



Technion - Israel Institute of Technology

The S. Neaman Institute

For Advanced Studies in Science and Technology

# ANNUAL REPORT 1989-1990

# Annual Report 1989-1990

Technion - Israel Institute of Technology

The S. Neaman Institute  
For Advanced Studies in Science and Technology

Cover: Vision of Industrial Dynamics

The Board of Governors received a comprehensive report on the activities of the S. Neaman Institute.

The Board of Governors acknowledges the broad scope of the research and workshop activity and its contribution to the Technion and Israel. The Board is pleased with the Institute's success in involving Technion faculty in its activities and in playing its part in bringing international recognition to the Technion.

The Board wishes to pay tribute to Mr. Samuel Neaman, whose initiative, vision and continuous involvement brought the Institute into being and furthered its development.

Technion Board of Governors Resolution,  
June 1989.

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Samuel Neaman  
Chairman



Professor Zehev Tadmor  
Director



Professor Uri Shamir



Professor Brian Silver



Itzhak Lederfelnd

**THE SAMUEL NEAMAN INSTITUTE**  
**FOR ADVANCED STUDIES IN SCIENCE AND TECHNOLOGY**

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**Staff**

Project and Workshop Coordinator: David Kohn, M.Sc., M.Phil.  
Administrative Assistant: Mrs. Ruth Rivkind

## **ABOUT THE INSTITUTE**

The Samuel Neaman Institute for Advanced Studies in Science and Technology is an independent public-policy research institute, established in 1978 to assist in the search for solutions to national problems in science and technology, education, economy and industry, and social development. As an interdisciplinary think-tank, the Institute draws on the faculty and staff of Technion, other institutions and scientists in Israel, and specialists abroad. The Institute serves as a bridge between academia and decision makers through research, workshops and publications.

The Institute pursues a policy of inquiry and analysis designed to identify significant public policy problems, to determine possible courses of action to deal with the problems, and to evaluate the consequences of the identified courses of action.

As an independent not-for-profit research organization, the Institute does not advocate any specific policy or embrace any particular social philosophy. As befits a democratic society, the choices among policy alternatives are the prerogative and responsibility of the elected representatives of the citizenry. The Samuel Neaman Institute endeavors to contribute to a climate of informed choice.

The Institute undertakes sponsored advanced research, formulates invitational workshops, implements continuing education activities on topics of significance for the development of the State of Israel, and maintains a publications program for the dissemination of research and workshop findings. Specific topics for research may be initiated by the Institute, researchers, government agencies, foundations, industry or other concerned institutions. Each research program undertaken by the Institute is designed to be a significant scholarly study worthy of publication and public attention.



## **Origins**

The initiative for establishing this Institute in Israel was undertaken by Mr. Samuel Neaman. He nurtured the concept to fruition with an agreement signed in 1975 between himself, the Noon Foundation, the American Society for Technion, and Technion. It was ratified in 1978 by the Senate of the Technion. Mr. Neaman, a prominent U.S. businessman noted for his insightful managerial concepts and innovative thinking, as well as for his success in bringing struggling enterprises to positions of fiscal and marketing strength, has since retirement devoted his time to the activities of the Institute.

## **Organization**

The Director of the Neaman Institute, appointed jointly by the President of the Technion and the Chairman of the Institute Board, is responsible for formulating and coordinating policies, recommending projects and selecting staff. The five-member Institute Board is chaired by Mr. Samuel Neaman and includes ex officio Technion Vice-President for Development and Vice-President for Research. The Board is responsible for general supervision of the Institute, including overall policy, approval of research programs, and overseeing financial affairs. An Advisory Council made up of members of the Technion Senate and distinguished public representatives reviews research proposals and consults on program development.

## **Funding**

The Institute's activities are financed largely by the fruits of the Samuel Neaman Research Fund, located at the American Society for the Technion. This ensures freedom and independence. At the same time, contract research is undertaken for government, public and private organizations, provided they are in convergence with Institute goals and objectives.

## THE DIRECTOR'S REPORT

The Samuel Neaman Institute, as conceived by its founder, in its continuing drive to contribute to informed public policy decision making in Israel, has strengthened its direction, focus and operations. Based on the Institute's experience accumulated since its establishment in 1978, it has formulated and supported a pro-active and strategic approach to its research activities.

Under the guidance and direction of the Institute's Board of Directors, and supported by input from members of the Advisory Committee, faculty, researchers and staff, SNI has identified the broad areas of industry and technology as central to Israel's economic independence, if not its economic survival. The Institute has set as its main objective a significant contribution to a national industrial vision for the future.

