engineering experience. This may well have represented an efficient use of scarce manpower, but gives little indication of the current need for training in their particular specialty. With a greater availability of personnel trained in business and management science this practice may well diminish.
- The demand for engineering specialties and levels in the 1988-1992 time period will reflect both the sectoral emphases of the VIIth plan, and the trend toward higher technology, higher quality, export-oriented production and services. In particular:
    - The VIIth Development Plan emphasizes growth in the higher-technology sectors within manufacturing, agriculture and food processing, and commerce and services.

The alternate assumptions incorporated into our demand estimates in Appendix 4 also reflect projected changes in the country's economic performance.

The data on which the estimates of current distribution of engineers by field and level were based consisted essentially of a 1981 study adjusted by a 1984 census, revised upward to the current (1987) level of engineering manpower.

It is therefore probable that the newer engineering specialties such as computer, telecommunications and bio-medical engineering are under-represented in the original projections. Telecommunications and bio-medical engineering are subsumed under "electrical" and "other" engineering. The number of computer engineers in the original projection, which was very low, has been doubled to allow for this phenomenon.

This approach gives the prospective demand for engineers in the 1988-1992 time period, if the use of engineers by specialty does not change. In Appendix 4, a number of alternate assumptions about an increased use of certain fields, notably agricultural, computer, metallurgical and chemical engineering, in the economy were made and the demand projected on that basis.

Figures 3.1.1 and 3.1.2 display the demand for engineers by field and level for the base projection (with added computer engineers, and for one such assumption. A complete discussion of these cases appears in Appendix 4.

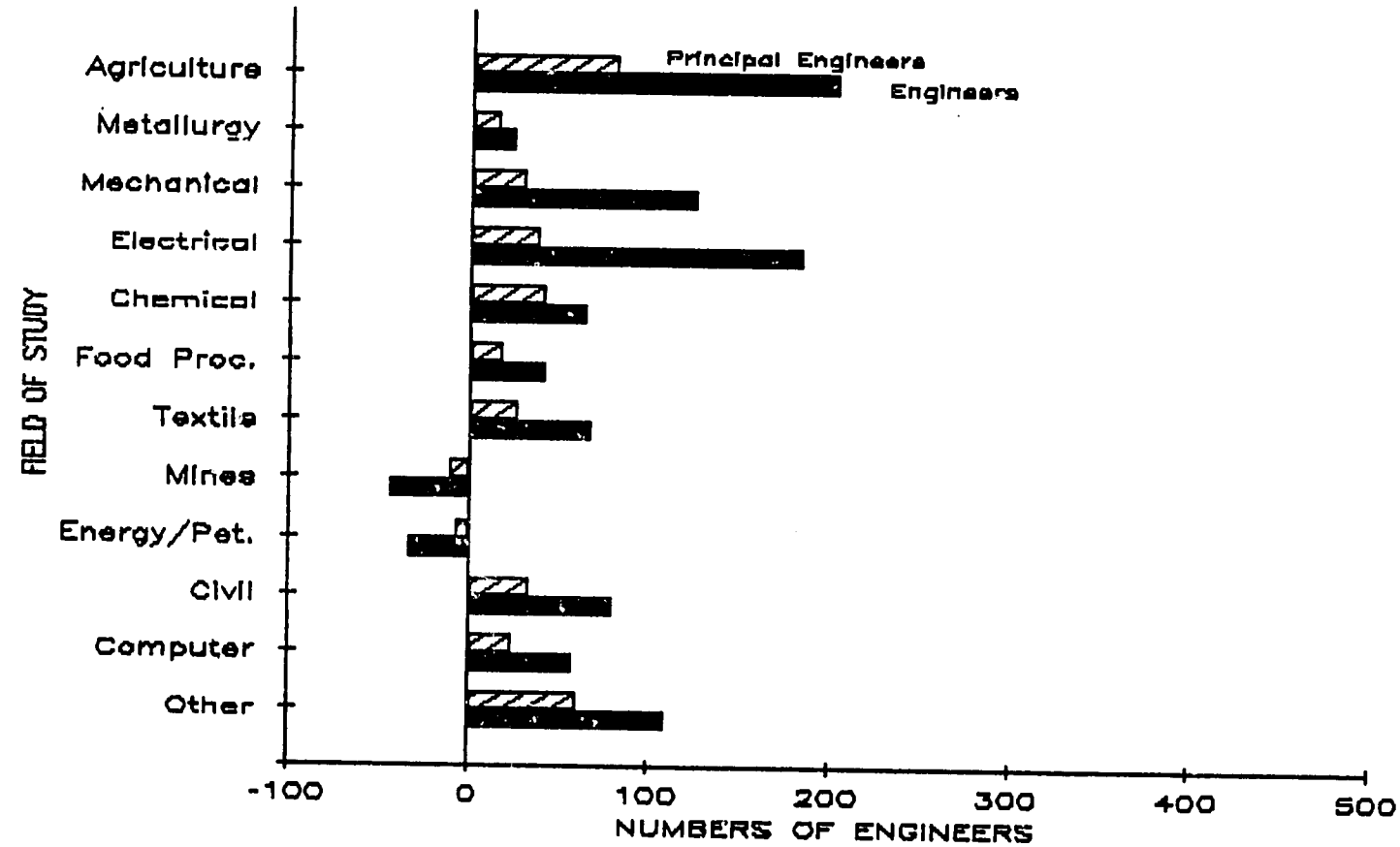
Figure 3.1.1 displays the number of additional engineers required in the 1988-1992 time period and the percent distribution of the engineering fields under $H_0$, the "no change" hypothesis. Figure 3.1.2 displays on top the $H_1$ hypothesis, the postulated percent additional engineers required for selected fields. The bottom of figure 3.1.2 displays the resultant number of engineers required given demand under $H_1$.

### 3.1.2 Views of Employers

Our interviews with public and private employers of engineers sought their views on the current supply and anticipated future demand for technically trained manpower. In general, Tunisian employers anticipated little change in their present distribution of engineering specializations. And, while they expressed some criticisms of the quality of the engineering graduates from Tunisian universities, they took the position that the needs of their enterprises were being met satisfactorily. Their principal criticisms reflected a belief that Tunisian engineering programs placed too much stress on the theoretical and not enough on practical applications. In this connection, they expressed approval of the practice of the cooperative placement of students in summer jobs. It was also clear from our discussions, especially with private sector employers, that personnel costs were a major concern. Such economic considerations have led to some reluctance on their part to hire the more skilled principal engineers, in part because of their higher initial salaries, and in part because of the added tax burden that those salaries would entail.

Tunisian private employers admitted that in not employing a greater number of principal engineers they restrict their ability to innovate and otherwise improve the performance of their enterprises. To a certain extent, however, these businessmen do accept the increased personnel costs just mentioned by hiring Technology Transfer graduates as well as other foreign-trained engineers. These engineers are perceived to have more technologically sophisticated skills that can be immediately applied in the workplace. It is the judgment of the team that these responses reflect:

FIGURE 3.1.1
DEMAND FOR ENGINEERS/Ha



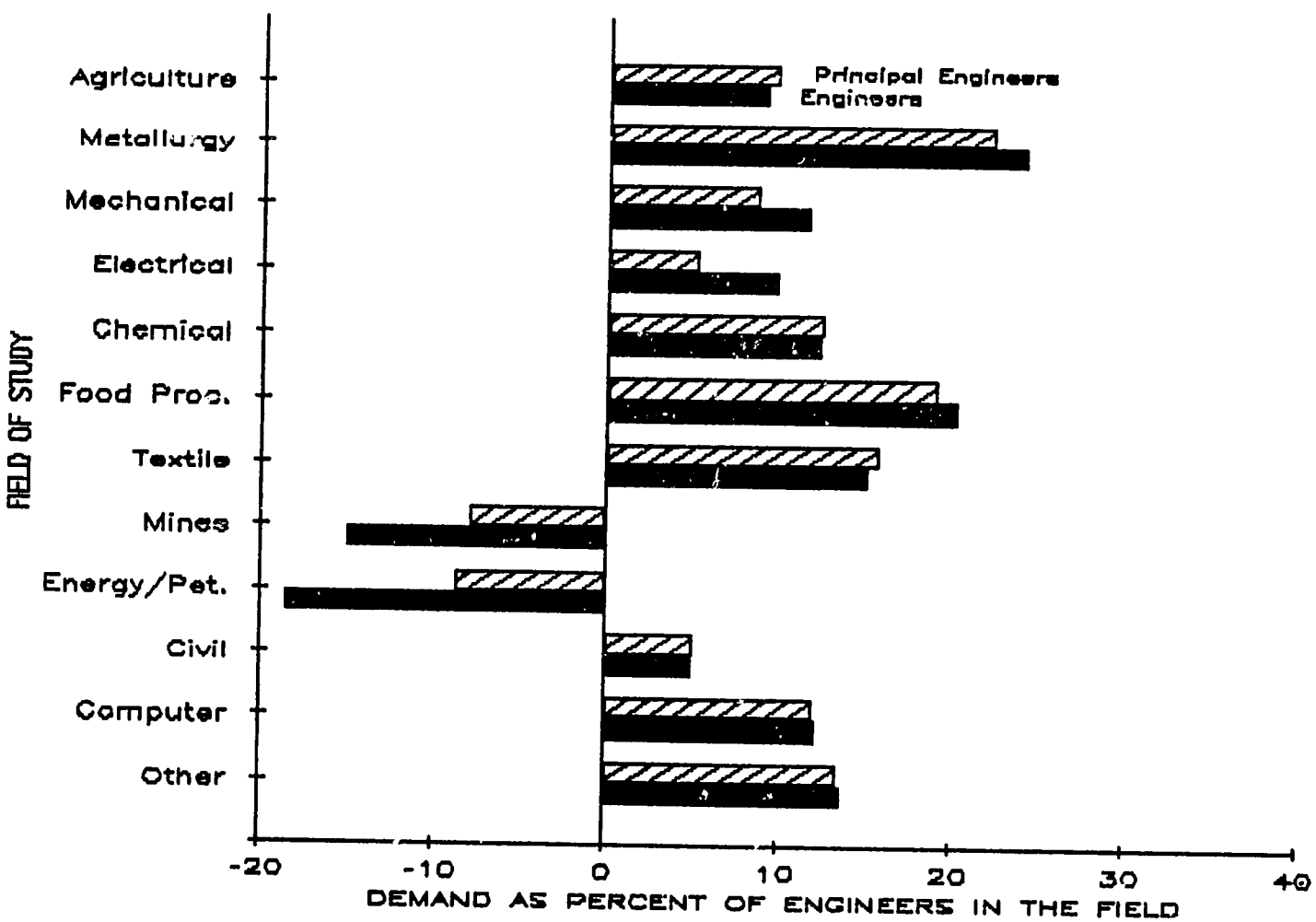
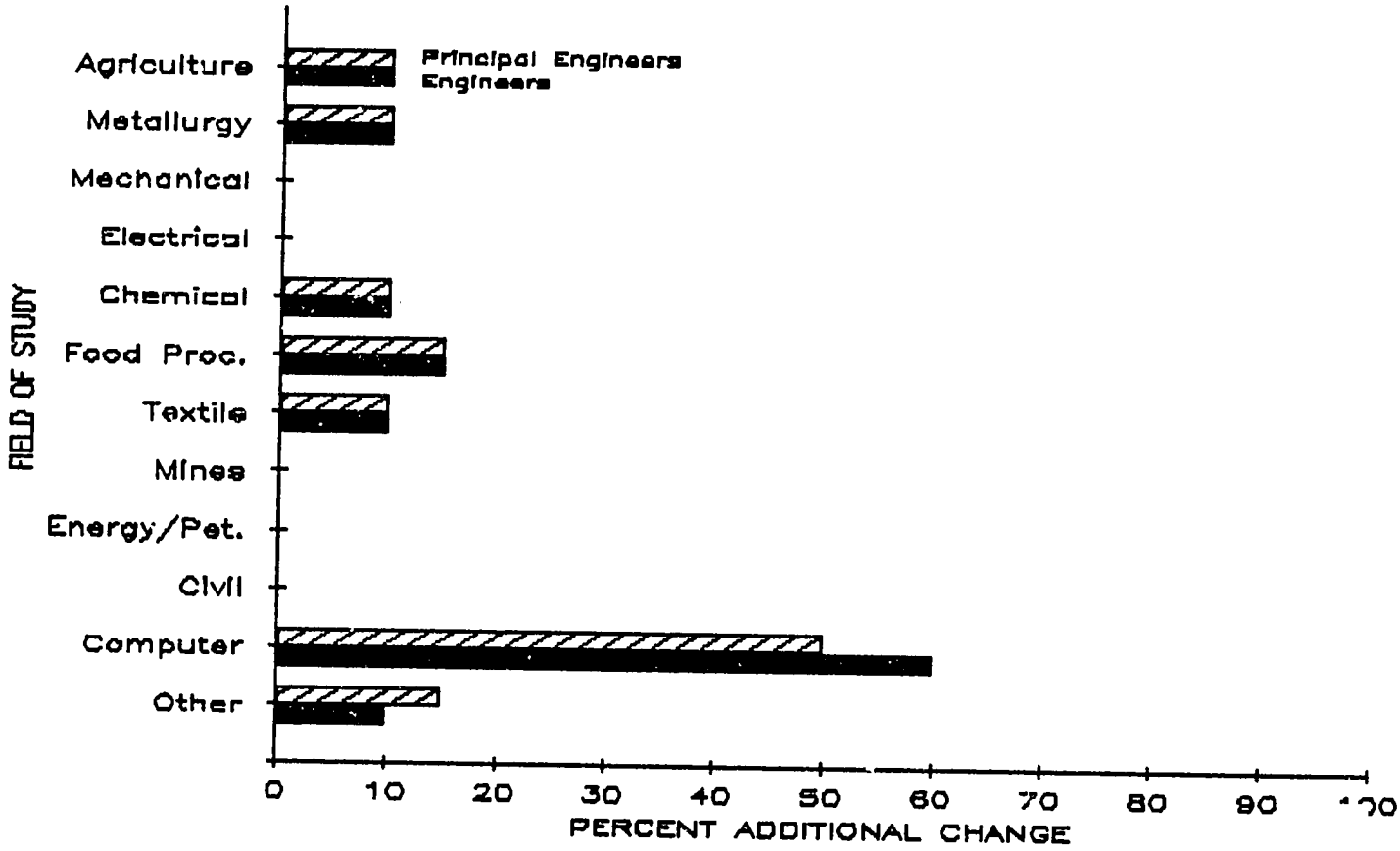
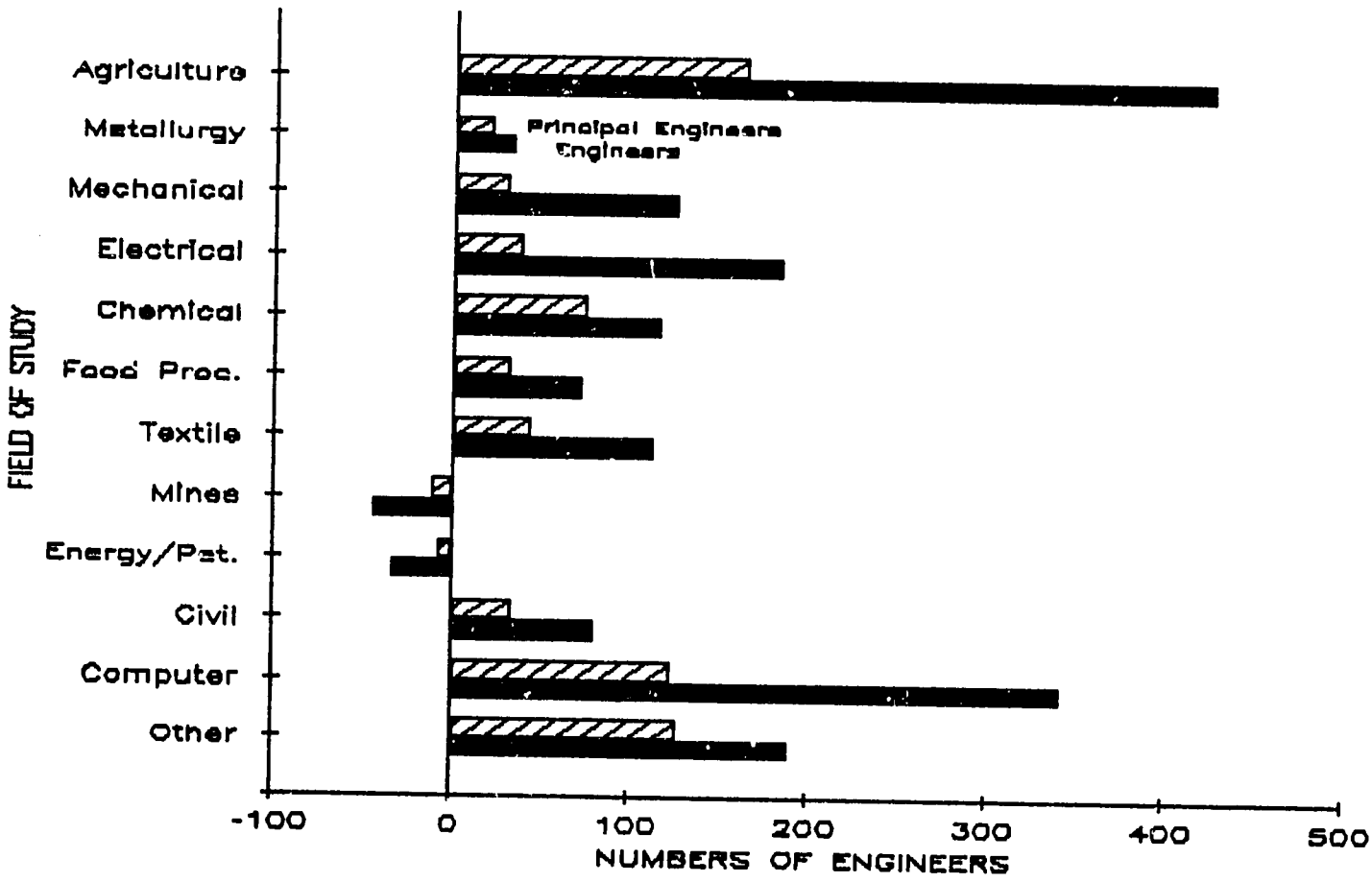



FIGURE 3.1.2

H1 SCENARIO: PERCENT ADDITIONAL CHANGE IN DEMAND




DEMAND FOR ENGINEERS/H1



- real concern with the high cost of personnel, which includes a 40 percent payroll tax; and

- tension among respondents regarding the need for technology and quality improvement and their high cost.

The responses also underline the practical difficulties of moving toward the use of more sophisticated equipment and methods. This difficulty is the consequence of an asymmetry of incentives which encourage investment in modern machinery and equipment, while discouraging investment in the highly trained personnel needed to put these to optimum use.

A final observation from the interviews is the uniformly expressed need for better (and easier) maintenance of plant and equipment. This may well indicate an area for private sector activities that returned Project graduates could undertake.

## 3.2 Supply: Size and Composition of the Output of Engineering Programs

The bulk of engineers currently in the labor force, as well as the majority of the prospective supply in the 1988-1992 time period are (and will be) Tunisian trained. Most of these are in the three fields of civil, mechanical and electrical engineering, and at the BSc (BAC+4) level.

This supply situation reflects an historical bias. When Tunisian institutions were being developed the VIth Plan called for heavy investment and job creation in infrastructure development and industrial manufacturing. A great demand in these fields was anticipated and the corresponding teaching faculties were enlarged. However, the rapid growth in enrollment of these institutions was not accompanied by an expansion of the engineering curricula. The capacity to provide advanced instruction and an expanded curricula are limited both by the capability and training of the faculties and staff and by limitations of equipment and research facilities.

A concern for the country's prospective demand for newer engineering specialties, and the availability abroad of the newest technology and facilities and of faculties able to teach these specialties motivated the GOT to initiate the large-scale U.S. training effort which has developed into the Technology Transfer Project. These considerations remain valid today, and will continue to underlie the need for the Technology Transfer Project in the 1988-1992 period. We discuss below the prospective supply of engineers by country of training.

Tunisia

For the period 1982-87 Tunisian schools produced about 97 percent of all engineering graduates. If we subtract from the Tunisian totals the almost 2,600 senior technicians (BAC+2), the local production remains quite high, approximately 95 percent of all engineers. Even though this represents an increase over the production of the previous five years, it should also be stated that their engineering enrollments began to decline with the academic year 1986-87. The three principal engineering schools (Tunis, Gabes, Sfax) enrolled a total of 2,478 students at the opening of 1986-87 which represented a slight decline from the 2,926 registered for the academic year 1984-85 [see reference 9]. Most of this drop occurred at the premier institution in Tunis. This suggests that the declining economic situation has begun to depress engineering enrollments because other enrollments at the university level show only slight decreases.

These figures indicate that Tunisia has made great strides in meeting its basic internal needs for first-level engineers. Indeed, Tunisia has also been able to furnish engineering personnel to other countries in the Maghreb and the Gulf States through its own international cooperation program.

Through 1987 the funded foreign contribution to the supply of engineers has been quite small, totalling only 226 graduates from the U.S., France, and Canada. Tunisia does turn to foreign institutions for assistance in training in the "high-tech" disciplines, and for advanced training unavailable in Tunisian engineering schools. Among such disciplines are computer sciences, computer engineering, alternative energy and agricultural engineering. Again, the number of foreign degree recipients in these fields is not large. Three countries, France, The United States and Canada have the most substantial engineering scholarship programs for Tunisian students.

### 3.2.2 Other Donor Programs

France

As might be expected, France until recently had the single, largest such program. For the period 1979-86, France provided science and technology scholarships to approximately 324 students at MSc (69 percent) or doctorate level (31 percent) [see reference 19]. French program officials estimated the following distribution by degree for graduates:

Graduate/Ing.Princ. .....122

Doctorate ..... 63

The fields of study selected by these scholarship recipients reflected the Tunisian preference for civil and electrical engineering. Interestingly, mechanical engineering was relatively

less popular among the students attending French institutions. The third most popular field was a combination of geological and mining engineering.

Like the Americans, the French have begun to raise some concerns about the suitability of their training to current Tunisian development needs. In discussions with the Service Culturel et de Cooperation we learned that France is considering a reduction in the number of scholarships for engineering disciplines to approximately 50 per year beginning in 1987-88.

It should also be kept in mind that there is a large complement of Tunisian students in French universities who are not participants in the scholarship program. Precise information on the fields of study or the numbers of these students was not available.

Canada

The Canadian Scholarship program continues to be relatively small, currently enrolling approximately 100 students (1987) in a variety of disciplines, but with a majority in engineering. While some consideration is being given to small increases in the number of participants, the Canadians appear to be more interested in developing partnerships between Canadian and Tunisian universities. Canada also makes available a number of provincial scholarships that are awarded on a competitive basis.

Other Donors

Tunisia has other bilateral and multi-lateral cooperation programs which also provide scholarships for engineering education with countries such as Sweden, Belgium, the Soviet Union, Japan, West Germany, and others. In terms of their individual contributions these activities tend to be small, and a number of them are not degree-oriented, e.g., the programs of Japan and West Germany. Due to their small size there is little systematic attention given to them by MESRS or the respective embassies. However, because they operate by means of scholarships and their financing is treated as scholarships by MESRS we have grouped these smaller programs in our totals and projections.

The total contribution of these smaller programs is probably overstated because in some cases they are aimed at skills improvement, or they treat particular specializations by means of short-courses for practicing engineers. In our conversations with the embassies' representatives in Tunis we found that none expected any expansion to occur in their existing programs, with the possible exception of some growth in the West German short-courses. In some respects, then these smaller programs might best be regarded as a form of on-the-job training rather than being viewed as major contributors to Tunisia's engineering stock.

### 3.2.3 U.S.: The Technology Transfer Project

The GOT is principally responsible for managing the Technology Transfer Project, from selecting participants through returning them to Tunisia after they receive their final degree, or until they otherwise cease to participate in the program. Tunisian officials have a considerable voice in the selection of fields of study for those students who go to an American university in pursuit of the bachelor's degree. Students who have completed the BAC+4 degree in a Tunisian institution are usually allowed to continue in the same field for their advanced degrees. With the exception of obligating funds and working with USIS to organize pre-departure language training at the Bourguiba Institute, USAID/Tunis plays a limited role in the management of the project.

The original impetus behind the Tunisian initiative to train a large number of students in the U.S. was the desire to transfer the most modern technology, the desire to have students trained in the practical approach, and the desire for them to develop intellectual independence and possibly to gain some familiarity with the American system of private enterprise.

This motivation persists today. It has lead the GOT to keep students in the program for second and even third degrees, so as to provide them with a thorough exposure to the American educational approach. Other students are being brought in with Tunisian bachelors degrees (BAC+4) to continue their studies for advanced degrees.

The fact that many students remain in the program for two or even three degrees has made program accounting difficult. There are far more degrees granted than there are students graduated or in the program. At the end of this section data are displayed which indicate the relation between the number of students and the number of degrees.

The priority engineering disciplines for project participants remained more or less the same between 1981 and 1985. This helps to explain why the project has such a large number of students in the three fields that we have already indicated (civil, mechanical and electrical engineering). However, according to MUST, beginning with the 1984-85 academic year the GOT stopped accepting BSc-level students for those fields. In view of our findings regarding a surplus in the above areas, this is a desirable policy development. (It appears, however, that this decision, based upon the Tunisians' reading of their labor market, was not immediately communicated to USAID.) Again, from the data provided to us by MUST a significant proportion of the students are remaining in the program to study for advanced degrees in disciplines in shorter supply. For example, of the 60 graduates as of August 1987, 53 were continuing for advanced degrees. This represents a significant change from the number of continuations by those who received degrees between June 1983 and December 1986 when 20 of 82 graduates remained in school.

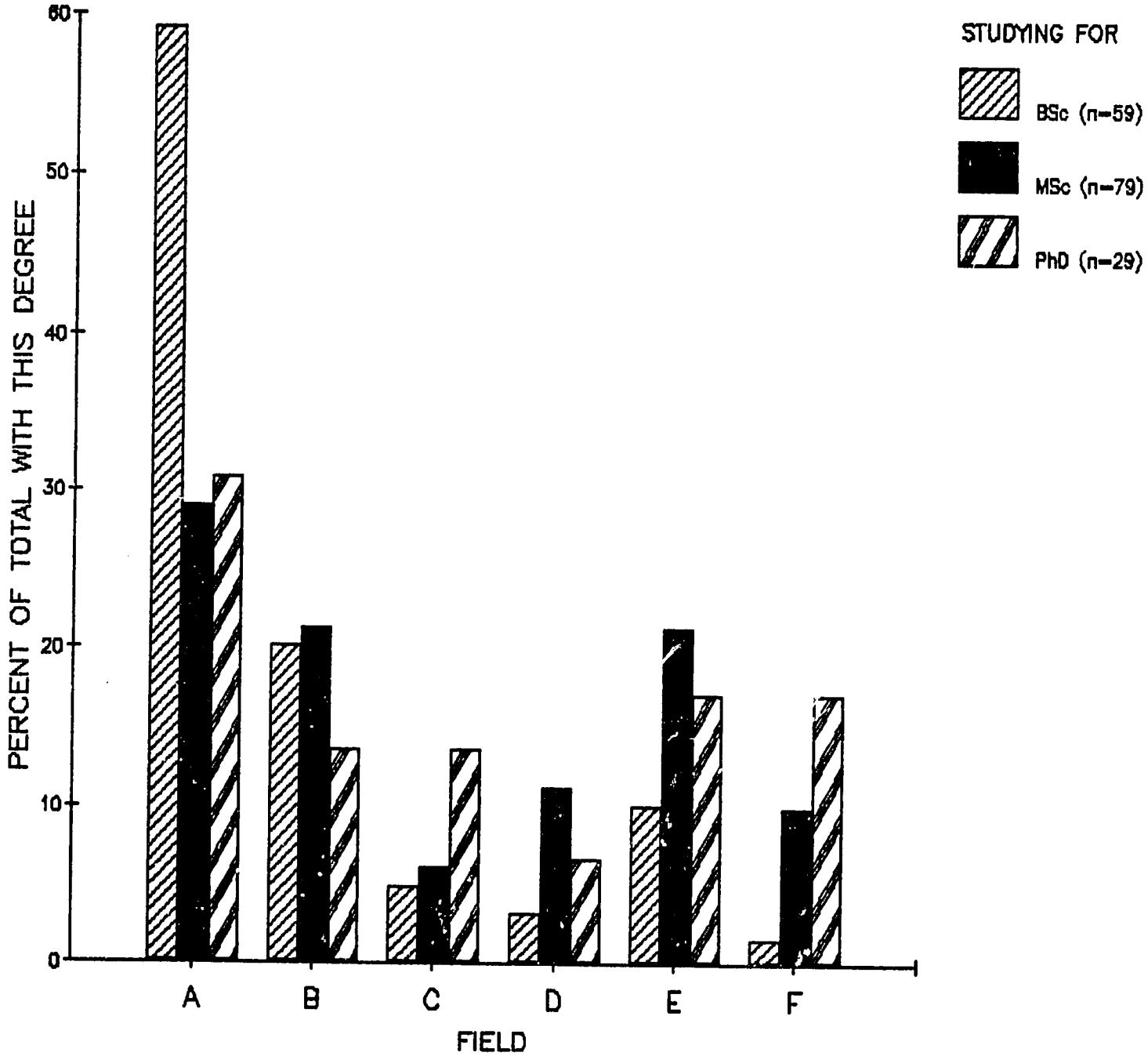
Figures 3.2.1 and 3.2.2 display some of the changes that have been taking place. Figure 3.2.1 displays the distribution of degrees of those students who have left the program, by field of study. Although a large proportion of students graduate in the "conventional" engineering fields of civil, mechanical, chemical, mining and petroleum engineering (Group A), the phenomenon becomes less pronounced at the higher degree levels. Electrical engineering (Group B) has been displayed separately because the designation is that of the department that granted the degree and many of these degrees may be in electronic, telecommunications, or even computer engineering, depending on departmental arrangements. Group C contains those designated as "computer engineers." Group D, specialty fields, includes a number of specialties that are in short supply in Tunisia, such as ceramics, agriculture, hydraulics, biomedical sciences, and the like. Group E, management-related, includes economics, business administration, financial management, etc., and also industrial engineering. Group F includes degrees in the sciences, as well as a small number of degrees in areas such as nuclear physics, astronautical engineering and some in the social sciences.

The trend away from "conventional" engineering fields toward management related and specialty engineering fields is confirmed in figure 3.2.2. This figure displays the distribution of fields for students still in the program, separately for those studying for the three degrees. The emphasis on the "A" group is much less pronounced, especially at the BSc level. Electrical is up a bit at the BSc and PhD levels; according to MUST this is partially due to the teaching of specialties such as electronic, telecommunications and even computer and biomedical engineering in electrical engineering departments.

Computer engineering shows some increase at the lower level, and specialty engineering fields, except at the MSc levels. Management related training is up proportionately at the MSc level, and up at the PhD level.

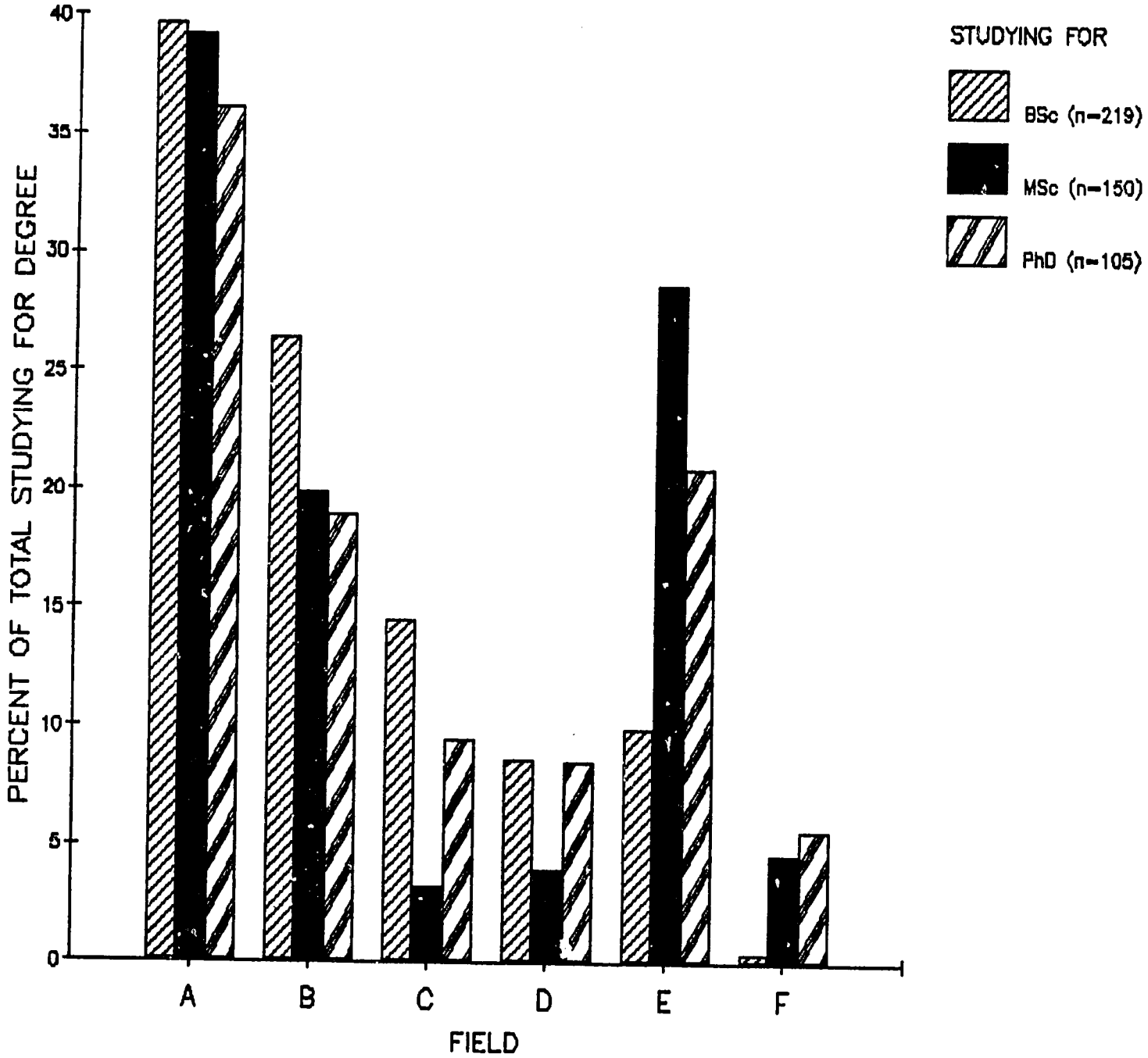
The shift to more advanced degrees and, separately, the shift to the newer engineering fields, represents a reasonable response on the part of MUST and the GOT to the findings made explicit in the current study. AID should consider incorporating this approach into project policy amendments.

FIGURE 3.2.1
DISTRIBUTION OF DEGREES BY FIELDS
FOR GRADUATES LEAVING THE PROGRAM




A = Conventional engineering disciplines = civil/mechanical/mining/chemical/petroleum
B = Electrical engineering
C = Computer engineering and computer science
D = Engineering specialties
E = Management and policy-related, including MIS, economics and industrial engineering
F = Miscellaneous

FIGURE 3.2.2
DISTRIBUTION OF FIELDS BY DEGREE PROGRAM
FOR STUDENTS CURRENTLY ENROLLED IN PROGRAM




A = Conventional engineering disciplines = civil/mechanical/mining/chemical/petroleum
B = Electrical engineering
C = Computer engineering and computer science
D = Engineering specialties
E = Management and policy-related, including MIS, economics and industrial engineering
F = Miscellaneous

Number of Students and Number of Degrees

As indicated above, the fact that many students in the Technology Transfer Project obtain several degrees within the program, though admirably fulfilling the original and continuing program objectives of supplying American trained and oriented personnel to the Tunisian economy, makes it difficult to give an accounting of program output.

Figures 3.2.3 through 3.2.5 present an overview of the inputs to the program, the degrees granted, and the number of students involved.

Figure 3.2.3 presents the number of students who have entered each level of study since the start of the program, separately for those entering with Tunisian and with program degrees, and the number of degrees granted for each level.

Studying for the bachelors, 425 students entered the program; 206 bachelors degrees have been granted, of whom 149 continued to the masters program and 57 finished (see figure 3.2.5). Two hundred nineteen are still in the program (see figure 3.2.4).

Similarly, 345 students in all have entered the masters program, 195 degrees have been granted, of whom 111 continued to the PhD program. Hence, 84 MSc's finished the program (figure 3.2.5) and 150 students are currently enrolled for a master's degree.

In the PhD program, a total of 130 have entered (19 with Tunisian MSc's) and 25 have left (figure 3.2.5). Hence, 105 are currently enrolled in the program (figure 3.2.4).

In toto, 643 students have entered the program. Of these, 166 have left and 477 are still in the program. Three of these 477 are on post-graduate study, leaving 474 currently studying for degrees.

Figure 3.2.4 breaks down the 474 students currently enrolled by degree-level, and where their previous degrees(s) was (were) obtained. As indicated in the introduction, a significant proportion of these students are receiving a thorough exposure to American techcnology and its applications.

Finally, figure 3.2.5 shows this exposure in terms of the number of American degrees earned under the program.

The output so far has been relatively small, but a heavy influx of program graduates may be expected in 1989 and onward (see section 3.4 below). The program to date has maintained a high level of academic achievement among the students. The aggregate grade point average is better than 3.3 on a four-point scale.