Such a vision, with its technological, economic and social implications for Israel, requires the constant participation, contribution, and involvement of Technion faculty. This faculty forms an unmatched knowledge resource in Israel which spans the key areas of technology and science essential to creating an industrial vision for the 21st century. Technion's charter specifically calls for its faculty to make such contributions, and the Samuel Neaman Institute was designed as an ideal framework and organization to bring this mission to fruition.

A vision of technology based industries of the future cannot be developed, however, without deep involvement in and intimate knowledge of science policies and educational policies. The policy areas of **industry and technology, science, education, and national resources and quality-of-life** when taken separately, highlight aspects of national planning in which innovative policy studies, are, of course, badly needed and each has profound significance in its own right. But, when taken together they provide a rich synergy upon which the Institute hopes to capitalize. At SNI, these four research areas are integrated and provide a unique base for development of a national industrial-technological vision for the future.

This year, 28 Technion professors from 10 departments have been involved in SNI research. In addition, six professors

from other universities in Israel, four visiting professors from the U.S., and 13 other researchers were involved in these projects. The total cost of the research was approximately US\$500,000, of which US\$320,000 came from the Samuel Neaman Research Fund in the United States. The results of these studies are summarized in the research reports in this volume.

Highlights of SNI's research results this year include, in the area of **industry and technology**, the formulation of an extensive research plan for a study of the Future of Israeli Industry. The project will relate to other industry oriented research activities undertaken at SNI, including Automation in Israeli Industry, Technometric Indices (a joint project with the Institut fur Systemforschung in Germany), and a comprehensive research program on the Israeli Plastics Industry. The study of the Plastics industry will also serve as a model study of an industrial sector for use by several similar SNI research projects.

In the area of **science and scientific research**, the Israeli Academy of Sciences and Humanities has added its sponsorship to the SNI study of Trends and Effects of Israeli Science. Also the Council of Higher Education's Planning and Grants Committee has commissioned special SNI studies in this field. SNI's research project Trends in Science and Technology in the Middle East is concentrating on the issues of the technological 'gap' between Israel and the Arab countries in education, science, computers and aerospace, resulting in significant insights relating to an understanding of these trends.

The third area of focus at SNI is **education**. The Ministry of Education has requested that SNI conduct an extensive study of pre-university scientific and technological education. The project on the Teaching of High School Science and Mathematics by video-cassette, conducted jointly with the Unit for the Improvement of Learning at Technion, has been very successful. As a result, the Ministry of Education decided to extend the project to all high-schools and pre-academic educational systems. A joint steering committee of the Ministry of Education and SNI has been established in order to implement this project on a national basis.

Continuing its ongoing exploration of Engineering Education in the 21st Century, the Institute has also concentrated on two major aspects of engineering education. The first was the Place of Design in Engineering and the second, the Impact of Computer Technology on the Content and Methods of Teaching Mathematics to SNI's work on **national resources and quality-of-life** issues currently involves two studies. One ongoing project is the study of oil pricing policies in Israel, which has special significance in view of the imminent sweeping national policy reforms in this segment of the economy. Also, a study of the Law Enforcement System in Israel in the 21st Century has just been approved by the Ministry of Police. The Ministry of Police, the Police Department itself, the Ministry of Justice, and other think-tanks, will participate in this study.

In addition to these studies, the President of Technion requested that SNI engage in a policy study and formulate a plan of action for Technion to deal with the absorption of new immigrants from the Soviet Union. The absorption of the new immigrants has become the most important and urgent item on Israel's national agenda. The relevant issues cut across all four of SNI's research areas and they demand a multidisciplinary approach. SNI's study was adopted by Technion and adapted into an operational plan. SNI has now begun a more detailed study of the professional backgrounds and needs of new immigrant engineers and scientists.

The Institute has also focused on strengthening the administrative support it gives to its researchers. SNI staff are committed to providing each research team with computer, library and data base management services, as well as coordination of the publication and dissemination of SNI project reports. Over the past several years the quality and sophistication of these services has improved dramatically.

In the area of computer and data base management, the Institute has embarked upon a state-of-the-art program to provide computers for managing the complex and intersecting data-bases which are built and maintained for the many SNI research projects. These systems will also

support the dissemination of research results, the management the Institute itself, improvement in the quality and frequency of public and inter-institute communications, and the interface between SNI and Technion faculty and staff.

Another area of continuing improvement in SNI's capability is planning and implementing international workshops. Several world-class events related to SNI projects have been held and several others are in the planning stages. These workshops, and the publications arising from them, have served to strengthen the work done at the Institute and ensure up-to-date results and conclusions. The number of publications distributed by the Institute has risen by 30% over last year.

For the future, the main challenge the Institute faces, is continuing its course leading to the ability to deliver meaningful research, provide alternatives to decision makers, and be recognized as Israel's pre-eminent public policy think-tank. It is hoped that the Institute will continue to successfully involve Technion faculty and researchers in the policy development process.

Finally, I would like to recognize the steady and continuing commitment to the Institute by Sam Neaman. He gives not only of his time and not only of his resources, but he gives of his experience and vision. His dedication to the Institute embodies the kind of involvement that serves as a model of the collaboration that is possible within the world Jewish community. It is a pleasure working with him and the entire SNI staff, and I am grateful for the opportunity of serving as SNI's Director.

Zehev Tadmor

## INCOME AND EXPENDITURES

for Fiscal Years 1986/87 to 1989

Category	U.S. Dollars		
	1.10.86 to 31.12.87 (15 months)	1.1.88 to 31.12.88	1.1.89 to 31.12.89
Income:			
From the Neaman Fund	400,000	320,000	320,000
Other sources	208,862	327,178	192,489
<b>Total Income</b>	<b>608,862</b>	<b>647,178</b>	<b>512,489</b>
Expenditures:			
Education and Universities	196,532	162,272	136,026
Industry, Technology & Science	70,653	97,450	185,718
Quality of Life & Public Policy	108,523	51,262	20,425
Miscellaneous Projects	243,139	55,968	30,217
Institute Administration (including general expenses: administration, accounting, office equipment, computers and publishing)	127,273	177,176*	131,929
<b>Total Expenditures</b>	<b>746,120</b>	<b>544,128</b>	<b>504,315</b>

\* Including \$ 64,955 for office renovation

## **SNI RESEARCH PROJECTS**

### **Education and Universities**

1. **Role and structure of technological universities**  
Prof. P. Singer
2. **Design in engineering curricula**  
Prof. R. Shinnar (USA), Prof. Z. Tadmor, Dr. R. Karni
3. **Mathematics in engineering education**  
Prof. M. Wolfshtein, Prof. Z. Ziegler, Prof. N. Liron,  
Prof. L. Pismen
4. **High-school education in sciences and mathematics**  
Prof. G. Eylam, Prof. A. Berman, Prof. E. Dubinsky (USA)
5. **High-school education in technology**  
Prof. A. Shitzer, A/Prof. S. Waks
6. **Teaching of science and mathematics by video**  
Prof. M. Livio, Ing. D. Kohn, Mrs. I. Adler
7. **Trends in R&D manpower planning in OECD countries**  
Ing. D. Kohn, Dr. B. Toren

### **Industry and Technology**

- \* 1. **Israeli industry in the 21st century**  
Dr. Z. Bonen, (coordinator), Prof. Z. Kohavi,  
Prof. E. Kehat, Prof. M. Avriel, Prof. E. Rosenstein,  
Mr. I. Dror, Mr. S. Drori, Ms. V. Kovary
2. **The Israeli plastics industry**  
Dr. S. Kenig, Prof. Z. Tadmor, Prof. D. Vofsi,  
Dr. D. Frenkel, Dr. R. Albalak, Prof. A. Ram,  
A/Prof. J. Miltz

3. **Automation in industry**  
Prof. E. Lenz, A/Prof. J. Rubinowicz, Prof. K. Preiss,  
Prof. N. Finger,(Dr. Z. Bonen, coordinator)
4. **Technometric analysis of industrial products**  
A/Prof. S. Maital, Mr. A. Frenkel
5. **Trends in fertilizers and fertilization**  
Prof. J. Hagin, Mr. G. Segelman

## **Science**

1. **Productivity and impact of Israeli science**  
Prof. G. Czapski, Mr. A. Frenkel, Ing. D. Kohn,  
Mr. A. Shoham
2. **Science indicators**  
Prof. G. Czapski, Mr. A. Shoham, Ing. D. Kohn
3. **Trends in science and technology in the Middle East**  
Prof. A. Dar, Gen. A. Gilboa, Prof. G. Gilbar,  
Prof. M. Yoeli, Dr. M. Itzkowicz, Prof. A. Rosen,  
Dr. D. Frenkel, Ms. M. Navot
4. **Centers for scientific excellence**  
Prof. S. N. Eisenstadt, Dr. S. Katz

## **National resources and quality of life**

- \* 1. **Law enforcement system in the 21st century**  
Prof. M. Yadin
2. **Comparative study of oil prices**  
Dr. A. Mandel
- \* 3. **Energy alternatives for Israel**

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\* in preparation





Prof. P. Singer

## The Role and Structure of Technological Universities

Professor Paul Singer

Technological universities, including the Technion, will require major structural reforms in the future, in order to properly meet the challenges of a changing world. This project seeks to define the optimal organizational structure for a technological university, and is based on comparative research studies.