FIGURE 3.2.3
PROGRAM INPUT & DEGREES GRANTED

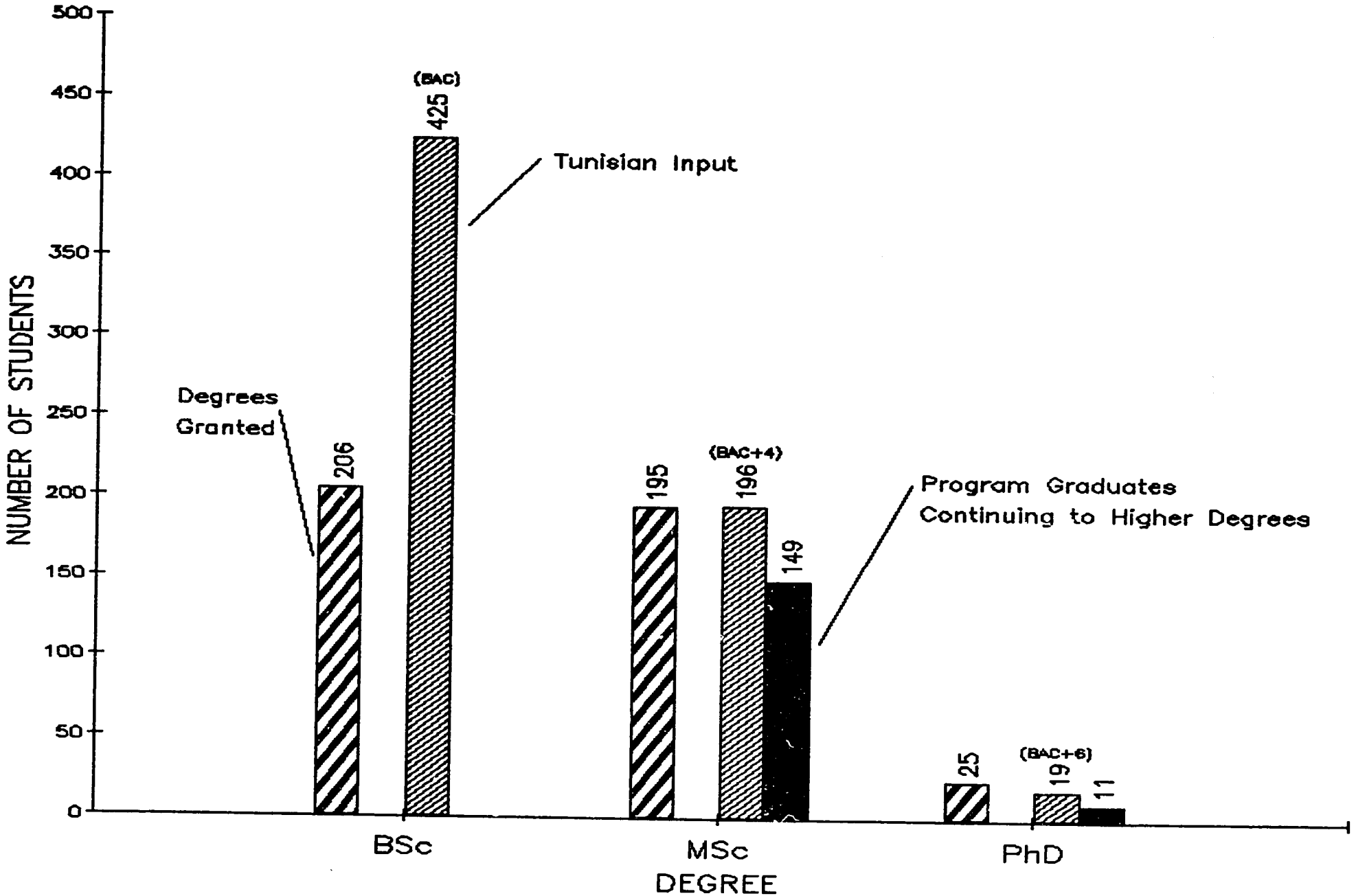


FIGURE 3.2.4
AMERICAN DEGREES FOR THOSE CURRENTLY ENROLLED

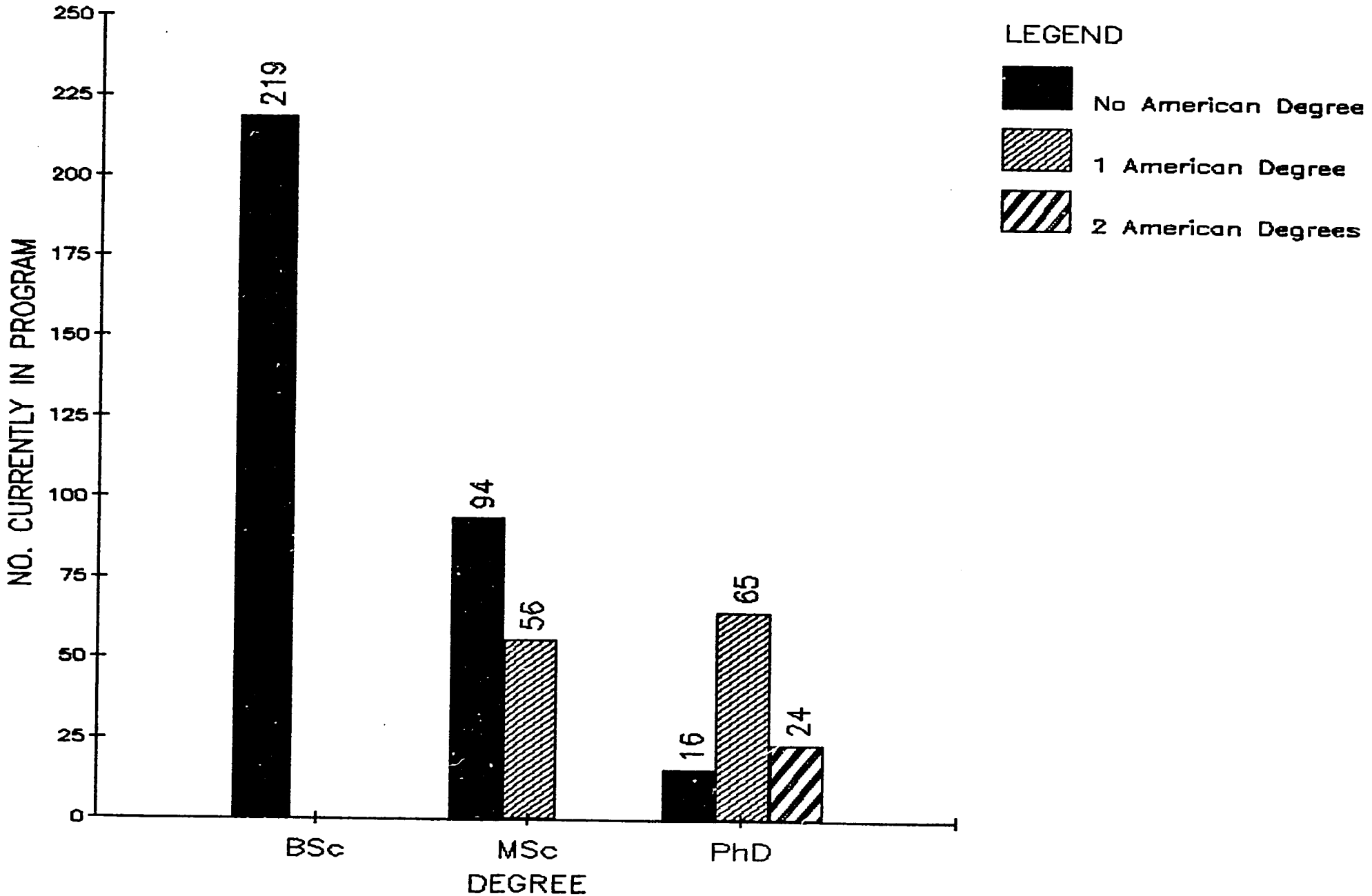
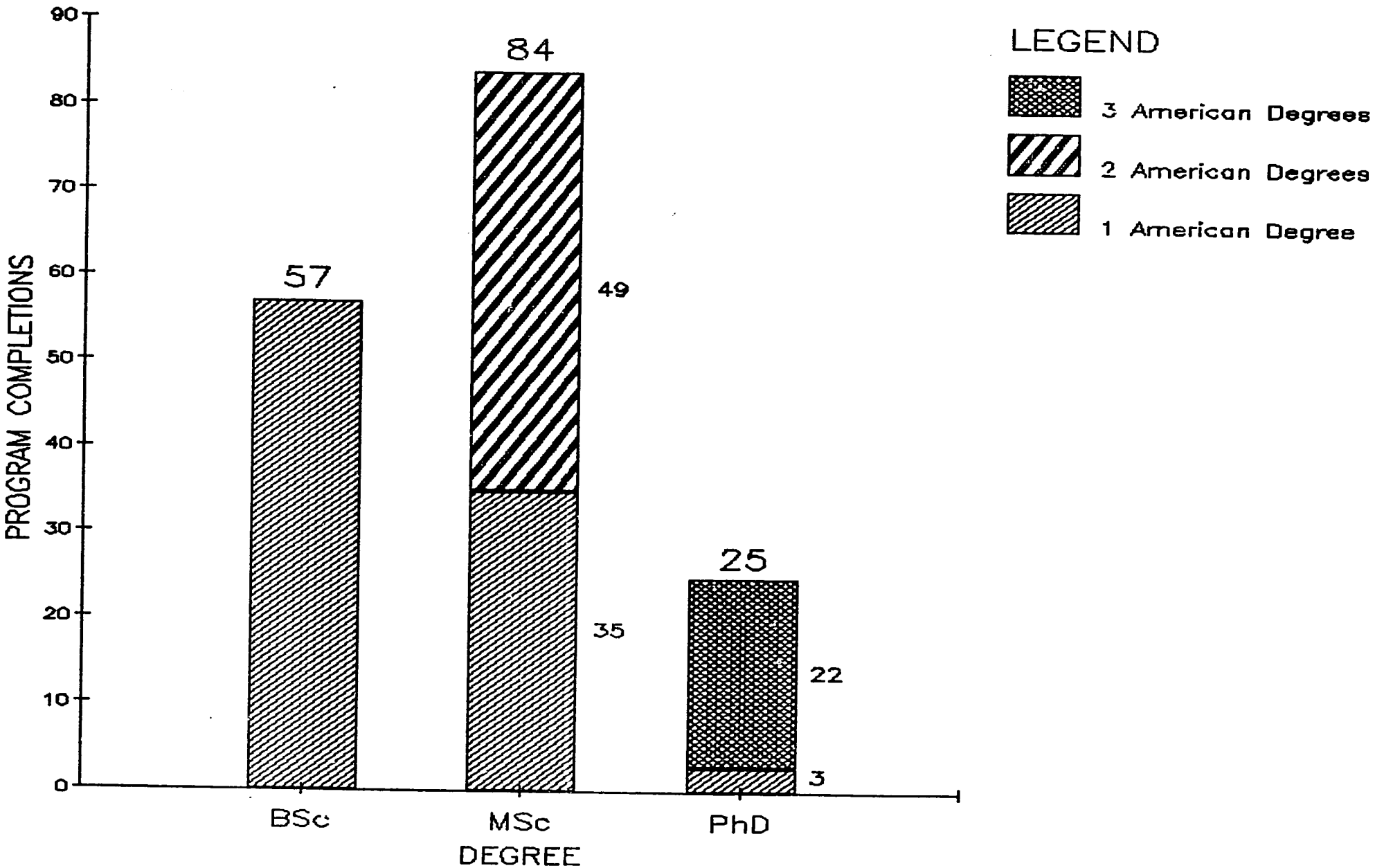


FIGURE 3.2.5
NUMBER OF AMERICAN DEGREES FOR
STUDENTS HAVING COMPLETED THE PROGRAM



Summary

Tunisia will have approximately 18,000 engineers by the end of the VIIth Plan in 1992. More than three-fourths of these will be at the first professional degree level which we anticipate will encounter difficulty in entering the workforce. But if current trends continue, the programs of the United States, France and Canada are likely to graduate more "employable" engineers by concentrating on the level of Principal/Graduate Engineer.

The prospective demand for engineering manpower identified in the previous section suggests an on-going need for advanced training and/or training in specialties that can currently be obtained only abroad. The U.S., French and Canadian contributions toward training will continue to fill an important need during the next five years.

Table 3.2.1 summarizes the estimated supply of engineers to the Tunisian economy, by engineering field, level of training, and country supplying the training. Note that numbers for the Technology Transfer Program are Mission estimates.

## 3.3 Balance

It is evident, from the analysis of the demand for and the supply of engineering manpower presented in sections 3.1 and 3.2 above and in greater detail in Appendix 4, that serious imbalances in engineering manpower may be anticipated in Tunisia in the next several years.

The balance for supply and demand is shown under two assumptions in figures 3.3.1 and 3.3.2. Assumption $H_0$ is the "no change" assumption, that specialties will be required in 1992 in the same proportion as they were used in 1987. In figure 3.3.1, the imbalance is shown in numbers on the top chart, in percent of engineers in the specialty under $H_0$ in the bottom chart. Assumption $H_1$ postulates some percentage increases in the requirements for selected fields. The precise percentage increases are displayed in the top chart and the imbalance in the bottom chart in figure 3.3.2.

In Appendix 4, a number of different hypotheses are worked out, but the main outline of the situation is not much affected by the change in hypotheses. We therefore use $H_1$ as a reasonable approximation of what might in fact happen.

Table 3.2.1

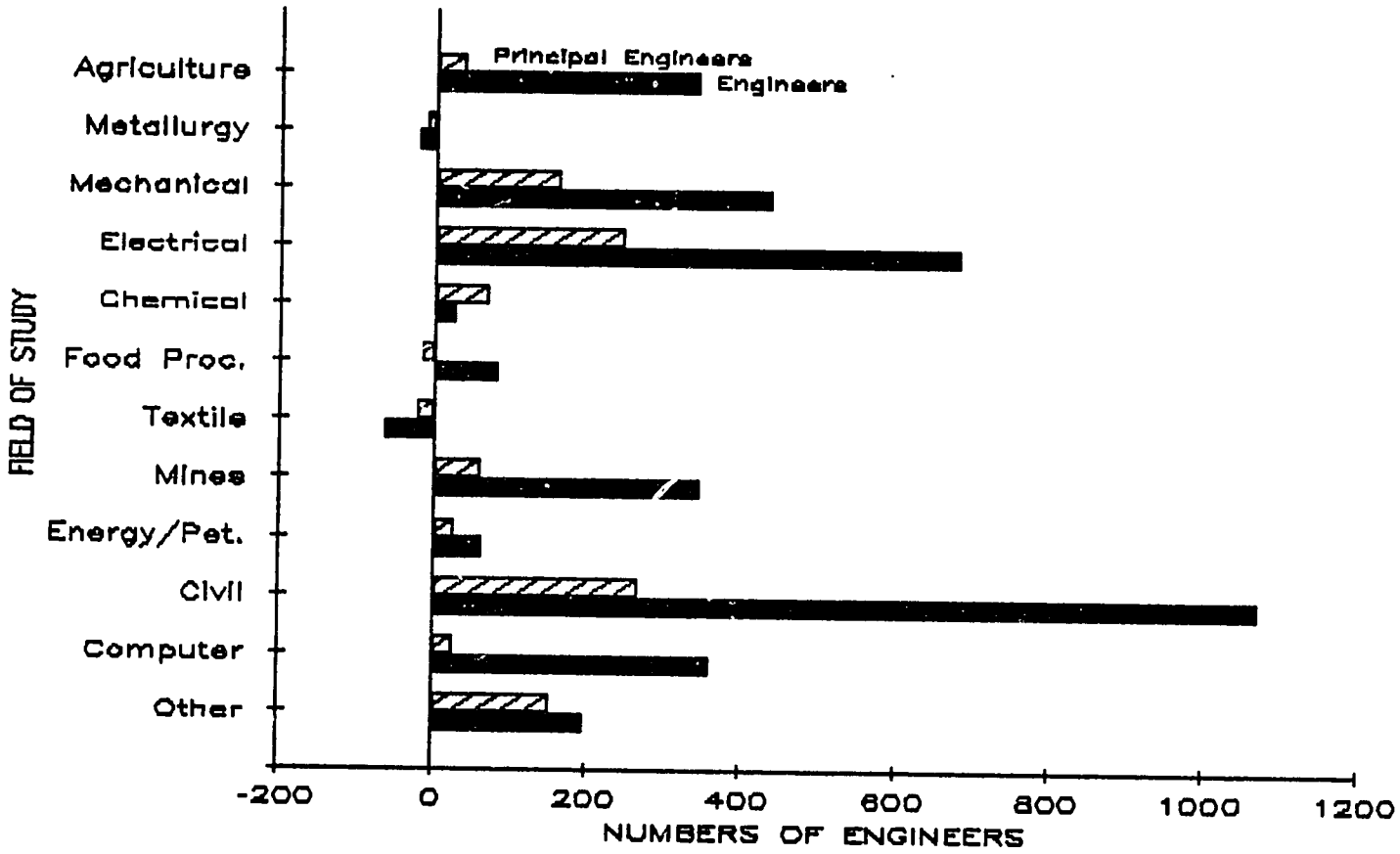
PROJECTED ENGINEERING GRADUATES, 1988-1992*

| | Tunisia | U.S. | Canada | France | Other | Total |
|---|---|---|---|---|---|---|
| Agricultural | | | | | | |
| PE** | 75 | 3 | 2 | 38 | - | 118 |
| E** | 544 | - | 3 | - | - | 547 |
| Metallurgical | | | | | | |
| PE | - | 1 | - | - | - | 1 |
| E | - | 1 | - | - | - | 1 |
| Mechanical | | | | | | |
| PE | 46 | 100 | 23 | 13 | 9 | 191 |
| E | 448 | 20 | 14 | - | 81 | 563 |
| Electrical | | | | | | |
| PE | 66 | 117 | 47 | 37 | 18 | 285 |
| E | 677 | 27 | 5 | - | 159 | 868 |
| Chemical | | | | | | |
| PE | 62 | 21 | 8 | 19 | - | 110 |
| E | 89 | 2 | 2 | - | - | 93 |
| Food Processing | | | | | | |
| PE | - | - | - | - | - | - |
| E | 124 | - | - | - | - | 124 |
| Textiles | | | | | | |
| PE | - | 4 | - | - | - | 4 |
| E | N/A | 2 | - | - | - | 0 |
| Mines | | | | | | |
| PE | - | 12 | 2 | 34 | - | 48 |
| E | 299 | 3 | 1 | - | - | 303 |
| Energy/Petroleum | | | | | | |
| PE | - | 20 | - | - | - | 20 |
| E | 22 | 5 | 1 | - | - | 28 |
| Civil | | | | | | |
| PE | 126 | 78 | 24 | 64 | 10 | 302 |
| E | 1,022 | 27 | 16 | - | 87 | 1,152 |
| Computer | | | | | | |
| PE | - | 44 | 8 | - | - | 52 |
| E | 395 | 14 | 10 | - | - | 419 |
| Other | | | | | | |
| PE | 38 | 46 | 4 | 107 | 20 | 215 |
| E | 113 | 9 | 2 | - | 184 | 308 |
| TOTAL | | | | | | |
| PE | 413 | 446 | 118 | 312 | 57 | 1,346 |
| E | 3,733 | 110 | 54 | - | 511 | 4,408 |
| GRAND TOTAL | 4,146 | 556 | 172 | 312 | 568 | 5,754 |

*See Annex 4 for a full discussion of the derivation of the projections shown here.

**PE = Principal Engineer (graduate degree).
E = Engineer (undergraduate degree).

FIGURE 3.3.1
EXCESS SUPPLY/Ho



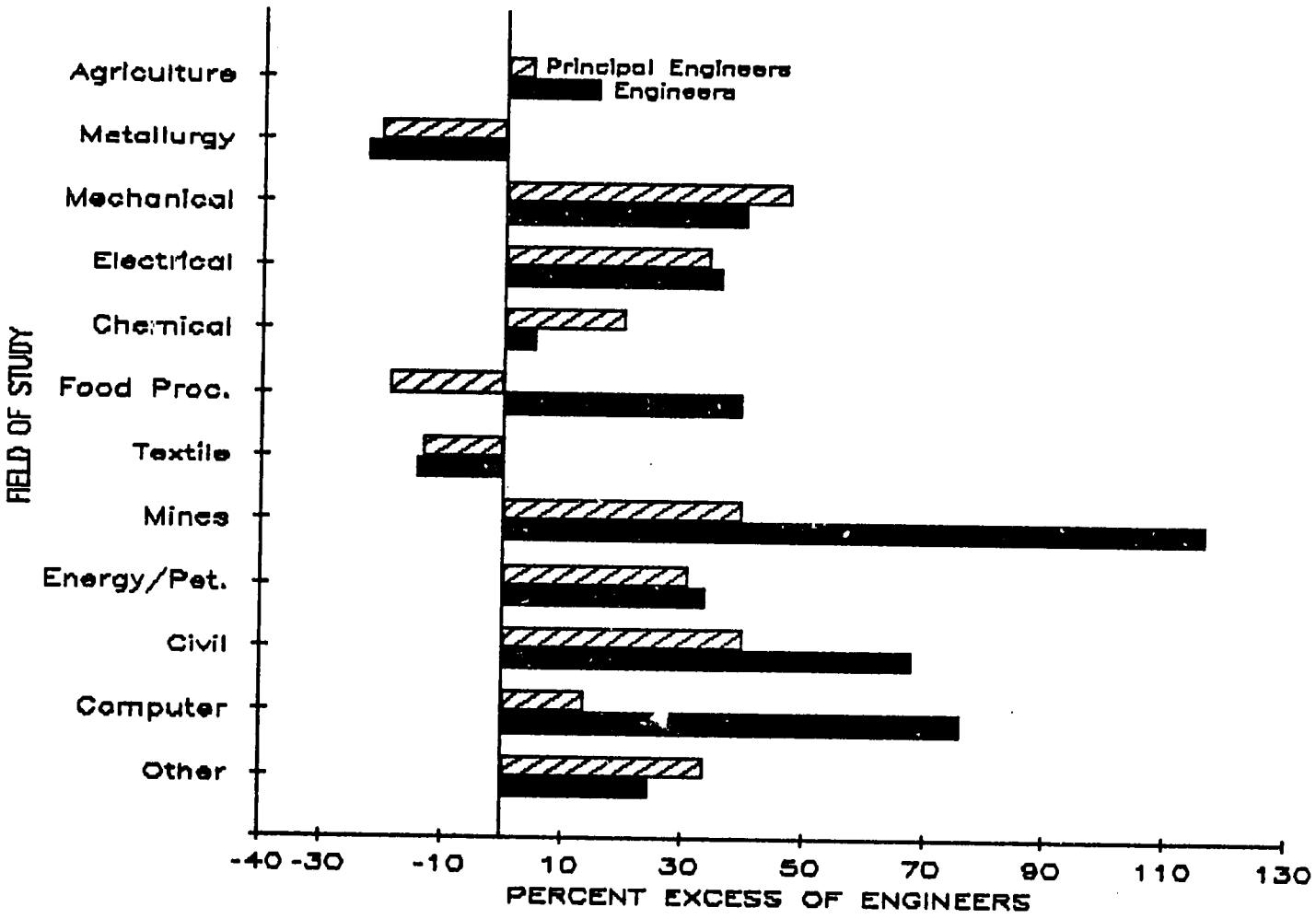
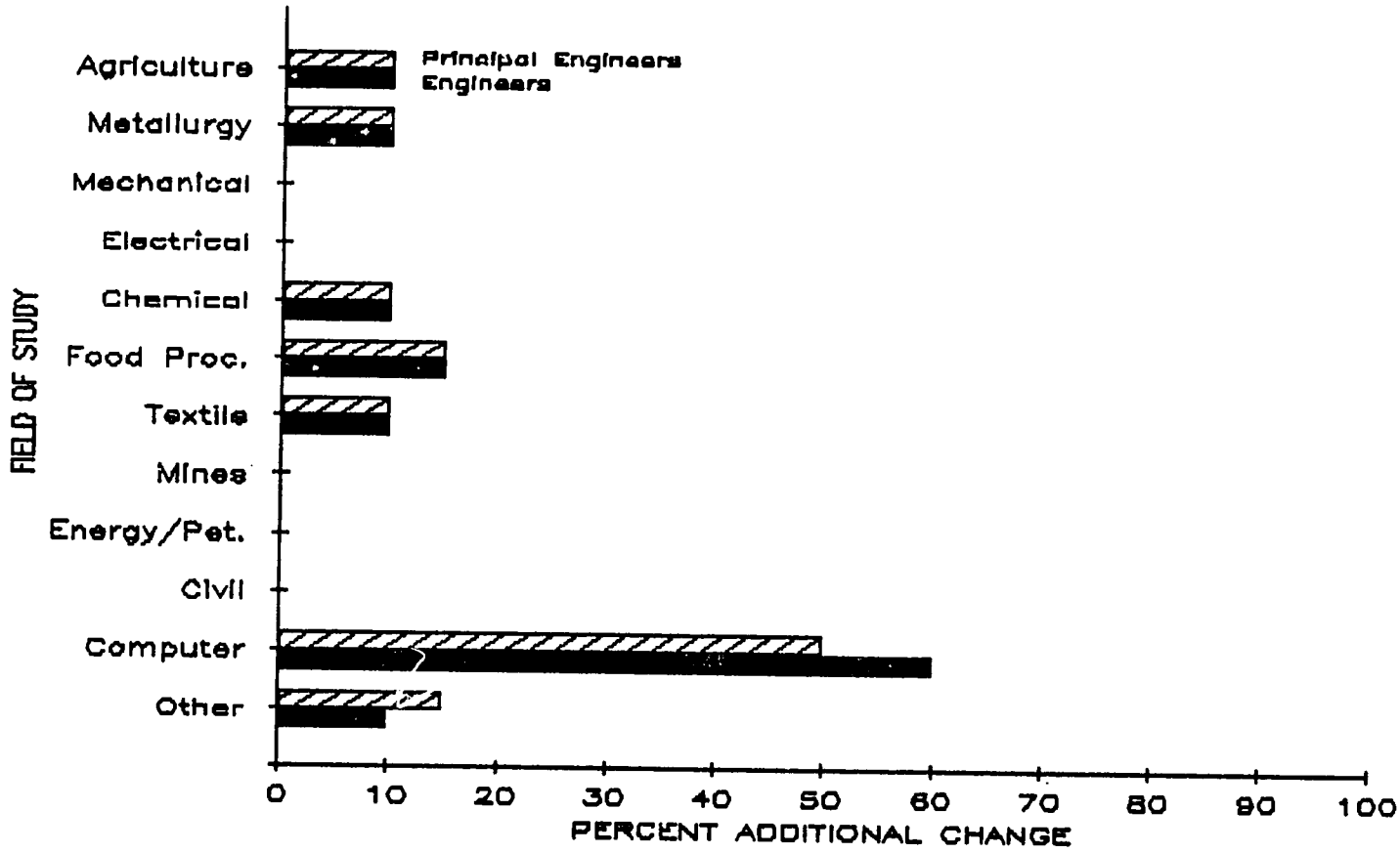
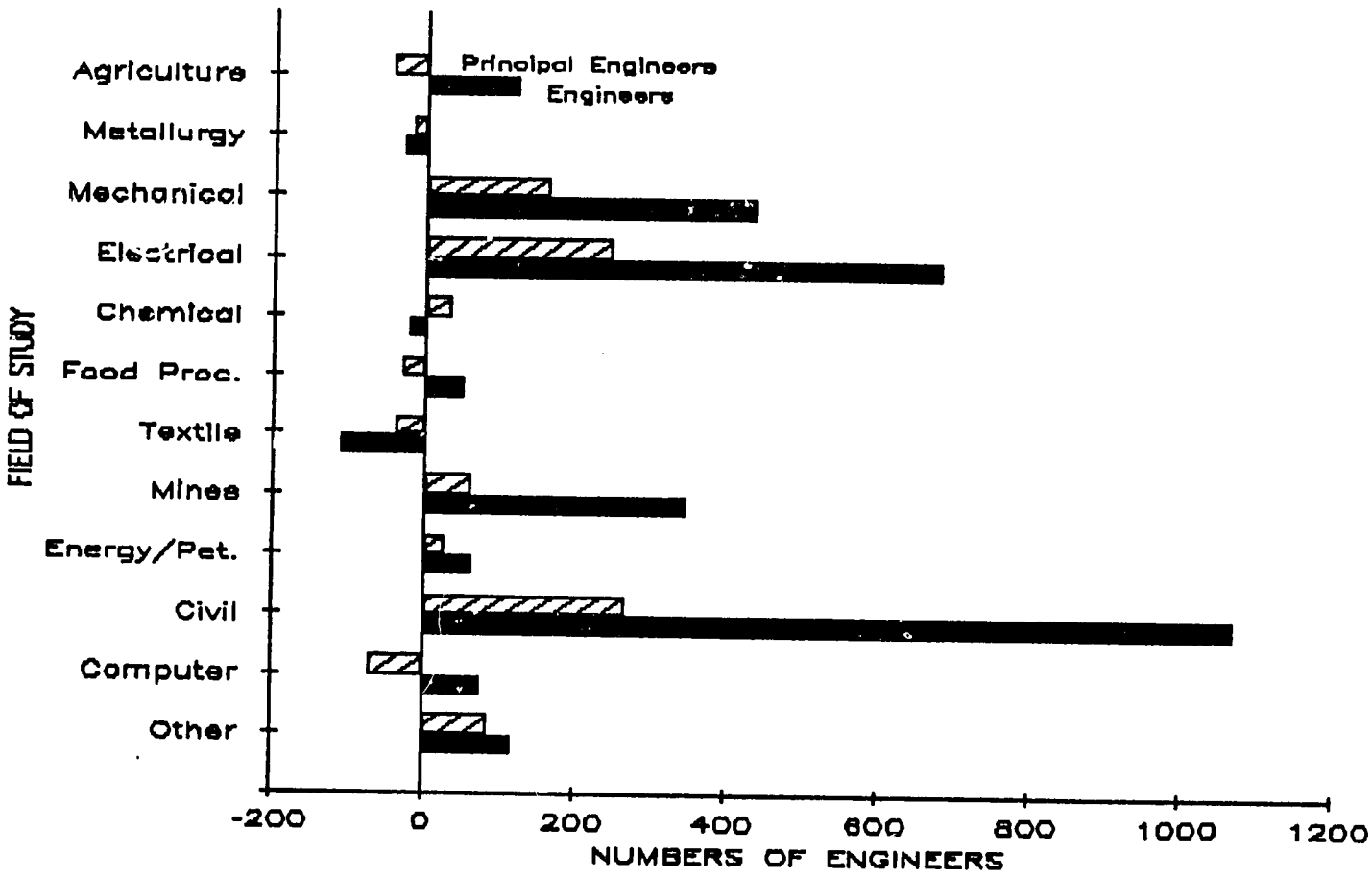