Among the topics slated to be investigated are:

- ◆ University-Industry Relations: industry's role in faculty selection and development; organization of joint R&D projects; use and ownership of equipment; and development of the results of joint research.
- ◆ Interdisciplinary Units on Campus: organization of units that cut across several disciplines; mechanisms for forming and dissolving such units; institutional authority over such units.
- ◆ Continuing Education: collaborative schemes with government and professional organizations.

During the past year, well-known experts visited SNI and presented seminars and short workshops, including Sir Claus Moser, President of Wadham College at Oxford University, (U.K.), Professor Kenneth K. Keller, former President of the University of Minnesota, Professor Jeffrey Pfeffer of the Graduate School of Business of Stanford University, Professor Claude Maury, of the Ecole Polytechnique in Paris.

A joint SNI - Ecole Polytechnique study on "Functions and Perspectives on Technological Universities", was carried out by two students from the Ecole Polytechnique, Mr. Jean-Marc Germain and Mr. Oliver Markl. Their report concentrated on the main problems of a dozen major European technological universities, based on meetings and interviews with senior officials, administrators and professors.

An international workshop planned for 1991 will convene at SNI 20-30 leading educators and administrators. At this workshop, a working paper will be presented, summarizing the preliminary results.



Prof. R. Shinnar



Dr. R. Karni

## The Place of Design in the Engineering Curricula

Professor Reuel Shinnar, Professor Zehev Tadmor,  
Dr. Reuven Karni

Engineering design deals with ideas and plans for producing artifacts or systems, while analysis focuses on the subsequent evaluation of these ideas and plans.

Therefore, design is both the originating and creative component of the total engineering process. Engineering education should reflect this reality and help to prepare engineers to confront today's design challenges, particularly in manufacturing.

Unfortunately, this is not usually the case, especially in research-oriented technological universities. In the past, design was a focal element in the engineering school, and eminent engineers were sought after as faculty members. Academic progress was made contingent upon, amongst other considerations, excellence in design. With the increased permeation of the natural sciences into the engineering curriculum, and the evolution of the "engineering sciences", a basic shift of emphasis has occurred, from methodologies of synthesis to analysis. This has led to the de-emphasis of design and design proficiency, both as an educational component and as a factor influencing academic promotion.

SNI convened an international workshop, coordinated by Professor Reuel Shinnar of City College, New York (CCNY), in order to highlight the importance of design in the engineering process, and suggest ways in which its role could be re-introduced and strengthened within the engineering curriculum. Only in this way would engineers be able to meet the technological challenges confronting the manufacturing industry today.

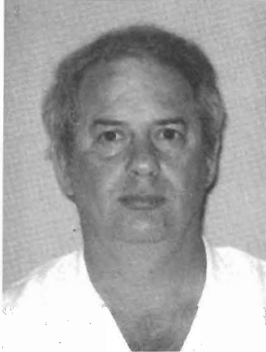
The participants overwhelmingly endorsed the thesis of the centrality of design and proposed that faculty should be encouraged to specialize in design (and be rewarded accordingly) and participate in high-calibre research in design methods and techniques.

## Mathematics in Engineering Education

Professor Micha Wolfshtein, Professor Nadav Liron,  
Professor Leonard Pismen, Professor Zvi Ziegler



Prof. M. Wolfshtein



Prof. N. Liron



Prof. L. Pismen



Prof. Z. Ziegler

The objectives of this study are twofold: to re-examine the scope and content of the mathematical foundations of engineering education, in light of the forceful anticipated impact of computer technology on mathematical tools applied to science and engineering instruction; and, to examine the software and hardware computing needs of Technion, both for research and teaching.

The study began with an in-depth analysis of Technion courses that have mathematical content, in order to determine whether changes are required in light of the widespread availability of computers. A survey of the literature and search for computer software were initiated. A leading American expert on the subject, Professor Ed Dubinsky, visited SNI, and offered his perspective and introduced some software used at Purdue University for teaching undergraduate mathematics.