FIGURE 3.3.2

H1 SCENARIO: PERCENT ADDITIONAL CHANGE IN DEMAND




EXCESS SUPPLY/H1



If we accept about 20 engineers and/or 10-15% of the demand as a cut-off of accuracy below which no very firm conclusions can be drawn, then, under $H_1$,

- The heavy oversupply is at the "engineer" level in the fields of mechanical, electrical, mining and civil engineering.

- Principal engineers in the fields of mechanical, electrical and civil engineering are also in over-supply.

  Note that electrical engineering is a special case; there will undoubtedly be an oversupply in the conventional field, but it also includes specialties like electronic and telecommunications engineering which will be in short supply.

- Shortages appear for a number of types of principal engineer, which are numerically small, but will be significant to the economy.

- Engineers are short in metallurgy and textiles.

- The excesses in the "other" category may mask shortages in several newer high technology fields.

The over-supply is mostly in the output of Tunisian institutions. Figure 3.3.3 presents the estimated surplus in the fields mentioned above versus the projected output of Tunisian institutions. The overage in these fields is made worse by the very small increases anticipated in the demand for civil, electrical, and mechanical engineers and the actual, small decrease in the need for mining engineers.

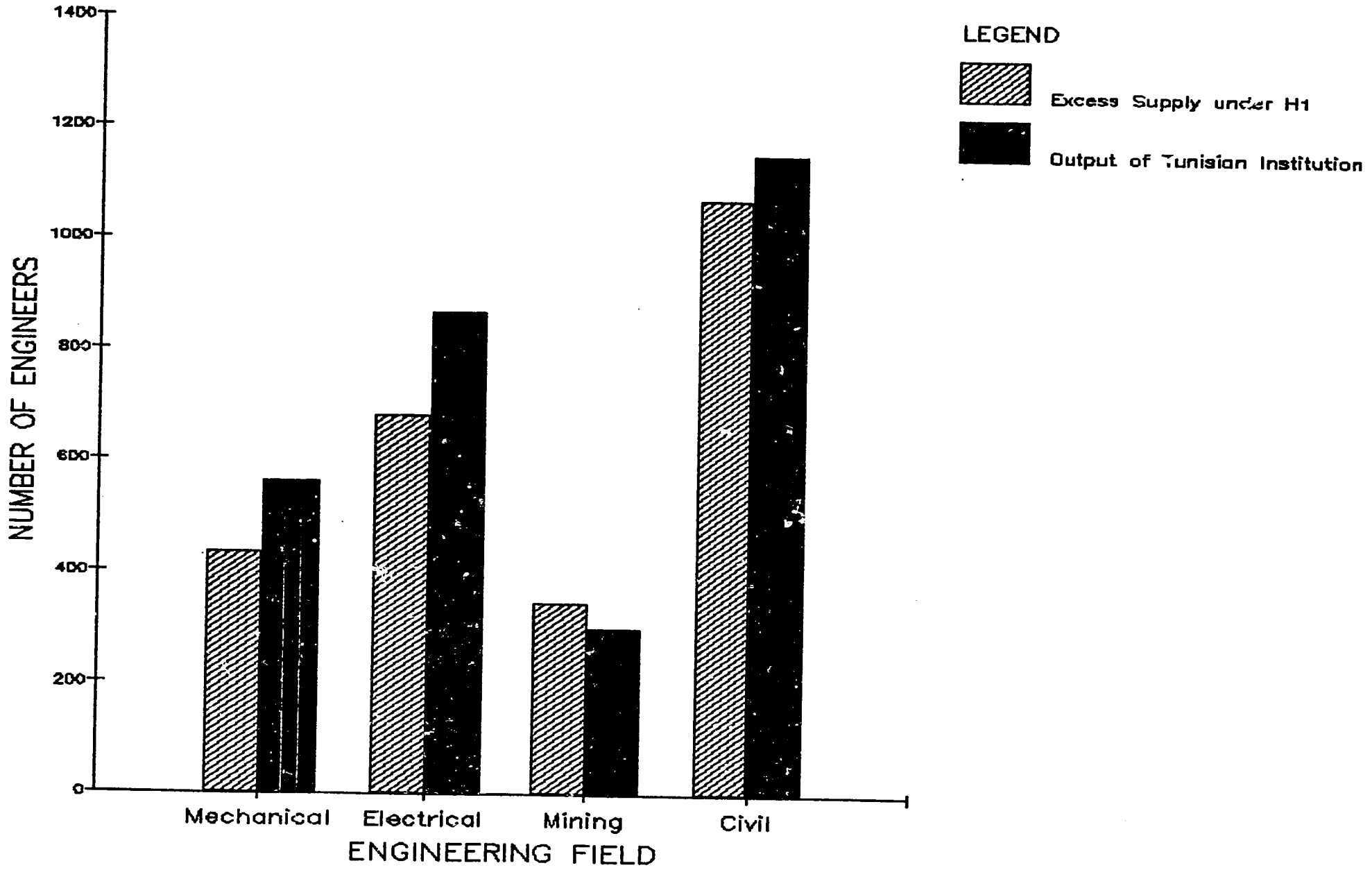
The picture presented is one of a bifurcated labor market in which a serious over-supply in some areas coexists with a continuing need for the higher technology fields and training levels which are the output of the Technology Transfer Project.

## 3.4 Current and Prospective Status of Technology Transfer Graduates

### 3.4.1 Introduction

The Statement of Work called for a study to examine current methods of locating employment for engineering graduates, including activities by the Scientific Mission for Tunisia in Washington (MUST), by the Ministry of Higher Education and Scientific Research (MESRS), and of other institutions; the effectiveness of these organizations in finding employment for university

FIGURE 3.3.3
EXCESS SUPPLY AND TUNISIAN-TRAINED SUPPLY
OF ENGINEERS FOR SELECTED FIELDS (HYPOTHESIS $H_1$)



graduates in general and the Technology Transfer Project in particular; and to make recommendations regarding job placement for Technology Transfer graduates, including

- coordination of MESRS and MUST for job placement
- active involvement of other GOT organizations and private sector organizations
- strengthening of the system by
  - additional staff
  - technical assistance and training of current and/or additional staff
- establishment and operation of a job placement service, again possibly with additional staff and training.

The motivation for this aspect of the study arises from the non-standard features of the Technology Transfer Project as a participant training program. The program was originated by the GOT, and managed by MESRS and MUST, its agency in the United States. MUST performs most of the duties of managing the participants, including reviewing their progress, paying allowances, and keeping records. Selection of participants and approval of study programs, changes in study programs and continuation of studies for advanced degrees (and sometimes beyond) are made by committees of GOT officials in Tunis. These decisions are communicated to the participants through MUST.

Under the circumstances, USAID/Tunis often does not have on hand the information on the progress of students and their status in the program which is available in more orthodox participant training programs, and questions naturally arise as to

- whether or not students return to Tunisia at the conclusion of their program, and
- whether or not returned students are finding employment, and if so
  - whether they are using their specialized training, and
  - whether they are themselves contributing to technology transfer.

The study team's approach to addressing these problems has been to:

- Ascertain the status of TTP graduates and participants to the extent possible from MUST data. The MUST tracking system provides complete information on participants and their progress, until their departure for Tunisia at the

end of their program. Unfortunately, this information is not in the form in which it is most useful to USAID/Tunis.

- Interview a sample of returned participants to determine
  - employment status
  - methods for obtaining employment.

Our interviews helped us to identify the current contributions of MUST, MESRS, and other GOT agencies to placement of engineering personnel, as well as the general recruitment practices of employers.

### 3.4.2 Disposition of Technology Transfer Students

There are two major difficulties for USAID/Tunis in accounting for Technology Transfer Project students. One of these, the difficulty of reconciling degrees granted with the number of participants was discussed in section 3.2 above and the reconciliation was made.

The other difficulty is the line of communication between USAID and MUST. There is a clear need for improved information flow. Part of the difficulty in this regard stems from limited staff resources at MUST. This staff is responsible for the approximately 500 students enrolled in U.S. institutions as well as an additional approximately 100 who are studying in Canada. MUST possesses a good tracking system for its students. One option for improving information flow might be to extend this system to a data base system. Converting the MUST tracking system to a data base would make it relatively painless to report to MESRS and USAID/Tunis in the categories identified in figures 3.2.3 through 3.2.5 and would furnish USAID/Tunis with a complete accounting for both degrees granted and students participating.

Another consideration is the absence of information on students who have finished their programs. Measures to address this problem on a continuing basis are discussed in section 3.4.3 below. The team obtained a list of sixty-seven (out of 106) returned TTP students (all before May, 1987), and managed to verify their current locations. The results are displayed in table 3.4.1 below.

TABLE 3.4.1

SITUATION OF TTP STUDENTS, COMPLETING THEIR PROGRAM

| Highest Degree Obtained | Confirmed Resident in Tunisia | Working Abroad | Not on List | Program Graduates |
|---|---|---|---|---|
| BSc | 31 | 2 | 18 | 51 |
| MSc | 24 | 1 | 13 | 38 |
| PhD | 8 | 1 | 8 | 17 |
| | 63 | 4 | 39 | 106 |

Similarly, though not part of the statement of work, thirty out of sixty-three students were interviewed to ascertain their employment status and review their job search procedures. The results of these interviews are given in table 3.4.2.

TABLE 3.4.2

EMPLOYMENT STATUS OF GRADUATES

| | In Tunisia | Number Interviewed | Employed | Not Employed | Abroad |
|---|---|---|---|---|---|
| PhD | 8 | 3 | 3 | - | - |
| MSc | 24 | 11 | 7 | 3* | 1 |
| BSc | 31 | 17 | 14 | 1* | 1 |
| TOTAL | 63 | 30 | 24 | 4 | 2 |

* The "Not Employed" MSc students include voluntary unemployment in two cases where the students had left what they considered to be unsatisfactory jobs; they were actively seeking employment. The third graduate had been unable to find a job since returning to Tunisia in early 1987. The BSc student had been unemployed since returning to Tunisia and was actively seeking employment in his specialty (civil engineering).

The thirty students interviewed indicated that a majority of the remaining students were probably in other parts of the country, and in their opinions, had found employment. They believed that in spite of the general economic conditions, very few of their former classmates and friends from the Technology Transfer Project were unemployed. In sum, it does not appear that there is currently an employment problem for TTP graduates.

As shown above, the majority of Technology Transfer graduates whom we were able to contact had found employment. In almost every instance these returnees used informal networks consisting of friends, family members and relatives, and individual searches to locate their employment.

The formal employment assistance services of the National Professional Employment Office (BNEC) and the several branches of the Regional Employment Bureau (BRE) were generally ignored because they were considered to be time-consuming and ineffective. Informal networks and individual effort tend to be the rule for job-searching in general for Tunisians seeking employment.

### 3.4.3 Employment and Search Practices

GOT organizations potentially concerned with placement of Technology Transfer Project students and other engineering students are:

MESRS - which is responsible for higher education and research. They do not appear to consider placement as part of their mission.

MUST - which manages the Technology Transfer participants. MUST, in fact, provides returning students with some information and advice; this function can potentially be extended.

BNEC/BRE - the job placement agencies in the Ministry of Social Affairs, are not perceived to be relevant to the placement of engineering personnel by either employers or prospective employees.

Interviews with employers established that most positions are filled by networking, by direct applications from graduates, and sometimes (mostly for the ministries) by advertising in the newspapers. Some employers also maintain relations with Tunisian universities and some summer cooperative placement of students occurs. In some cases this leads to permanent employment. On the whole, employers are quite satisfied with their recruitment methods, and feel that they can find the personnel they need with these approaches.

Employees interviewed, as well as knowledgeable MUST and MESRS personnel, describe job search procedures as a combination

of personal networking, writing to prospective employers, and responding to newspaper advertisements (if any). Again, Technology Transfer Project graduates expressed confidence in these methods.

It must be remembered that Tunisia is a small, closely-knit country, in which networking and use of extended family and business acquaintances and connections may well ensure a thorough coverage of opportunities.

It appears that there is no perceived need for a formal job-placement service, especially one specifically oriented toward Technology Transfer Project graduates. It would run counter to accepted custom and might be difficult to establish given existing bureaucratic arrangements. However, it does seem that there are opportunities for strengthening the informal networking process, and, at the same time, maintaining contact with returned TTP graduates, thus partially solving the in-country tracking problem.

Opportunities for strengthening the cohesion of the returned TTP graduates, giving them some support and at the same time maintaining contact exist in two areas:

- An "amicale" has recently been formed for students returned from abroad. This amicale can be strengthened, and given some material support.

- Students returning from study in America are advised by MUST to consider going into business for themselves and given some information on opportunities in Tunisia. The Private Sector Development Office at USAID/Tunis could support this initiative.

We discuss both these approaches in further detail.

Strengthening the "Amicale"

To make the process of "reinsertion" go more smoothly and to enhance the use of informal networks, it would be worthwhile to consider using the amicale of foreign-trained engineering students that has recently been formed. The amicale could become a non-obtrusive means of establishing a tracking system for the returned students while simultaneously providing social support services to its membership. One such service, for example, could be a registration service, combined with support for the preparation of resumes, writing of letters, and perhaps minor financial aid for travel costs incurred while applying for jobs in remote locations.

Such secretariat services might be provided under contract by a local private sector firm with experience in personnel placement. A secretariat like this could also discreetly advertise to prospective employers that they could help in locating

personnel with particular skills. A small fee charged for this service might make the project self-supporting.

The secretariat would be regarded as managed by the amicale for the benefit of its members. Membership contacts could provide some feedback to USAID/Tunis on the status of returned TTP graduates.

At the same time an opportunity exists to establish closer cooperation between the amicale and the Order of Engineers. The latter is an officially chartered professional organization, to which all engineers working for the GOT are required to belong, but others are not. By establishing a climate of cooperation between the amicale and the Order another source of contacts for returned graduates might be established.

Entrepreneurial Development

There are many and increasing opportunities in the Tunisian economy for service organizations based on technical and engineering expertise. A great need exists for competitively priced services in the areas of, for instance:

- equipment maintenance, including maintenance of
  - factory equipment
  - computers and computer equipment
  - telecommunications equipment
- computer support, including
  - choice and installation of computers and software
  - programming, including development, installation and/or operation of turnkey systems in such areas as
    - management information systems
    - accounting systems
    - computer-aided design systems
    - other systems
- general engineering and management consulting in selected specialties in which individual firms may not want or need to permanently staff themselves. Such specialties might include:
  - manufacturing technology
  - cost control

- quality control and value engineering
- advanced materials
- energy conservation

It would be opportune for the Private Sector Development Office of USAID/Tunis to undertake a project to develop materials identifying such opportunities and describing available sources of advice, management and financial support. MUST could distribute some of the material, and returning TTP students, perhaps through the amicale described above, could be encouraged to register for further information and support. Such an effort would support high technology private sector growth in Tunisia by alleviating some of the human resource needs which currently constrain that growth. USAID/Tunis could further assist in this regard by including some of the TTP graduates in their projected privatization activities.

## 3.5 Future Management and Redesign of the Technology Transfer Project

### 3.5.1 Management

As detailed above, the Technology Transfer Project was originated by the GOT, which still provides more than half of the cost of the project. USAID/Tunis support, though constituting a significant portion of the Mission portfolio, is provided from ESF funds. The project is therefore managed by the GOT through MESRS and the MUST mission in Washington.

The project, within its own terms of reference, appears to be very well managed and, as will be detailed below, design changes currently in progress are consistent with the findings of this study, and should be strengthened and formalized in future design of the project.

There is, however, as detailed above, a significant information gap. MUST manages students individually, and has a very good tracking system for individual students. They do not, however, provide USAID/Tunis with the kind of accounting required for participant training projects. A suggestion has been made above to provide support to MUST, at a minimum to convert the tracking system into a data base system, so that such data can be provided to USAID/Tunis on a routine basis.

### 3.5.2 Project Redesign

The findings of the supply and demand study described in section 3.3 above and in Appendix 4 establish that the need for technical manpower in Tunisia in the 1988-1992 time period will be at the higher levels of training, and in the newer fields of engineering.

At the same time the goals of the VIIth Plan clearly call for personnel trained in policy analysis, business and services, and in management science. If the Technology Transfer Project is to be redesigned, it should be oriented toward training personnel in these areas. Recent changes which de-emphasize engineering in the programs of Technology Transfer students signal a movement in this direction. It is recommended that such changes be formalized in any new project modification.

A final comment is in order regarding the relatively high proportion of PhD candidates. Attention was drawn above to the limitations of the capacity of Tunisian institutions to develop graduates at higher degree levels and/or in specialized fields. Prospectively, the American trained PhDs will enable Tunisian institutions to increase this capacity, thus reducing the need for foreign training programs to produce skills necessary to Tunisian growth while simultaneously reducing the universities' need for expatriate faculty.

Given budgetary and other limitations on the availability of faculty positions in Tunisian institutions, however, it may well happen that program graduates must find post-graduate fellowship or teaching positions elsewhere while waiting for Tunisian positions to become available.

It should be clear that the goals of the VII Plan, while continuing to require technologically skilled manpower for their successful achievement, will also present other challenges to the government that demand different sorts of knowledge. These new, or additional challenges result from the nature of some of the objectives set forth in the VIIth Plan. Redressing balance of payments problems, economic decentralization, and job creation clearly have their technological elements, but it is the policy development and implementation aspects of reaching objectives that now confronts the GOT. For these activities it may be necessary to turn to other fields of study in the management and policy sciences, including

- management
- accounting
- policy analysis & formulation
- econometrics
- planning

- marketing
- financial analysis
- human resource management

Absorption of personnel with training in these fields may help to support VIIth Plan development initiatives by providing:

- human resource development planning for expansion of the tourist industry. The proposed opening of a school for hotel management at Djerba will support such planning;
- international finance and trade experts to reinforce the expansion of export development;
- demographers and labor economists to assist in the design and execution of labor market studies in support of economic decentralization, labor market trends and developing systematic approaches to data collection and policy formulation;
- capability in the computer sciences to handle the large quantities of data that will be required to maintain adequate controls and design appropriate systems for the manipulation of data (MIS). Although Tunisian institutions are producing a large number of graduates, they are at the baccalaureate level, and thus relatively inexperienced in the development of the required data management systems.

As mentioned above, considerable change is already taking place in the orientation of the Technology Transfer Program toward meeting the prospective demand both for technical and managerial/policy analysis skills.

Consideration should be given to embodying guidelines in the project agreement regarding:

- distribution of degree levels, and
- distribution of training slots among
  - engineering fields
  - policy sciences
  - business/mangement specialties

for future Technology Transfer students.

Some consideration might also be given to diverting part of the project resources to enabling prospective university faculty who are TTP PhD graduates to take up positions sooner than current GOT budgetary constraints allow.

In conclusion, this study shows that the Technology Transfer Project has made and continues to make a significant contribution to alleviating some of the manpower constraints on Tunisian economic development.

# CHAPTER 4

# FINDINGS

## 4.1 Supply and Demand for Engineers

1. An oversupply of engineering graduates may be anticipated in the 1988-1992 period in the conventional engineering disciplines (civil, mechanical, and electrical engineering) at the lower level of training (BAC+4/BSc).

2. Shortages of trained manpower may be anticipated in:

- higher technology fields (metallurgy, telecommunications, biomedical, etc.)
- some engineering specialties (food processing, ceramics, etc.)
- principal engineer levels of training in many fields.

There is a continuing need for the Technology Transfer Project to develop personnel in these fields.

3. Tunisian institutions are limited by the availability of both faculty and research facilities in the number of fields they can teach and the level of degrees they can grant. The Technology Transfer Project is developing prospective teaching staff (PhDs) trained in the most modern techniques to the most advanced standards. These prospective staff will, in time, help extend the capabilities of Tunisian institutions.

4. Currently, the emphasis in the Technology Transfer Project is shifting toward

- higher technology engineering fields
- higher degrees, including a greater proportion of doctorates
- management and policy sciences.

This trend, if continued, will furnish Tunisia with a significant number of personnel with multiple American degrees, who will have absorbed both American technology and American approaches to problem-solving and private enterprise.

## 4.2 Policy Analysis and Management Training

1. Though no demand analysis for graduates in the policy sciences was performed (since it was outside the Scope of Work provided the TvT team), it is evident that the VIIth Plan will require for implementation many additional personnel with skills in the policy sciences. Examples of objectives requiring such skills are:

- increased use of computers in administration and for information systems,
- increased emphasis on financial services,
- privatization and increased emphasis on the private sector,
- decentralization, and
- increased emphasis on export marketing and foreign exchange earnings.

2. Though the Tunisian institutions are supplying graduates in the policy science and management area, there currently are limitations to these programs which lead to

- too many graduates at the BA (BAC+4) level, and
- programs weak in
  - international trade and finance,
  - demography and labor economics,
  - human resource management, and
  - computer training for handling large data bases and information systems.

3. The study programs of Technology Transfer students are already shifting toward these fields. While 21 percent of Master's degrees and 17 percent of PhDs completing the program were in policy/business fields, among current enrollees the proportions are 29 percent of Master's students and 21 percent of PhD students. The proportions are much less among students for the Bachelor's degree, perhaps because of a preference for an undergraduate engineering foundation for advanced degrees in management.

## 4.3 Placement Services

1. No evidence was found that returning Technology Transfer students have difficulty finding jobs. Of thirty interviewed, two were involuntarily unemployed (looking for work). Two had resigned jobs to look for better ones. These thirty returnees thought that none of their group had had problems finding employment.

2. Job placement in the GOT is the responsibility of the Ministry of Social Affairs. However, their services are regarded as, and indeed function, chiefly for the placement of lower level personnel. Graduate engineers would have difficulty benefitting from, or even accepting, their services.

3. Interviews with employees established that the normal way of finding jobs is to talk to family, friends and family connections; to write letters to a number of firms; and to respond to advertisements occasionally placed by some establishments (mostly ministries). Interviews with employers established that they are satisfied with this approach, and feel that they have no trouble finding suitable personnel.

4. Interviews with employers also established a reluctance, in spite of the need, to hire expensive high technology personnel. This reluctance (often overcome) is based on the high cost of personnel, which includes a 40 percent tax. There appears to be an asymmetry between incentives for investment in equipment and a high tax on the personnel needed to put the equipment to optimal use. This disincentive toward hiring highly trained personnel may adversely affect the absorption of the large number of Technology Transfer graduates who will enter the labor market in 1989/1990.

5. Given the fact that both employers and employees are satisfied with current job/personnel search methods, and that in a small, close-knit society networking may well suffice to find all opportunities, there seems little room for developing a formal placement service. However, support for returned TTP graduates in their networking in the form of an unobtrusive tracking mechanism in-country seems feasible.

6. One possible mechanism for supporting a network for returned Technology Transfer students is to provide a small grant to a private sector firm to perform staff services for the Order of Enegineers and/or the newly formed "amicale" of students returned from abroad to maintain up-to-date information on returnees and help them keep in touch with each other. Such a secretariat could also become a point of contact for prospective employers needing special skills. The secretariat would furnish an unobtrusive means of obtaining follow-up on returned TTP graduates.

7. MUST encourages returning Technology Transfer students to consider "going into business for themselves" and provides them with data on the Tunisian economy to this end. There is

considerable need in the Tunisian economy for service firms in the areas of

- equipment maintenance and repair,
- computer support, and
- consulting in specialty engineering fields

which could be filled by private sector firms formed by TTP graduates.

An initiative by USAID to provide additional information on private sector and entrepreneurial support available through private sector programs to returning students might fit well into this orientation and provide an opportunity for obtaining additional follow-up data.

## 4.4 Project Management and Administration

1. The Project has already gone a considerable way in reorienting students toward the scarcer engineering fields and toward policy analysis/management training.

A substantial fraction of students are trained to the Master's and PhD levels, many obtaining two or even three American degrees. This appears consistent with the Project objective of transferring both American technology and American orientation toward engineering, management, and private enterprise.

2. Employers and returned participants expressed the opinion that employability of TTP graduates would be enhanced if their programs included summer cooperative work experience in the U.S. or Tunisia.

3. Project administration and monitoring at USAID/Tunis is very difficult, because of the difficulty of obtaining timely and accurate accounting of project input and output. The difficulty originates in the system used by MUST to manage the program participants. These are managed on an individual basis, and the system tracks individuals through their careers in American institutions. It does not, however, supply a reconciliation between the number of participants graduated or continuing and the number of degrees granted. Such an accounting is provided in section 3.2 of this report. Routine availablity of these data would require changing the current MUST individual tracking system to a data base system.

# CHAPTER 5

# RECOMMENDATIONS

The following represent recommendations which the team regards as appropriate responses to the findings of this study.

## 5.1 Project Continuation and Reorientation

The Technology Transfer Project is fulfilling its intended objective of transferring American technology and orientation toward technological, management and economic challenges to Tunisia. It should be continued at approximately its current level.

Flexible program goals should be formulated in the areas of:

- the distribution of project output among degree levels, and the distribution of the number of degrees earned with Project support;
- the distribution (by degree level) of degrees among
  - various engineering and other technology fields,
  - policy analysis, and
  - management;

and a modality, involving MESRS, MUST and USAID/Tunis should be developed to continue to adjust these goals to GOT development needs.

## 5.2 Project Administration and Information

Support should be provided to MUST to convert the present student tracking system to a data base system which will routinely deliver information on:

- the number of graduates at each level, and the number of American degrees for each, and
- the number of students studying for each degree, and the source (American or Tunisian) of their previous degrees.

This information will allow a complete accounting of project output in both individuals and in degrees.

## 5.3 Placement Service

We recommend that no formal placement service be initiated for Technology Transfer graduates; however, other support should be provided (see below).

## 5.4 Networking Support

An effort should be made to provide support in the form of a secretariat to the "amicale" of returned foreign students and/or the Order of Engineers. This secretariat could provide help in

- registration,
- preparation and mailing of resumes, and
- networking.

A local company might provide these services under contract; it would furnish a method of maintaining contact with and supporting returned graduates.

The contractor could also supply support to local employers in locating personnel with scarce skills. At a small fee for such service the secretariat might become self-supporting.

## 5.5 Private Enterprise Support

An effort should be made to support returned TTP graduates who want to go into business for themselves, either as a service business or as manufacturers. This support could consist of

- material identifying
  - the need (potential clients) for such businesses, especially service businesses, in the Tunisian economy, and
  - the support available for starting entrepreneurs;
- distribution of such material, to
  - MUST, for inclusion in a "return kit," and
  - to returned graduates; and
- perhaps, financial and business development advisory support for aspiring entrepreneurs who are TTP graduates.

## APPENDIX 1

## LIST OF INDIVIDUALS AND ORGANIZATIONS CONTACTED

| | |
|---|---|
| Hedi Abdennebi* | Directeur General<br>Hotel El Mechtel Abou Nawas |
| M. T. Al Falah* | President Directeur General<br>du Groupe KING,<br>President de la Chambre Syndicale<br>des Constructions Electriques |
| Saidane Ali* | Centre Technique des Industries<br>Mecaniques et Electriques<br>(CETIME) |
| M. Youssef Alouane | Director<br>Institut National Du Travail<br>The National Labor Institute |
| Mohamed Amara | Rector, The University of Tunis |
| Gastli Bakha* | Gerant de la Ste des Conserves<br>Alimentaires des producteurs du<br>Cap Bon |
| Abdelwaheb Ben Ayed* | President Directeur General<br>du Groupe Poulina |
| Hedi Ben Ghorbal* | Directeur Commercial<br>Societe des Industries Textiles<br>Reunies |
| Said Ben Sedrine | Research Associate<br>The National Labor Institute |
| Raouf Bouassida* | Asst to President Directeur-General<br>Groupe Poulina |
| Mohamed Bouhanek* | Ingenieur Arts et Metiers<br>President Directeur General<br>RECTIF S.A. |
| Mahmoud Bourguiba* | La Societe Tunisiene des Conserves<br>Alimentaires |

*Public and private sector employers

| | |
|---|---|
| Abelhamid Bouzain | Program Assistant, Office of the Director for International Cooperation<br>Ministry of Higher Education and Scientific Research |
| John Champagne | AID ANE/TR/HR<br>Washington, DC |
| Greta Cherchad | Program Assistant - USAID/T |
| Steve Conroy | Staff Associate<br>MUST |
| Lewis I. Cohen | Counselor, Economic and Commercial Affairs<br>Embassy of the United States, Tunis |
| Hassen Driss* | Directeur<br>Societe Tunisienne Ateliers Metallurgiques Mheni |
| Frederic Dumont | Deputy Counselor, Cultural and International Cooperation<br>Embassy of France - Tunis |
| Mouli Slah Eddine* | Chef de Service Personnel<br>Metallurgique de Tunisie |
| Annie Santamaria El Amouri | Institut El Amouri de Psychologie Appliquee |
| Tahar El Amouri | Directeur de l'Institut El Amouri de Psychologie Appliquee |
| Ali El Mir | Director of International Cooperation - MESRS |
| Adnane Glenza | Client Services Representative<br>UNISYS - Tunisia |
| Laval Gobeil | Conseiller, Cooperation<br>Ambassade du Canada |
| Khereddine Guellouz* | Directeur<br>de la Direction des Recherches et du Developpement<br>STEG, Tunis |
| Essia Hamouda | Ing. Techni-Commercial<br>Office National de l'Huile |
| Abdelhakim Hamrouni* | President Directeur General<br>Societe Tunisienne de l'Industrie Laitiere |



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| | |
|---|---|
| Mohamed Ali Hassairi | Program Assistant - USAID/T |
| Chebaane Hassiba | Directeur du Projet Transfers de Technologie Agricole<br>D. E. R. V. |
| Abdel Karem Jawah | Institut Economique et Quantitative |
| Mosbah Kanzari* | Directeur General Adjoint<br>STUDI SA. |
| Mark H. Karns | USAID/Tunis<br>Office of Project Development |
| Robert Krill | USIS/T Deputy Public Affairs Officer |
| Yvon Labrosse* | Ing. Directeur de Projet<br>SNC Inc. |
| Ramy K. Louis* | Directeur Adjoint de Projet<br>SNC Inc. |
| Joan MacDonald | English Language Programs - USIS/T |
| Bechir Mahjoub | Directeur General de l'Enseignement Superieur |
| Chedly Majoul* | A. Majoul & Cie "Conserves" |
| Habib Makni* | President Directeur-General<br>Alta Moda |
| Nobuhiro Matsuoka | Troisieme Secretaire<br>Ambassade du Japon, Tunis |
| Abdelkader M'hiri | Secretary of State for Higher Education/MESRS |
| Jacques Migozzi | Conseiller Culturel et de Cooperation Scientifique<br>Ambassade de France a Tunis |
| Limam Mohamed | Directeur Technique<br>Societe des Etudes Techniques et d'Ingenieurie |
| Radhouane Nouicer | Director - MUST |
| Chaouch Noury | President Directeur General<br>Centre Technique des Industries Mecaniques et Electriques |

| | |
|---|---|
| Jan Olsson | Conseiller<br>Ambassade de Suede, Tunis |
| Mohamed Salah Hannachi | Directeur des Etudes<br>Universite de Tunis<br>Institut Superieur de Gestion |
| Mohamed Sayah | Minister, Higher Education and<br>Scientific Research |
| Jonathan L. Sperling | Director, Program Office<br>USAID/T |
| Mahmoud Trabelsi | Ingenieur General<br>Bureau des Grands Travaux<br>Hydrauliques<br>Ministere de l'Equipement |
| Nancy M. Tumavick | Director, Project Management Office<br>USAID/T |
| C. Fritz Weden | Director - USAID/T |
| Timothy Williams | Ambassador<br>Embassy of Canada - Tunis |
| Salma Zouari | Professor<br>Faculte des Sciences Economiques<br>et de Gestion de Sfax |

## APPENDIX 2

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APPENDIX 3

STATEMENT OF WORK

The studies conducted by the contractor's team shall include the following task statements:

I. Demand Study

A. Describe existing structure and distribution across fields of engineering employment in the domestic economy.

B. Examine suitability of current trained stock of engineers to Tunisia's development needs.

C. Estimate annual requirements from 1988 to 1992 for trained engineers across different engineering fields and

- Project what portion of the annual requirements for each engineering field will be met by output of Tunisian educational institutions and by foreign degree training programs.

- Estimate the projected size of other donor programs producing foreign trained engineers.

- Estimate the relative surplus (deficit) of engineers by field produced by other Tunisian and foreign programs given current and projected trends in program outputs.

- Estimate in what fields of specialization, at what degree levels, and at what output levels within each field should Tunisian students be trained in the U.S. Technology Transfer Program based on:

  - Size, structure and output of other foreign and Tunisian programs.

  - Projected requirements of the Tunisian economy for trained engineers.

II. Placement Services Study

A. Identify status of current arrangements in Ministry of Education, Training and Scientific Research (METSR) and Scientific Mission for Tunisia in Washington, D.C. (MUST) to assist Technology Transfer Program graduates to find suitable employment in Tunisia.

B. Identify and briefly assess the operations of other institutions, organizations, offices or services, both

public and private in Tunisia, which are set up to assist university graduates to find professional employment. Assess the activities of MUST for placement assistance to program graduates.

C. Assess the effectiveness of these organizations in finding appropriate employment for university graduates in general and the Technology Transfer Project, in particular.

D. Make recommendations for establishment and operation of job placement service(s) which would operate to actively assist graduates of the Technology Transfer Program to find employment which matches their degree training.

E. Make recommendations for:

- Active involvement of other GOT organizations and private sector organizations in addition to the METSR and MUST.

- Staffing needs.

- Technical assistance and training needs for continuing operations.

- Coordination of METSR and MUST for job placement.

APPENDIX 4

DEMAND AND SUPPLY

## Estimation of the Demand for New Engineering Graduates

### 4.1 Outline of Methodology

The estimation of the demand for new engineers over the relevant time-period (1988-1992) involves, starting from the desired output, the following procedures.

Procedure 1

- Estimation of the demand in 1992.
- Estimation of the current use of engineers
- Subtraction to find the demand for new graduates.

The demand, to be useful, must be separately estimated by

- engineering field, and
- level of training. Two levels of training are estimated:
  - Engineer - BAC+4/BSc (E)
  - Principal Engineer - BAC+6/MSc or BAC+8/PhD (PE)

Estimation of the demand in 1992 has been made for a number of different hypotheses. These hypotheses reflect different assumptions regarding the relative use of engineers trained in various fields and at the two levels in the economy.

- The basic assumption ($H_0$) is that the use of engineers by level and field as a fraction of the total labor force remains the same in each sector of the economy. $H_0$ is the "no change in use of engineers" hypothesis.
- Alternate hypotheses are framed in terms of
  - percent increase in the use of engineers, by field and level, in the economy as a whole. The percent increase is in terms of the current use of the class (field and level) in the economy. For instance a 15 percent increase in PE in computer

engineering represents a 15 percent increase in the proportion of these engineers in the total workforce. [If this proportion were 1 percent, the change would be from one percent to 1.15 percent.]

- A number of alternate hypotheses have been framed, and the need for new engineers under these alternates calculated. This allows the GOT and USAID to

  - choose the hypotheses most nearly in accord with their experience, and

  - evaluate the sensitivity of the demand/supply balance to the hypotheses.

  The estimation procedure is embodied in a computer program; additional hypotheses could be evaluated as needed.

The above procedure develops the disaggregated demand for engineers on the basis of

- the current use

- hypotheses of no change ($H_0$), or of changes.

To do this it is necessary to estimate the disaggregated current use of engineers, and to estimate the future (1992) use under $H_0$. These are procedures 2 and 3.

**Procedure 2**

Estimate the future (1992) use of engineers by level and field, separately for each economic sector, under $H_0$. This is done by

- estimating the current use of engineers by level and field, separately for each economic sector, as a fraction of total employment in the sector (Procedure 3), and

- estimating the future (1992) total employment in each sector from current data

given the current use of engineers as a percent of the total labor force by sector.

This has been done by transforming the estimates of sectoral growth and investment in the VIIth Plan into estimates of the 1992 total labor force by sector.

Finally, one arrives at the task of

**Procedure 3**

Estimate the current use of engineers by field and level separately for each economic sector.

This was done on the basis of past studies, census data, and extrapolation and interpolation from these data.

The procedures outlined here are "top down": what has to be done to obtain the desired answers. In actual fact, the work has to be done "bottom up", starting with procedure 3 and working up to procedure 1. The succeeding sections of this Appendix describe these steps in that order. The final section presents the demand for new engineers.

## 4.2 The Current Use of Engineers

### 4.2.1 Categories

The estimation of current use of engineers by field and specialty, separately for each economic sector, requires in the first instance a uniform definition of

- engineering fields and levels of training
- economic sectors.