It was concluded that the time for a general revision of the curriculum has not yet arrived; the state of the art does not yet warrant sweeping changes. Computerization of the curriculum could best be achieved by individual faculties; considerable progress along these lines has already been made.

It was recommended that a Center for Computer Applications in Science, Technology and Education be established, to serve as a catalyst for future developments in this area. It would coordinate development and application of software, serve as a forum for Technion faculty members concerned with computer uses, and facilitate activities related to software applications in mathematics and related fields.



Prof. G. Eylam



Prof. A. Berman



Prof. S. Waks

## High-School Education in Sciences, Mathematics and Technology

Professor Gad Eylam, Professor Avraham Berman, Professor Ed Dubinsky, Professor Avraham Shitzer, Professor Shlomo Waks

This study was designed to formulate scientific and technological education policy and financed by the Ministry of Education, the Technological Education Networks, and SNI. The final report will include recommendations of what is required and possible within the scope of scientific pre-university education in Israel.

Four successful workshops were conducted, during which experts from all educational fields participated. The first workshop defined the problems and dealt with subjects relating to science and technology in high-schools towards the 21st century. The second one dealt with mathematics education in high-schools towards the 21st century. The third dealt with teacher upgrading and continuing education programs and the fourth was about educating for excellence.

An interim report was published, detailing our main assumptions and conclusions. The major assumptions are:

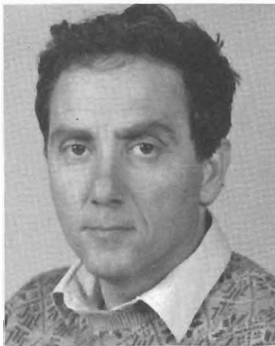
1. Studying is not limited to childhood and adolescence, in order to enable people to study when grown-up, adequate tools should be provided at a younger age.
2. Scientific education is not merely the study of facts, but mainly the study of scientific thinking.
3. In view of Israel's economic and geopolitical situation, there is no choice but to deepen and expand scientific education.
4. The high-school education system is awaiting word from academia on these subjects.

Our main conclusion is to focus on a "broad approach" instead of a narrow one. Namely, invest special effort in the majority of pupils, including those who will not continue in scientific subjects. This will help pupils to obtain an organized world view, enable organized thought and will expose them to basic terminology which will enable them to face future scientific and technological challenges.

In conjunction with Technion's Department for Teaching in Science and Technology, we are planning to adopt one or two high-schools in the northern region of the country and attempt to implement some of our research conclusions.

In conjunction with the Technion Department for Teaching in Science and Technology we are planning to adopt one or two high-schools in the northern region - and try to implement some of our research's conclusions.

The study was financed by the Ministry of Education, the Technological Education Networks and the S. Neaman Institute.



Prof. M. Livio

## **Teaching of Science and Mathematics by Video**

Professor Mario Livio, Ing. D. Kohn, Mrs. Ilana Adler

In view of the fact that in Israel there is an extreme shortage of physics and mathematics teachers in general, and good teachers in particular, we initiated the following project, with the intent of helping to improve the quality of the teaching of these subjects in high-schools. Our concept was to bring to the schools the best teachers at the university level to present the course material. The most practical way to achieve this goal was to video-tape an entire course in high school physics and mathematics, using the best teachers of the Technion and to use the video-taped lectures in high schools.

The first phase of the project involved an experiment in which we taped Prof. Livio, six time winner of the "outstanding lecturer" award, offering a complete physics course to a group of high school students. The video tapes were introduced for use in six high schools in Tiberias, Hatzor, Beit-Shean, Tel-Aviv, Haifa and Jerusalem, and in several pre-academic preparatory schools. During the experiment, the supervising research team visited a school once a month in order to meet with teachers, students and principals. This process ensured that immediate feedback was received which helped to determine the best use of the video tapes. It was found that the videoed lectures allow great flexibility in their use. In some places the tapes were used to introduce new material, in others it was used for preparation before tests. Students also borrowed the tapes for use in their homes, especially if they missed some classes.

At the end of one full school year a survey was conducted in all the schools and the general response has been enthusiastic. The project has met with support from the Minister of Education which has recently formed a committee lead by their head of high school education, to investigate and decide on the process by which the videotapes will be distributed to and used in schools all over the country. To further this goal, a series of meetings have been scheduled to present the project to high school teachers.