Not all sources use the same classification schemes, so that some cross-cutting has been necessary. The categories used, and their sources, are given in tables A4.1 and A4.2.

### 4.2.2 Sources and Estimation

Any estimate of the stock of engineers and the structure of engineering employment in Tunisia is precarious due to the unavailability of an updated and comprehensive manpower data base. Due to this absence of a consistent data source, it was necessary to draw information from several sources. The estimates of the stock of engineers and the structure of engineering employment in this study are based on data drawn from the following (numbers refer to the list of sources in Appendix 2):

- a study of manpower needs in industrial sectors, mining, and energy by the National Center of Industrial Studies (CNEI) in 1981 [7];

TABLE A4.1

CLASSIFICATION OF ENGINEERING FIELDS

| Specialization | Includes |
|---|---|
| Agricultural | Rural works and irrigation engineers, plant and soil scientists |
| Chemical | Chemical |
| Civil | Meteorologists, hydraulics, building, land transport, and public works engineers |
| Computer | Computer engineers, some programmers and information systems analysts with an engineering degree |
| Electrical | Electrical, electronic, electromechanical, and telecommunications engineers |
| Mechanical | Mechanical |
| Metallurgical | Metallurgical |
| Mines | Mining and geological engineers |
| Textile | Textile, wood and ceramics engineers |
| Food Processing | Food processing |
| Other | Bio-medical, aerospace, naval, transportation, non-classified (general engineering sciences), nuclear engineering |

LEVELS USED:

| | |
|---|---|
| Principal Engineer | requires six or more years of university study, equivalent of either a PhD or an MSc. Most are at the MSc level. |
| Engineer | requires four years of university study, equivalent to the BSc. |
| Technician | Requires two years of university study. |

Note: The designations of engineering fields may be self-reported or reported by employers. At universities, especially in the U.S., the designation refers to the department in which a student is enrolled. For instance, such specialties as bio-medical, computer or telecommunications engineering are often taught in electrical engineering departments.

TABLE A4.2

ECONOMIC SECTOR CLASSIFICATIONS

SECTORS

1. Agriculture and Fishing - soil science, irrigation, rural development.

2. Mines

3. Energy - includes electricity, gas and hydrocarbon industries.

4. Construction and Public Works - building, sealing, pre-fabricated materials, equipment installations, heating, refrigeration, security equipment, public works (sanitation).

5. Manufacturing Industries

   a. Mechanical, Metallurgical and Electric Industries - includes iron, steel and metal products, agricultural and public works equipment, electric equipment and supplies, elevators, automobile parts, factory equipment, shipbuilding, bicycles, motorcycles, and the like.

   b. Construction Materials Industry - includes cement, lime, insulation, sand processing, marble, pipes and tubes, tiles, crockery and ceramic ware.

   c. Chemical Industries - including fertilizers, pesticides, soap, rubber products, pharmaceutical products, cosmetics, explosives, industrial and medical gases.

   d. Food Processing Industries - includes milk, oils, cereals, etc.

   e. Textiles, Clothing and Leather Goods

   f. Miscellaneous - includes wood, paper and plastic products.

6. Administration - includes all ministries.

7. Commerce and Services - includes banks, tourism, transportation, telecommunications, and other services.

Source: Economic Yearbook of Tunisia, 1987-1988. L'Union de l'Industrie du Commerce et de L'Artisanat, 1987.

- an analysis of the CNEI data by Salma Zouari [24];
- the 1980 census of industrial activity published by Institut National de Statistiques [10];
- the 1984 census [10]; and
- statistics on the number of engineers employed in the administration in 1987 obtained from the Ministry of Public Function and Administrative Reform.

One missing source of data on engineers is the membership list of the Order of Engineers. This is the only source of more recent information. Although the membership list has been used in previous studies, the information was not released for this study.

Estimating the engineering stock and describing the structure of engineering employment based on these sources has several problems which affect the reliability of the estimates. First and most obvious, the data are dated. Second, there are definitional differences between the sources on industrial sectors and on engineering disciplines. Third, each source treats only a part of engineering employment.

The CNEI survey, for example, is now six years old and its coverage is limited to all enterprises in the mining and energy sectors, and 52 percent of all manufacturing firms. Agricultural, transportation and telecommunications, construction and public works and most of the commercial and service enterprises were not included in the study. Hence, any estimates based exclusively on these data will underestimate the number of agricultural, civil, mechanical, and electrical engineers in the Tunisian economy.

The 1984 census reports provide a more recent estimate of the number of engineers employed in the economy. The reports however do not distribute engineering employment by sector and the occupational classifications are too broad to be useful for estimation and planning purposes. All engineers, for example, are grouped into one of six categories: civil engineering, mining, agriculture, telecommunications, mechanical, or other (statistical and methodological). Although the census data are inadequate for manpower planning purposes, they were used to supplement estimates based on the CNEI survey and to serve as a check for those estimates.

Given the above, all numbers displayed in this report should be interpreted as best estimates on incomplete data rather than as precise values for the stock and demand for engineers.

Method of Estimation

To estimate the 1987 stock of engineers, we replicated Zouari's analysis [10] of the 1981 CNEI data in order to obtain a breakdown of the number of engineers employed by engineering specialization for 1981. To extrapolate from the survey data, we assumed that the proportion of engineers to total employment in enterprises not surveyed is the same as the proportion found in the enterprises surveyed.* The resulting estimates reflect the number of engineers employed by enterprises supervised by the Ministry of National Economy which accounted for approximately 50 percent of the total number of engineers employed in mining, energy and manufacturing industries. These results were then doubled to estimate the total number of engineers in the national economy for these sectors.

An annual attrition rate of 0.7 percent was applied to these estimates to account for retirees and deaths for the period 1981-1987. This 0.7 percent attrition rate is an estimate of the Ministry of Plan and is very low in comparison with an average rate of 4 percent found in other countries. This low rate may be partially explained by the relatively young labor force in Tunisia.

After arriving at this estimate, the number of engineers who graduated from Tunisian institutions and estimates of the number who graduated from schools abroad between 1982 and 1987 were tabulated. The number of graduates were then added to the 1981 employment estimates adjusted for attrition.

These estimates were then compared to the 1984 census, and the number of agricultural, civil, and electrical/communications engineers was adjusted upward to correspond to the census totals.

Although the 1981 estimates reflect the number of engineers employed, unemployment among engineers did not begin to surface until 1985. Hence, the estimates for 1987 using this method more accurately reflect the approximate number of engineers in the national economy rather than the number of engineers actually employed in 1987. The number of unemployed engineers is estimated at between 400 and 600 in 1987.*

Table A4.3 represents the estimated stock of engineers by level and field in Tunisia in 1987.

One modification has been made in Table A4.3 before further use: because the data are essentially based on a 1981 study adjusted by a 1984 census it was felt that the number of computer personnel engaged in the economy was probably underestimated, and the number was arbitrarily doubled. The resultant current

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* An alternate hypothesis, that the proportion of engineers in non-surveyed establishments was 50 percent of that in surveyed establishments, was also tried, but discarded because of lack of fit with the 1984 census data.

# TABLE A4.3

## ESTIMATED ENGINEERING STOCK BY SPECIALIZATION AND LEVEL OF EDUCATION, 1987

| Sector / Engineer | Agri-culture | Mines | Energy | Public Works | Mechanical & Electrical Products | Construc-tion Materials | Chemi-cals | Food Pro-cessing | Textiles, Wood & Leather Goods | Misc. Indus-tries | Sub-total Mfg. | Commerce & Services | Admini-stration | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Agriculture** | | | | | | | | | | | | | | |
| PE | 544 | 10 | 9 | - | - | - | 4 | 8 | - | - | 12 | 2 | 177 | 754 |
| E | 1,687 | 24 | 22 | 3 | - | - | 10 | 21 | - | - | 31 | 4 | 246 | 2,022 |
| **Metallurgy** | | | | | | | | | | | | | | |
| PE | - | - | - | - | 29 | 11 | - | - | - | - | 40 | - | 12 | 52 |
| E | - | - | - | - | 61 | - | - | - | - | 3 | 63 | 3 | 9 | 75 |
| **Mechanical** | | | | | | | | | | | | | | |
| PE | - | 6 | 90 | - | 44 | 26 | 20 | 12 | 3 | 8 | 112 | 30 | 73 | 311 |
| E | - | 105 | 148 | 14 | 203 | 153 | 81 | 39 | 11 | 22 | 510 | 64 | 117 | 957 |
| **Electrical** | | | | | | | | | | | | | | |
| PE | - | 19 | 250 | - | 69 | 88 | 56 | 13 | - | - | 225 | 31 | 161 | 686 |
| E | - | 60 | 467 | 15 | 318 | 388 | 99 | 69 | 20 | 10 | 905 | 40 | 208 | 1,695 |
| **Chemical** | | | | | | | | | | | | | | |
| PE | - | 31 | 24 | - | 10 | 12 | 75 | 19 | 2 | 7 | 126 | 44 | 69 | 294 |
| E | - | 70 | 37 | 4 | 53 | 47 | 123 | 42 | 7 | - | 272 | 23 | 56 | 462 |
| **Food Processing** | | | | | | | | | | | | | | |
| PE | - | - | - | - | - | - | 2 | 35 | - | - | 36 | 22 | 18 | 76 |
| E | - | - | 1 | 1 | 2 | - | 2 | 128 | - | - | 133 | 9 | 20 | 164 |
| **Textile** | | | | | | | | | | | | | | |
| PE | - | - | - | - | 8 | - | - | - | 76 | 21 | 106 | 4 | 34 | 144 |
| E | - | - | - | - | 14 | - | - | - | 232 | 43 | 288 | 47 | 47 | 382 |
| **Mines** | | | | | | | | | | | | | | |
| PE | - | 40 | 65 | - | - | 10 | - | - | - | - | 10 | 8 | 38 | 162 |
| E | - | 177 | 94 | 9 | 3 | 27 | - | - | - | - | 20 | 3 | 42 | 343 |
| **Energy/Petroleum** | | | | | | | | | | | | | | |
| PE | - | 10 | 54 | - | - | - | 4 | - | - | - | 4 | 7 | 23 | 98 |
| E | - | 145 | 41 | - | - | - | - | - | - | 1 | 1 | 2 | 26 | 216 |
| **Civil** | | | | | | | | | | | | | | |
| PE | - | 65 | 52 | 223 | 9 | 19 | 15 | 11 | 7 | 11 | 72 | 118 | 102 | 632 |
| E | - | 154 | 121 | 525 | 21 | 45 | 37 | 26 | 18 | 26 | 174 | 277 | 240 | 1,490 |
| **Computer** | | | | | | | | | | | | | | |
| PE | - | 9 | 5 | 2 | 2 | 5 | - | - | - | - | 7 | 54 | 11 | 88 |
| E | - | 21 | 12 | 4 | 5 | 13 | - | - | - | - | 19 | 126 | 27 | 208 |
| **Other** | | | | | | | | | | | | | | |
| PE | - | - | 55 | - | 12 | 22 | 10 | 18 | 4 | 18 | 85 | 160 | 92 | 392 |
| E | - | - | 98 | - | 28 | 40 | 83 | 8 | 15 | 28 | 201 | 307 | 84 | 690 |
| **TOTALS** | | | | | | | | | | | | | | |
| PE | 544 | 180 | 605 | 225 | 183 | 193 | 186 | 116 | 93 | 65 | 757 | 480 | 824 | 3,689 |
| E | 1,687 | 755 | 1,040 | 581 | 709 | 703 | 135 | 333 | 303 | 132 | 2,694 | 905 | 1,106 | 8,805 |
| **GRAND TOTAL** | 2,231 | 946 | 1,646 | 806 | 892 | 896 | 621 | 449 | 395 | 198 | 3,451 | 1,385 | 1,930 | 12,394 |

distribution of engineers by field and level is displayed in figure A4.1, and this distributon has been used for the "no change" hypothesis, $H_0$.

## 4.3 Projecting the Future Use of Engineers

### The Base Case

The base-case for projection is the null-hypothesis ($H_0$) that the proportion of engineering employment in each economic sector by field and level of employment (taux d'encadrement) does not change from the current use represented in Table A4.3 above.

The projections used are represented in the following three tables:

- Table A4.4, taken from the VIIth Plan, shows the projected growth of GDP by sector over the period 1987-1981.
- Table A4.5 displays the projected investment by sector over the same period.
- Table A4.6 shows the resultant projection for total growth in employment by sector. This projection (to 1992) is based on investment plans, estimates of costs of job-creation and of productivity trends.

Finally, the projected total use of engineers in the economy by 1992 under the null hypothesis is displayed in Table 4.7. This table was obtained as follows:

- The row-totals of Table A4.3 represent the total use of engineers by field and level in the economy in 1987.
- If these are divided into total employment, one obtains the percent of total employment for each field and level of engineering.
- Under the null hypothesis, these proportions will remain invariant until 1992.
- By applying these fractions to the projected total employment for 1992 one obtains Table A4.7 - the projected employment of engineers by field and level if there is no change in the taux d'encadrement.

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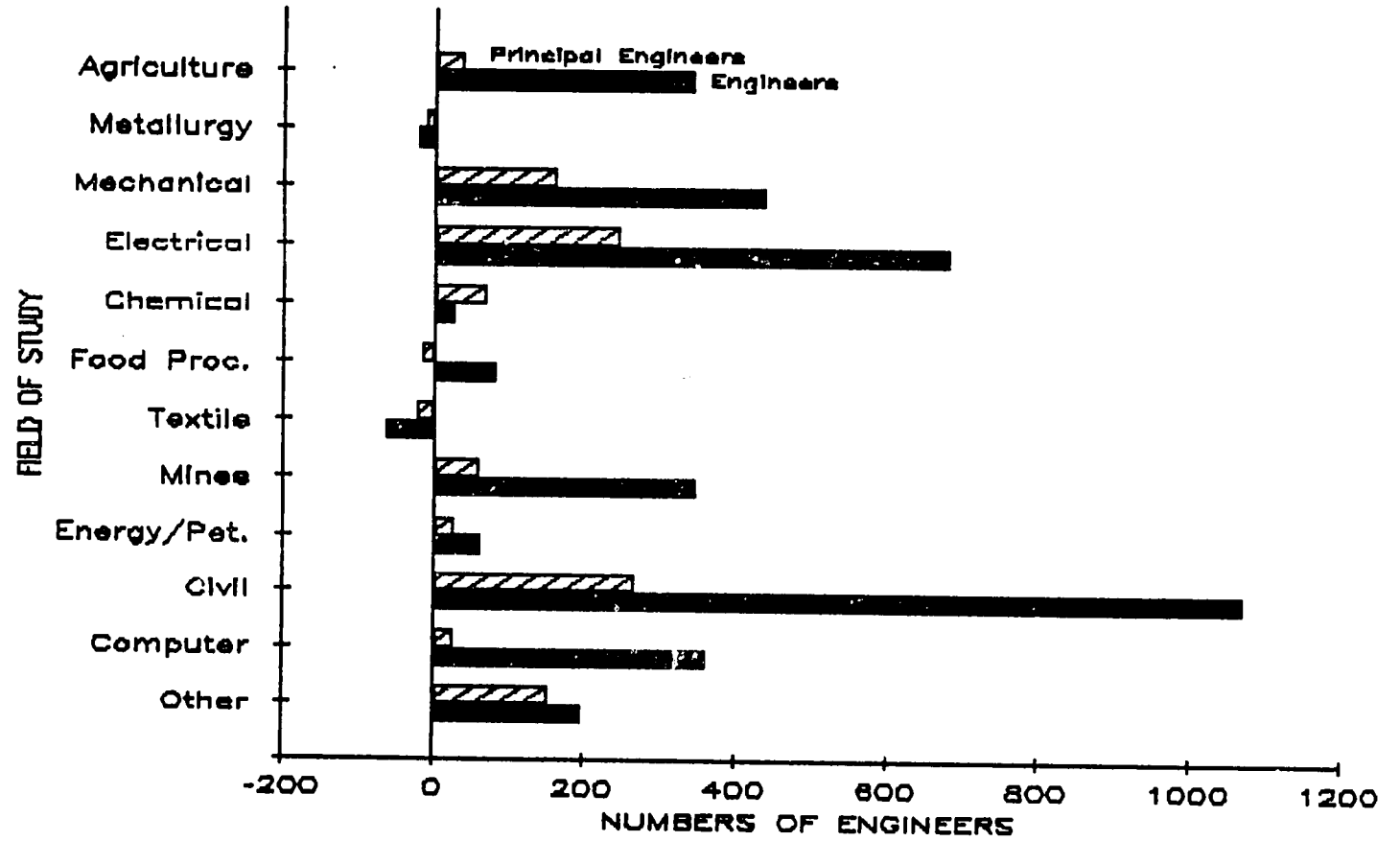
* The 400 estimate was obtained from the Order of Engineers: the 600 from UTICA. This number, because of the impossibility of distributing it across fields and levels, has been disregarded in further calculations.

FIGURE A4.1
EXCESS SUPPLY/Ho



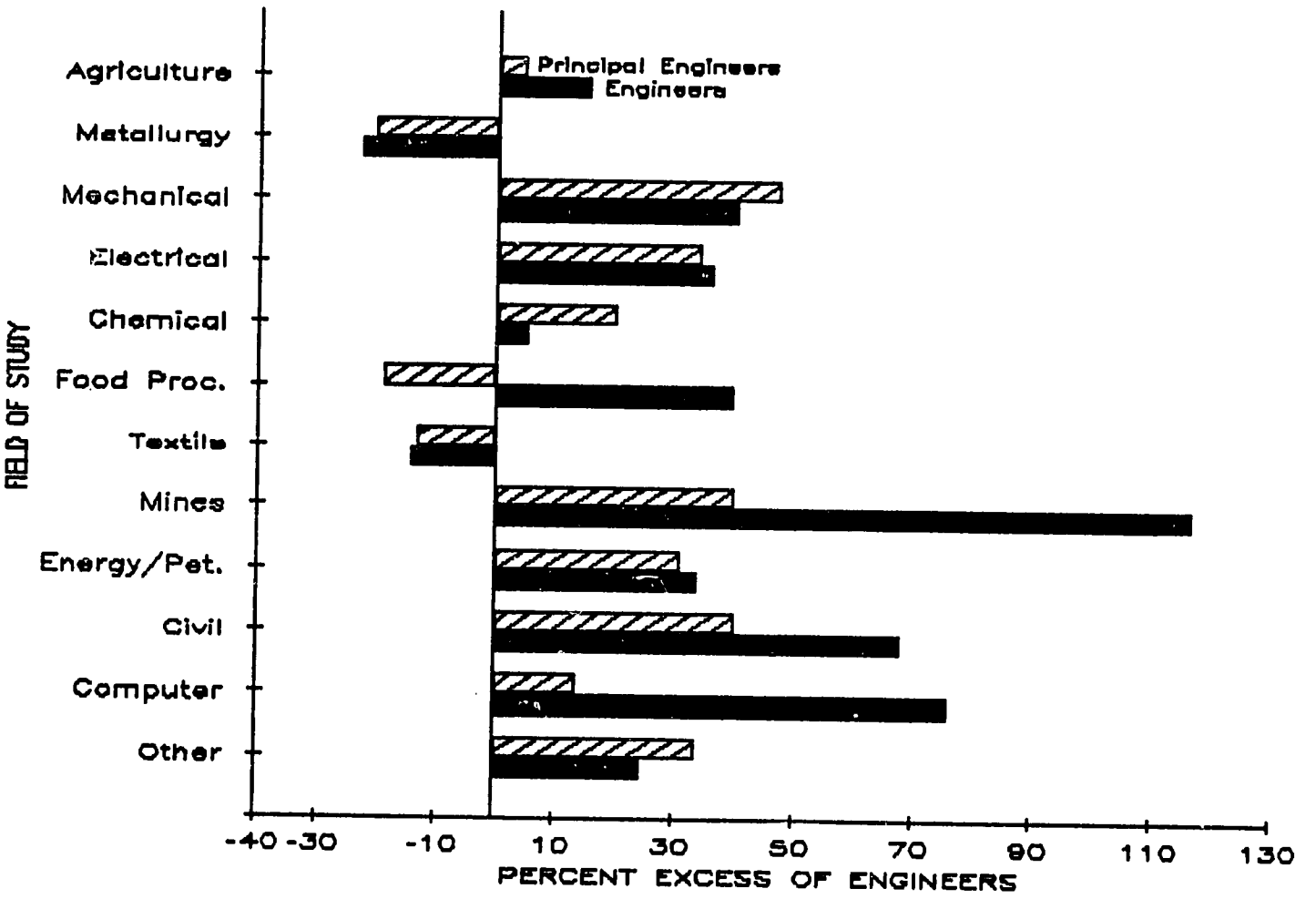



TABLE A4.4

GROSS DOMESTIC PRODUCT (GDP) BY SECTOR
(in thousands of dinars at 1980 prices)

| | 1987 | 1988 | 1989 | 1990 | 1991 | Total | Avg. Annual Growth Rate |
|---|---|---|---|---|---|---|---|
| GDP at Market Prices | 4484.1 | 4653.9 | 4816.1 | 5012.1 | 5206.8 | 24173.0 | 4.0 |
| GDP at Factor Cost | 3921.1 | 4068.9 | 4212.4 | 4382.4 | 4552.6 | 21137.4 | 4.0 |
| Agriculture | 622.0 | 646.0 | 670.0 | 705.0 | 735.0 | 3378.0 | 6.0 |
| Mines | 58.1 | 59.9 | 61.9 | 62.7 | 63.5 | 306.1 | 3.1 |
| Electricity, Gas & Water | 425.2 | 419.2 | 401.3 | 395.0 | 391.4 | 2032.1 | -2.0 |
| Construction & Public Works | 220.0 | 220.0 | 227.0 | 235.0 | 243.0 | 1145.0 | 1.0 |
| Manufacturing Industries | 657.6 | 700.4 | 743.5 | 789.0 | 837.2 | 3727.7 | 6.3 |
| Mechanical & Electrical | 92.3 | 99.5 | 106.0 | 113.9 | 124.0 | 535.7 | 7.6 |
| Chemical | 80.2 | 87.7 | 91.4 | 95.3 | 101.0 | 455.6 | 5.6 |
| Food Processing | 146.0 | 153.0 | 160.0 | 169.0 | 175.0 | 803.0 | 5.4 |
| Textile, Leather, Clothing | 141.4 | 148.1 | 158.5 | 168.6 | 178.4 | 795.0 | 5.9 |
| Construction Materials | 101.7 | 109.5 | 117.1 | 123.3 | 129.9 | 581.5 | 6.5 |
| Others | 96.0 | 102.6 | 110.5 | 118.9 | 128.9 | 556.9 | 7.6 |
| Commerce and Services | 1938.2 | 2023.4 | 2108.7 | 2195.7 | 2282.5 | 10548.5 | 4.2 |
| Transport & Communications | 217.0 | 229.8 | 244.6 | 261.3 | 275.5 | 1228.2 | 6.2 |
| Tourism | 164.0 | 172.0 | 181.0 | 195.0 | 208.0 | 920.0 | 7.5 |
| Administration | 506.5 | 517.0 | 527.0 | 538.0 | 548.0 | 2636.5 | 2.0 |
| Commerce | 836.7 | 881.6 | 924.1 | 960.4 | 1000.0 | 4602.8 | 4.8 |
| Other | 214.0 | 223.0 | 232.0 | 241.0 | 251.0 | 1161.0 | 4.0 |

Source: VIIth Economic and Social Development Plan, 1987-1991. Vol. 1.

TABLE A4.5

PLANNED INVESTMENTS BY SECTOR, 1987-1991
(millions of current dinars)

| | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | Total 1987-1991 | Percent of Total |
|---|---|---|---|---|---|---|---|---|
| Agriculture and Fisheries | 332.0 | 331.0 | 346.0 | 390.0 | 444.0 | 489.0 | 2000.0 | 19.2 |
| Non-Manufacturing Industries | 322.6 | 242.0 | 295.0 | 325.0 | 343.0 | 426.0 | 1631.0 | 15.7 |
| Hydrocarbons | 165.0 | 112.0 | 149.0 | 174.0 | 166.0 | 189.0 | 790.0 | 7.6 |
| Electricity | 67.7 | 47.0 | 51.0 | 53.0 | 74.0 | 135.0 | 360.0 | 3.5 |
| Water | 57.5 | 49.0 | 58.0 | 59.0 | 61.0 | 55.0 | 282.0 | 2.7 |
| Mining | 27.4 | 24.0 | 25.0 | 24.0 | 25.0 | 25.0 | 123.0 | 1.2 |
| Construction and Public Works | 5.0 | 10.0 | 12.0 | 15.0 | 17.0 | 22.0 | 76.0 | 0.7 |
| Manufacturing Industries | 253.0 | 245.0 | 303.0 | 316.0 | 390.0 | 446.0 | 1700.0 | 16.3 |
| Mechanical and Electrical | 69.0 | 53.0 | 78.0 | 103.0 | 123.0 | 133.0 | 490.0 | 4.7 |
| Textiles, Clothing & Leather | 21.0 | 31.0 | 54.0 | 54.0 | 61.0 | 70.0 | 270.0 | 2.6 |
| Construction Materials | 63.0 | 66.0 | 50.0 | 47.0 | 51.0 | 56.0 | 270.0 | 2.6 |
| Food Processing | 23.0 | 26.0 | 34.0 | 45.0 | 67.0 | 88.0 | 260.0 | 2.5 |
| Miscellaneous | 21.0 | 18.0 | 30.0 | 40.0 | 54.0 | 68.0 | 210.0 | 2.0 |
| Chemical | 56.0 | 51.0 | 57.0 | 27.0 | 34.0 | 31.0 | 200.0 | 1.9 |
| Commerce and Services | 658.3 | 731.0 | 783.0 | 804.0 | 846.0 | 918.0 | 4082.0 | 39.3 |
| Housing | 359.0 | 395.0 | 403.0 | 385.0 | 394.0 | 423.0 | 2000.0 | 19.2 |
| Transport and Communications | 187.2 | 238.0 | 286.0 | 310.0 | 317.0 | 328.0 | 1479.0 | 14.2 |
| Tourism | 78.0 | 58.0 | 58.0 | 74.0 | 95.0 | 100.0 | 385.0 | 3.7 |
| Other Services | 34.1 | 40.0 | 36.0 | 35.0 | 40.0 | 67.0 | 218.0 | 2.1 |
| Community Services | 144.1 | 161.0 | 188.0 | 200.0 | 207.0 | 231.0 | 987.0 | 9.5 |
| Other | 83.5 | 93.0 | 102.0 | 102.0 | 104.0 | 113.0 | 514.0 | 4.9 |
| Education | 37.6 | 45.0 | 58.0 | 66.0 | 67.0 | 77.0 | 313.0 | 3.0 |
| Health | 23.0 | 23.0 | 28.0 | 32.0 | 36.0 | 41.0 | 160.0 | 1.5 |
| TOTAL | 1710.0 | 1710.0 | 1915.0 | 2035.0 | 2230.0 | 2510.0 | 10400.0 | 100.0 |
| GDP at market prices | 7111.5 | 7970.7 | 8850.1 | 9742.4 | 10754.9 | 11858.8 | 49176.9 | |

Source: VIIth Economic and Social Development Plan, 1987-1991. Vol. 1

TABLE A4.6

EMPLOYMENT (in thousands) BY SECTOR

| | Actual[1] 1987 | Estimated[2] 1992 |
|---|---|---|
| Agriculture and Fisheries | 479,700 | 509,700 |
| Non-Manufacturing Industries | 270,800 | 251,800 |
| Electricity, Water, Gas | 15,900 | 15,400 |
| Mining | 20,400 | 11,900 |
| Construction and Public Works | 234,500 | 224,500 |
| Manufacturing Industries | 387,150 | 454,150 |
| Mechanical and Electrical | 35,150 | 46,150 |
| Textiles, Clothing & Leather | 219,800 | 241,800 |
| Construction Materials | 30,600 | 37,100 |
| Food Processing | 34,650 | 43,150 |
| Miscellaneous | 53,850 | 70,050 |
| Chemical | 13,100 | 15,900 |
| Commerce and Services | 763,200 | 884,200 |
| Transport and Communications | 90,850 | 95,850 |
| Tourism | 43,500 | 51,500 |
| Administration | 270,950 | 305,950 |
| Commerce and Banks | 143,550 | 173,550 |
| Others | 214,350 | 257,350 |
| TOTAL | 1,900,850 | 2,099,850 |

1. Source: Ministry of Plan Employment Data. Based on National Institute of Statistics, 1984 Population Census.

2. Sources: Ministry of Plan estimates based on projected sectoral growth, investment costs of job creation, trends in productivity.

The first two columns of table A4.5 contain the current stock of engineers by field and level; the next two the stock that will be required in 1992 under the "no change" hypothesis ($H_0$); the last two columns contain the change in requirements, i.e., the demand for engineers in the period under $H_0$.

TABLE A4.7

DEMAND FOR ENGINEERS 1988-1992

($H_0$)

| Current Stock | | Projected Needs | | Demand | | |
|---|---|---|---|---|---|---|
| PE | E | PE | E | PE | E | Field |
| 754 | 2022 | 835 | 2226 | 81 | 204 | Agriculture |
| 52 | 75 | 67 | 99 | 15 | 24 | Metallurgy |
| 311 | 957 | 341 | 1083 | 30 | 126 | Mechanical |
| 686 | 1695 | 724 | 1880 | 38 | 185 | Electrical |
| 294 | 462 | 336 | 527 | 42 | 65 | Chemical |
| 76 | 164 | 94 | 206 | 18 | 42 | Food Process |
| 144 | 382 | 171 | 450 | 27 | 68 | Textile |
| 162 | 343 | 150 | 298 | -12 | -45 | Mines |
| 98 | 216 | 90 | 182 | -8 | -34 | Energy/Petrol |
| 632 | 1490 | 666 | 1570 | 34 | 80 | Civil |
| -- | 208 | 100 | 237 | 12 | 29 | Computer |
| 392 | 690 | 453 | 800 | 61 | 110 | Other |
| 3689 | 8704 | 4027 | 9558 | 338 | 854 | TOTAL |

## 4.4 The Balance Between Supply and Demand

The last two columns of table A4.5 represent the estimated demand for engineers, by field and level, in the 1988-1992 time period under the "no change" hypothesis. This demand must be subtracted from the estimated supply to obtain the estimated **excess supply**. The estimated supply are the row-totals of Table A4.1. The resultant difference is displayed in figure A4.1, both as numbers and as percent of the projected number in the workforce in 1992.

Four different hypotheses have been formulated regarding the number of engineers which will be demanded in various specialties. These hypotheses, $H_1$ through $H_4$, are formulated in terms of the percent of engineers currently in the work-force that will be required in addition to those generated by sectoral changes to $H_0$.

The hypotheses and the "excess supply" under each hypothesis are displayed in figures A4.2 through A4.5. In each figure the postulated percent additional requirement by level and field is displayed in the top half, the resultant excess supply by level and field in the bottom half of the figure.

The figures display an essentially bifurcated labor market.

### Surpluses

- Under all assumptions there will be a heavy over supply of engineers (BAC+4/BSc) in the fields of agricultural, mechanical, electrical, mining, and especially civil engineering. The surplus in electrical engineering may mask a shortage in higher technology aspects such as electronic and telecommunications engineering.

- Significant surpluses exist also in principal engineers (MSc/BAC+6 and higher) in electrical, mechanical and civil engineering.

- A consistent, though small, surplus is also shown in the mining sector; this is primarily due to the fact that sectoral projections ($H_0$) show a decrease of activity in this sector.

These excesses, though varying with the hypotheses, persist under the whole range of hypotheses; they may be assumed to be real.



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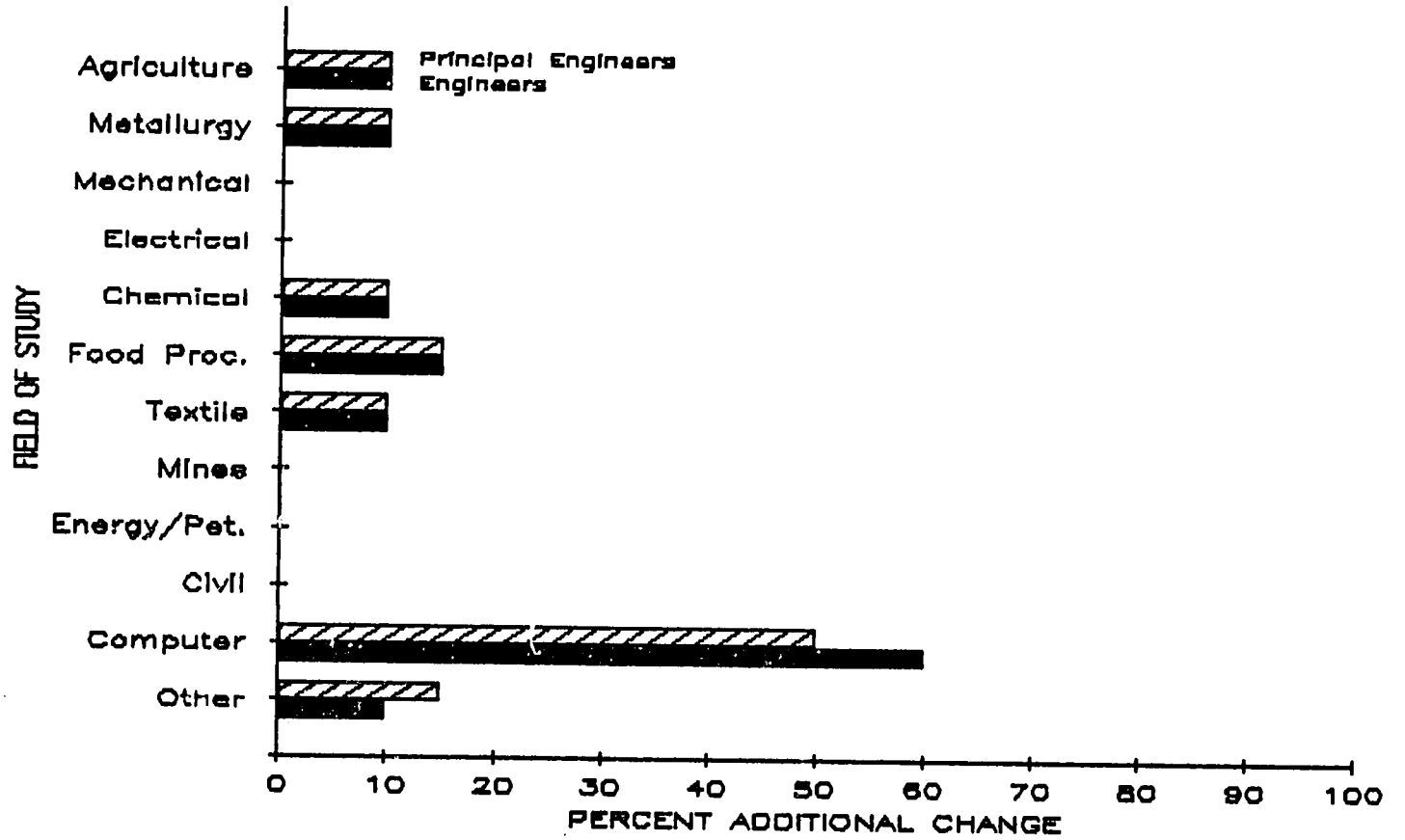
FIGURE A4.2

H1 SCENARIO: PERCENT ADDITIONAL CHANGE IN DEMAND




EXCESS SUPPLY, H1

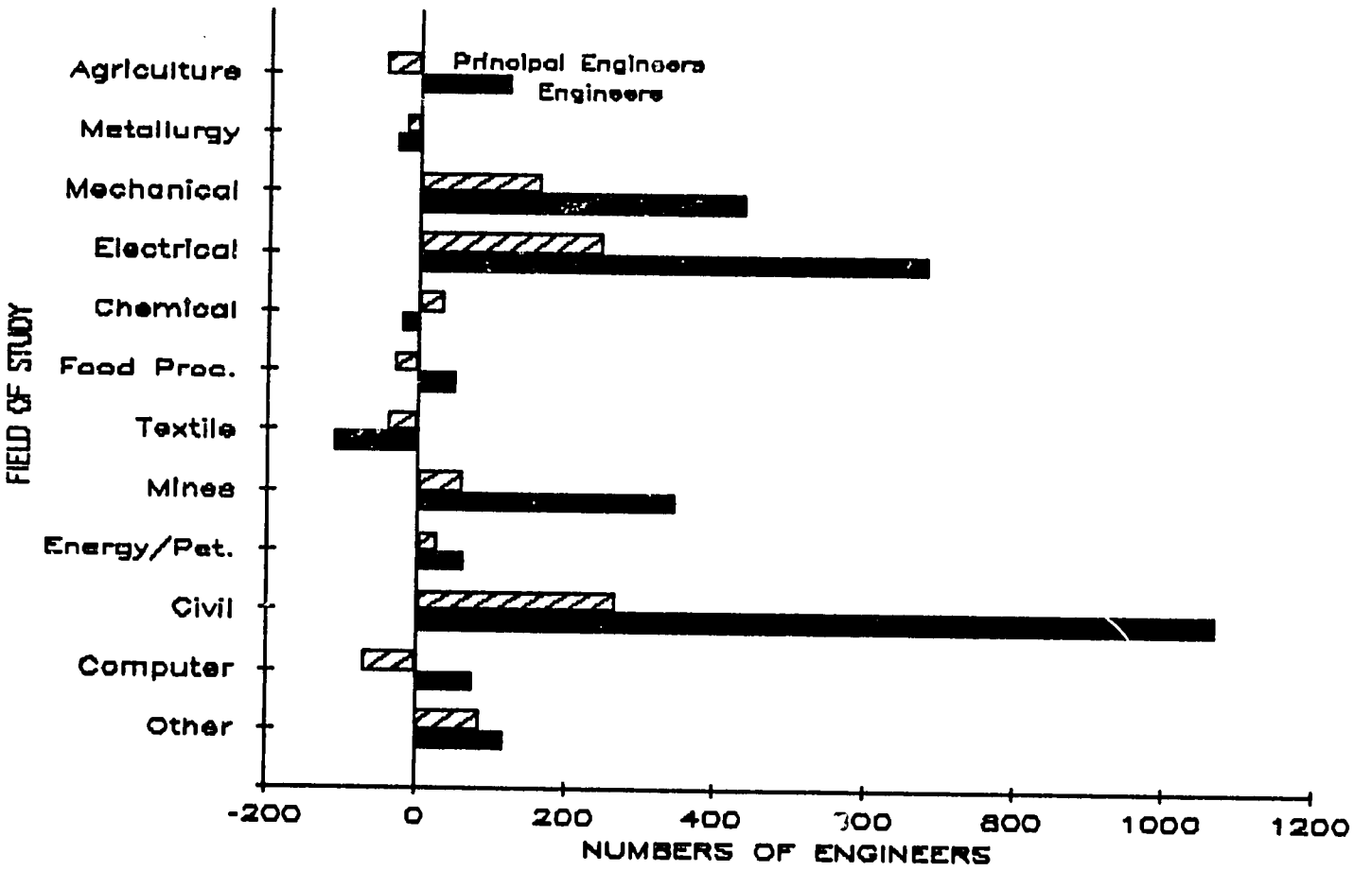
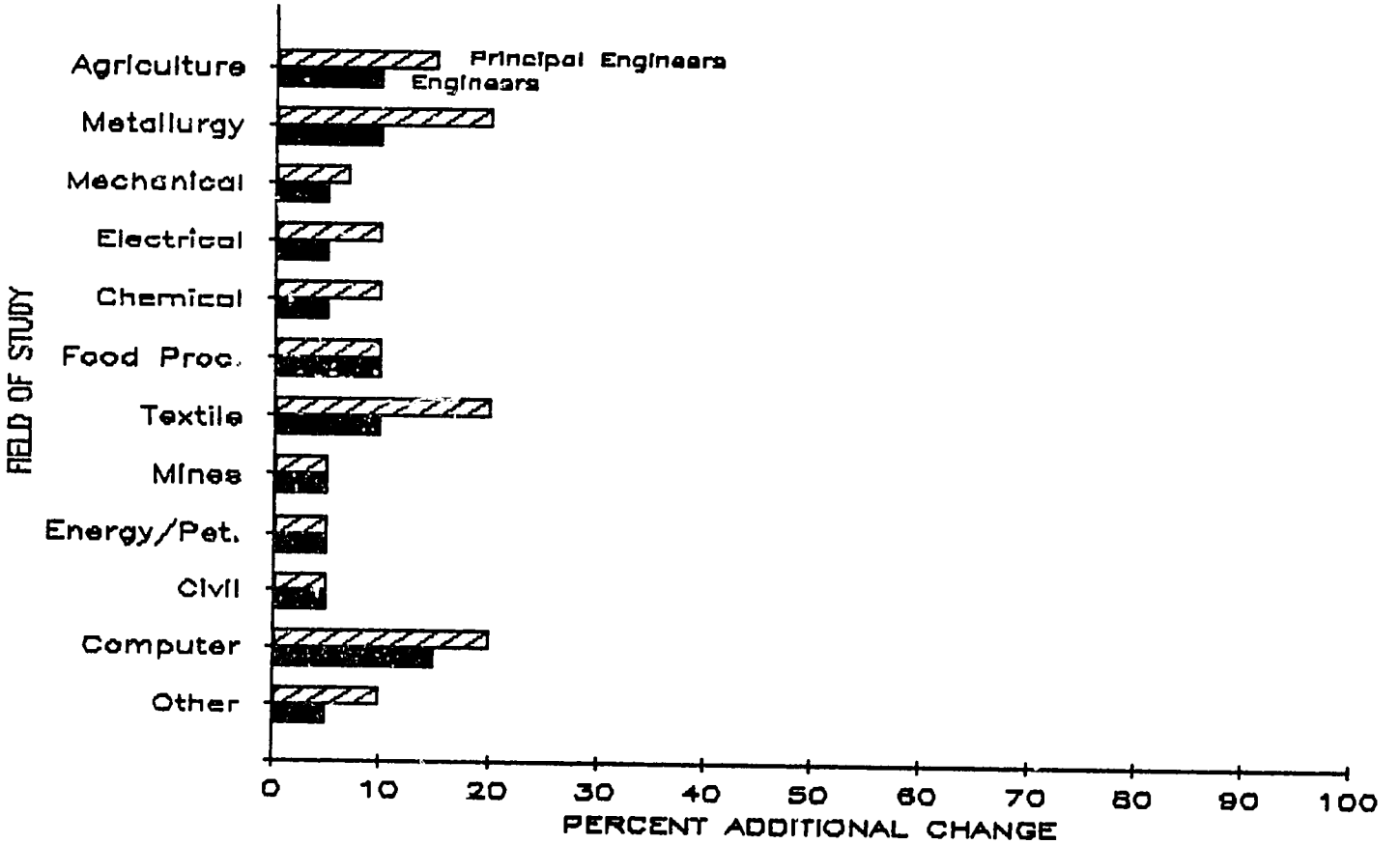


FIGURE A4.3

$H_2$ SCENARIO: PERCENT ADDITIONAL CHANGE IN DEMAND




EXCESS SUPPLY/$H_2$

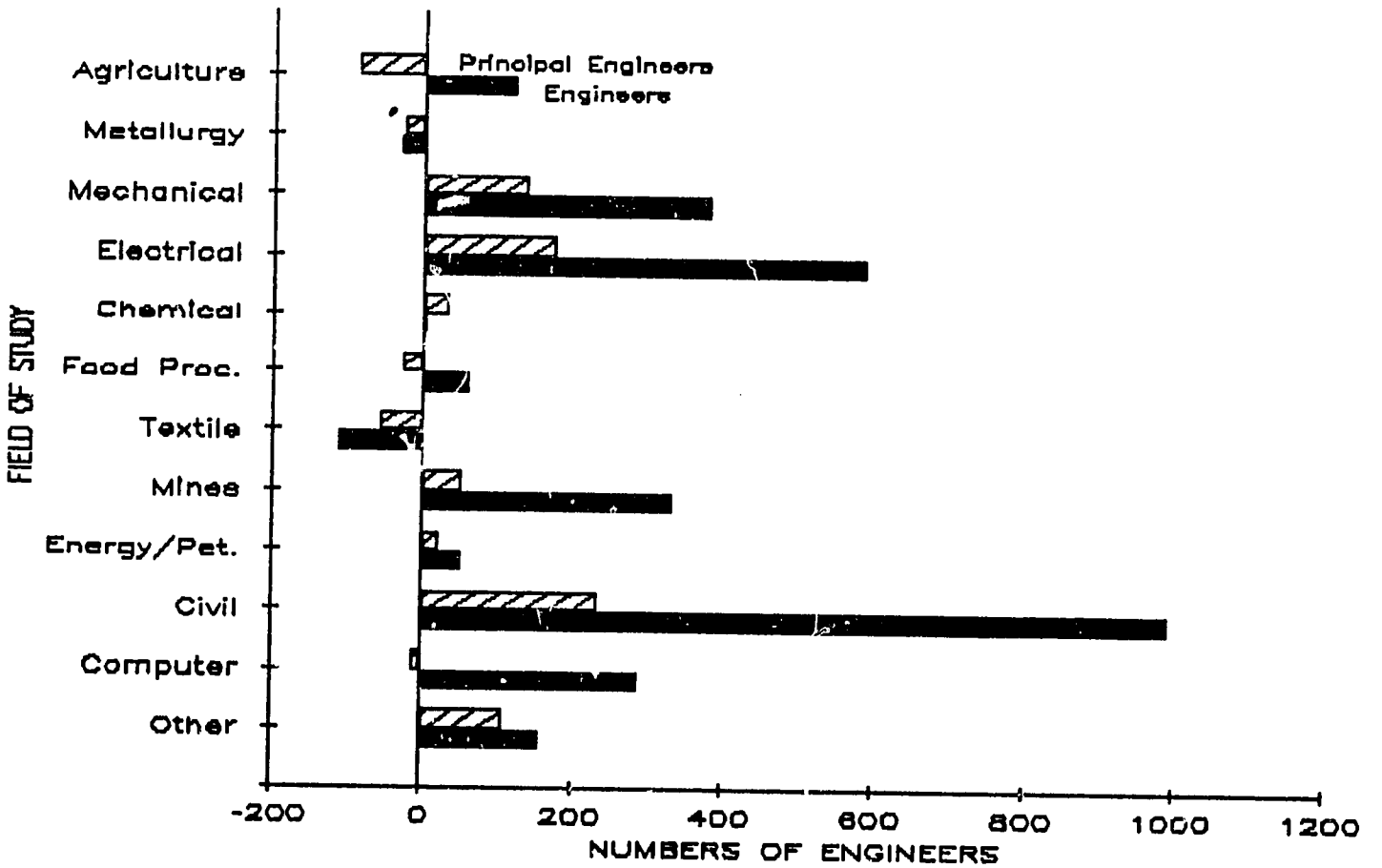
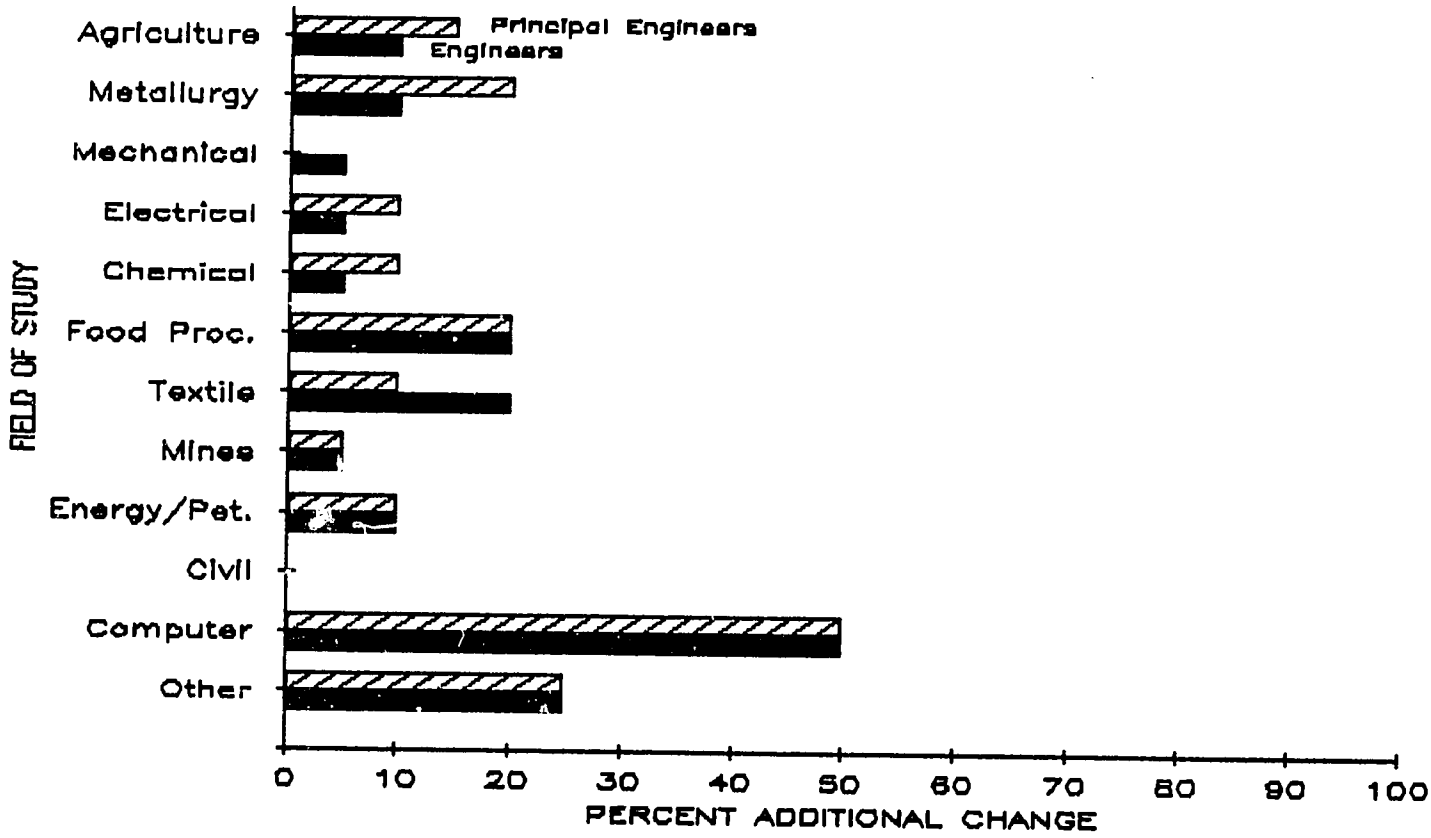


FIGURE A4.4
H3 SCENARIO: PERCENT ADDITIONAL CHANGE IN DEMAND




EXCESS SUPPLY/H3

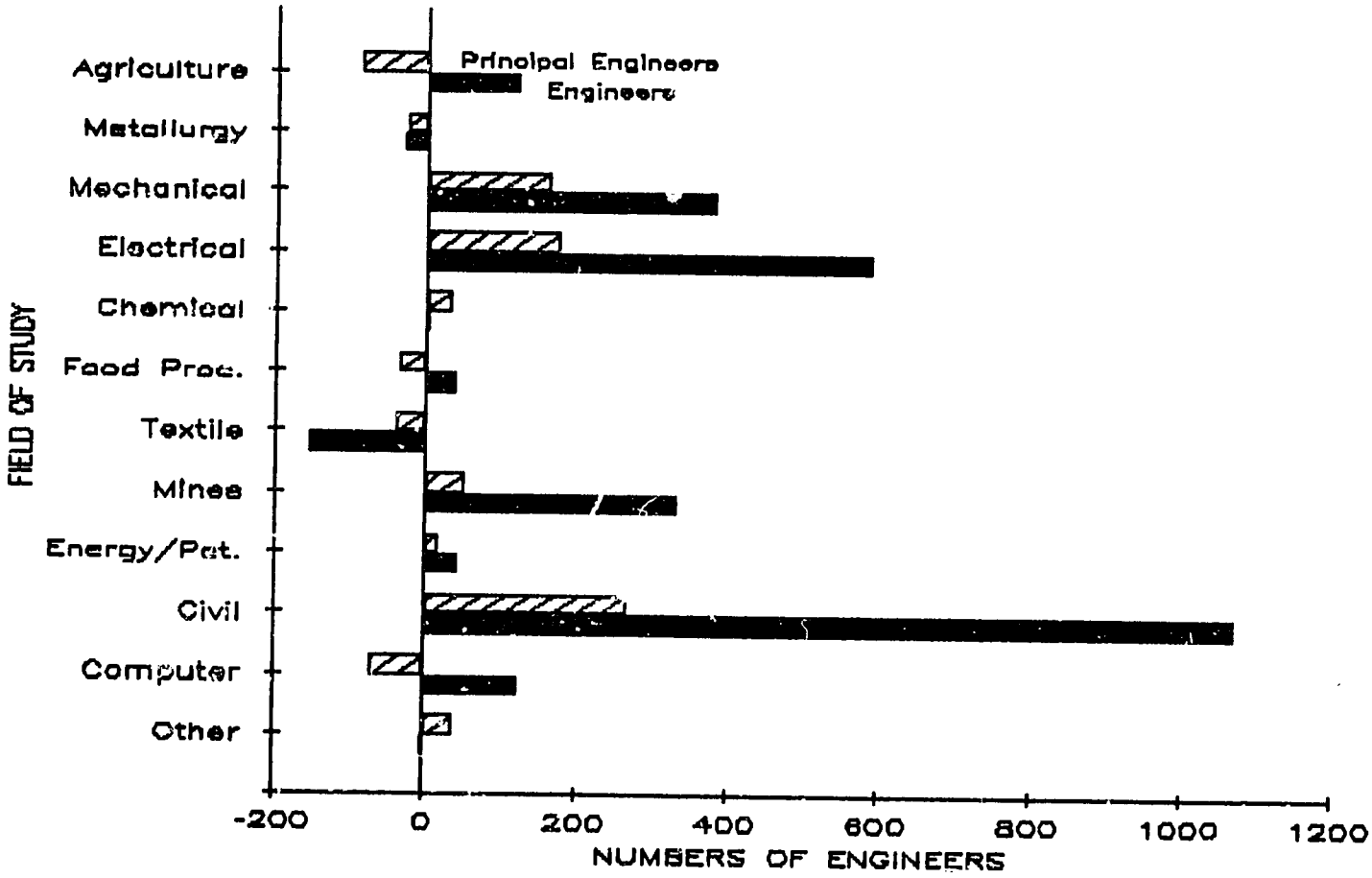
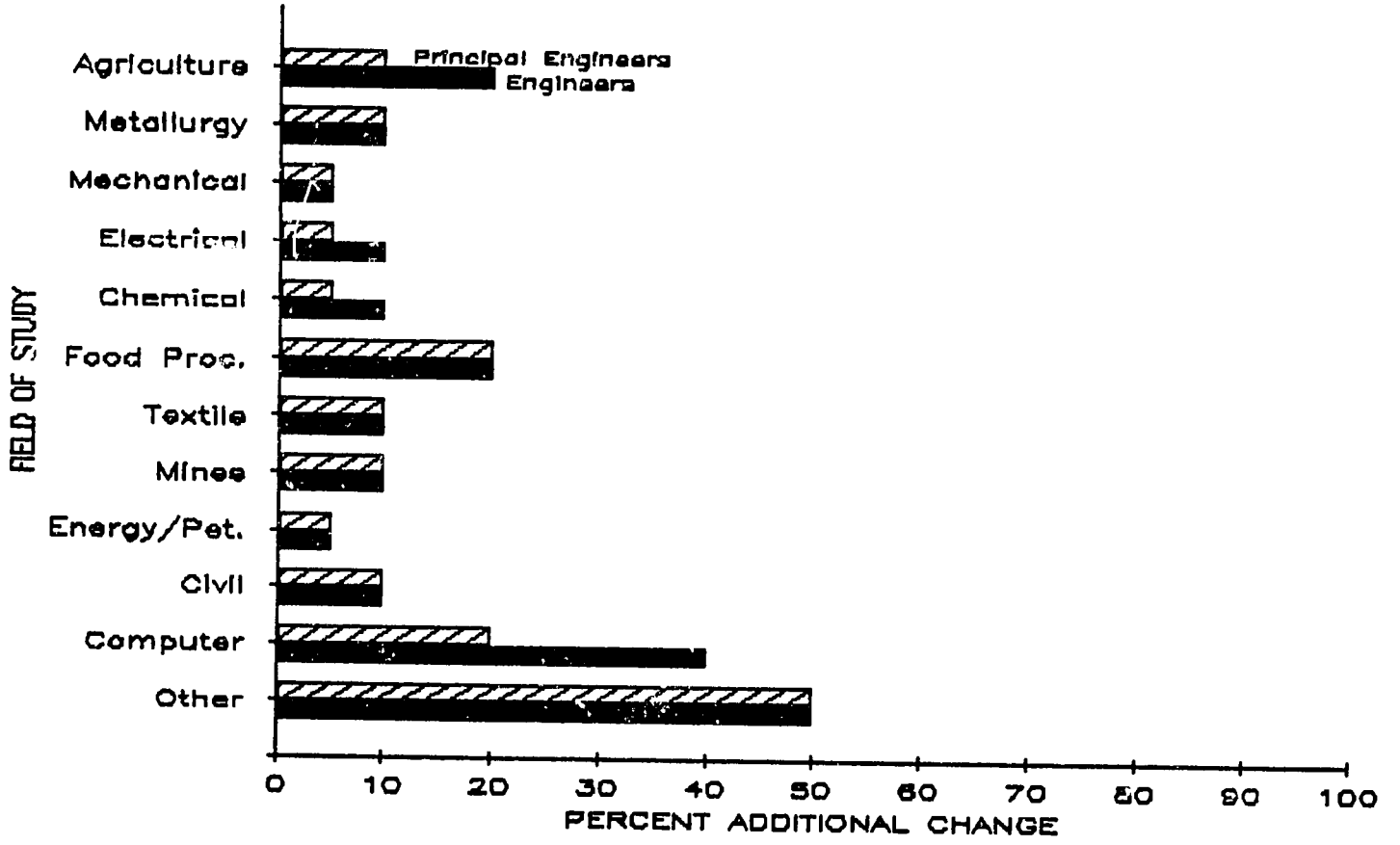
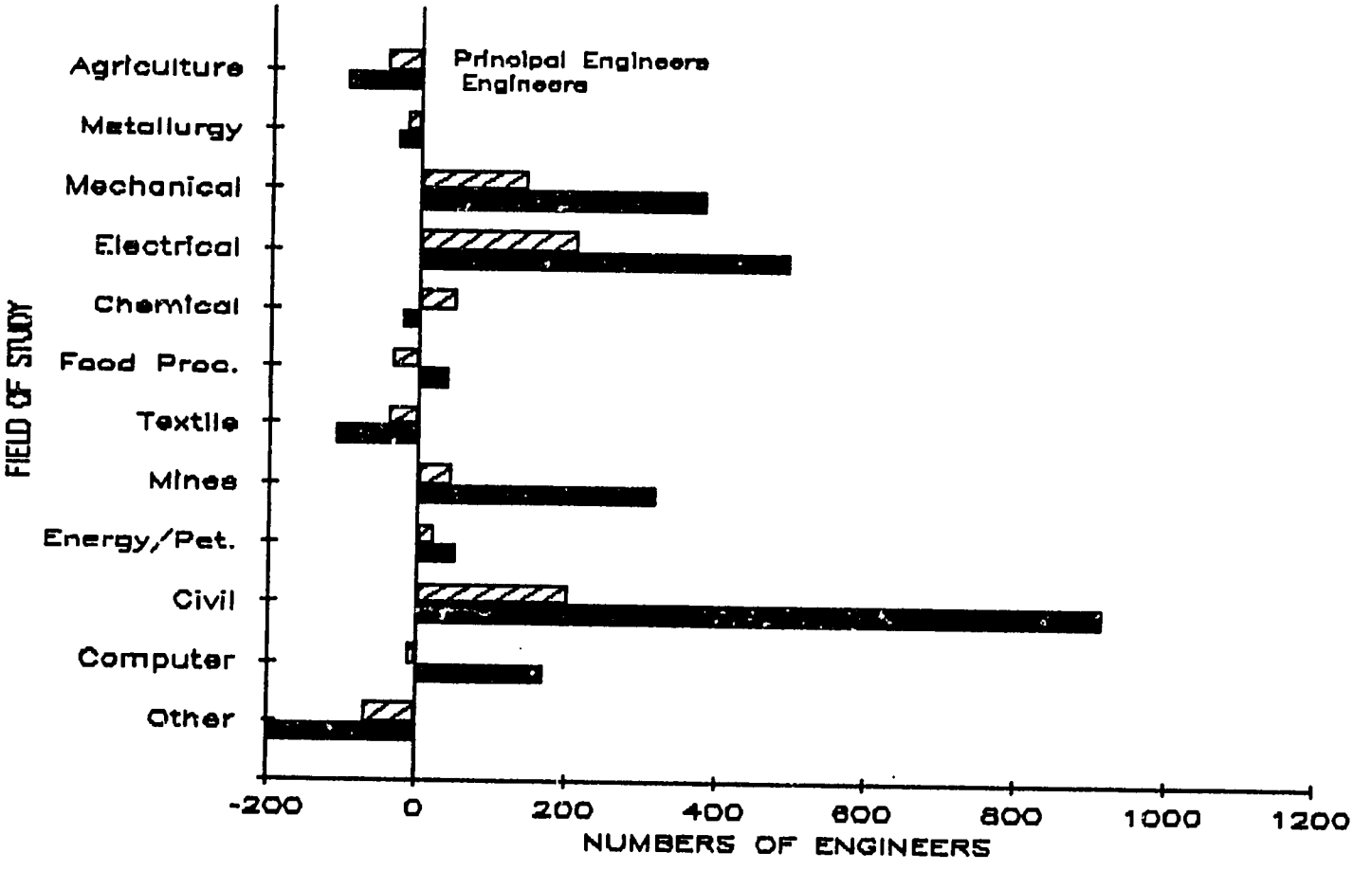


FIGURE A4.5

H4 SCENARIO: PERCENT ADDITIONAL CHANGE IN DEMAND




EXCESS SUPPLY/H4



Balance and Shortages

- In all the other fields, except perhaps that of computer engineer, fairly mild assumptions will cause a deficit or very small surplus, especially in principal engineer.

- The "other" category is a catchall, which includes newer specialties such as ceramic, materials, and biomedical engineering as well as quality related disciplines such as value and quality control engineering which are certainly in short supply, and miscellaneous older specialties and "unclassified."

- The excess of computer engineers may in fact materialize. On the other hand, if a computer maintenance and repair capability developed in the private sector, together with a diverse and competitive computer sales sector, these engineers would probably be absorbed.

In summary, in all fields other than the ones in surplus it is likely that shortages will materialize, especially at higher levels of training and in the higher and newer technology specialities in each field.