The videotaping of lectures in mathematics has begun with calculus and algebra presented by Prof. Ron Aharoni of the Department of Mathematics, Technion and Mr. Haruvi of Technion Preparatory School, respectively. Prof. David Zilag, Department of Mathematics, Technion, is preparing lectures in selected topics in mathematics.

The research plan includes expansion of the program to include chemistry and biology over the coming year and the publication of a final report.



Ing. D. Kohn

### **Trends in R&D Manpower Planning in OECD Countries**

Ing. D. Kohn, Dr. B. Toren

This study reviews the techniques which OECD member countries are employing to predict the future supply of, and demand for research manpower. It also examines the ways in which OECD countries are attempting to alleviate the negative consequences of an over- or under-supply of R&D manpower.

The study is performed in collaboration with the Jerusalem Institute for Israel Studies and funded by the Ministry of Science and Technology.



Dr. Z. Bonen



Prof. Z. Kohavi



Prof. M. Avriel



Prof. E. Kehat



Prof. E. Rosenstein

## Israeli Industry in the 21st Century

Dr. Zeev Bonen (coordinator),

Professor Zvi Kohavi, Professor Mordechai Avriel,

Professor Ephraim Kehat, Professor Ellezer Rosenstein,

Israel Dror, Shalom Drori, Vally Kovary

Planning has begun for an extensive research program to investigate and formulate a competitive strategy for Israeli industry into the 21st century and create a vision of how to advance export-driven economic growth. It will emphasize the technology of the future and involve Technion faculty and leaders in government and industry.

The study team has adopted a 'systems approach' to the work that considers perspectives both within industry and outside it. It will include analyses at three distinct but related levels: national issues such as the position of Israel in the international business environment; the industrial sectors such as the chemicals and electronics industries; and cross-section analyses of the infrastructure for science and technology. The results will be synthesized into a vision for the future which will include various alternatives and policy recommendations required to bring them about.

To date, the research problem has been formulated, inspired in part by the MIT Commission on industrial competitiveness entitled, "Made in America". The program preparation team, made up of Technion professors and others, has met several times to address topics including the characteristics of Israeli industry, the national macroeconomic environment, and a suitable methodology for attacking the complexity of the research problem. This issue was focussed on at a workshop on Industrial Sectorial Analysis and Strategic Planning. The program preparation team also met with Lester Thurow, Dean of the MIT Sloan School of Management, and MIT Commission member, to discuss the process involved in that work.

The urgency of this program has increased dramatically with the expected inflow of Soviet immigrants to Israel, and their need for jobs in the economy which will sustain their successful absorption. Communicating this urgency is our top priority and we will continue with the preparatory work for the research until the funding needed to launch the program is secured.

## The Israeli Plastics Industry

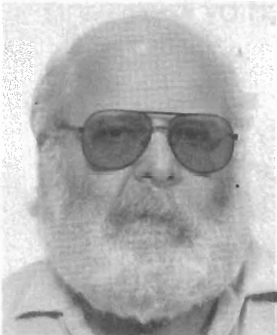
Dr. Shmuel Kenig, Professor Zehev Tadmor, Professor David Vofsi, Dr. David Frenkel, Dr. Ramon Albalak



Dr. S. Kenig



Prof. D. Vofsi



Dr. D. Frenkel



Dr. R. Albalak

The objective of the research program is to identify and evaluate future policy alternatives for the Israeli Polymer and Plastics Industry (IPPI), in order to increase exports and achieve stable economic growth. A systems approach has been adopted. Initially, the plastics and polymer industry will be examined with respect to technological, economic and marketing aspects and important global trends in these areas will also be identified. Based on the current state of the industry in Israel and abroad, alternative scenarios will be outlined, and based on them, future needs regarding manpower, R&D, marketing, raw materials, machinery, technology and investments, will be defined.

An initial workshop was held, in which representatives from industry, universities, government and research institute gave their views on the current state of the industry and on world trends. Study groups were then formed with members of industry, government and academia, which are conducting a multidisciplinary analysis of industry needs and related policies.

The project is carried out in conjunction with the Society of Israeli Plastics Industries, the Israel Industrial R&D Center, Chief Scientist's Office, Ministry of Industry and Commerce, and the Jerusalem Institute for Israel Studies.





Prof. E. Lenz



Prof. K. Preiss

## Automation in Industry

Professor Ehud Lenz, Professor Yaakov Rubinovitz, Professor Kenneth Preiss, Professor Nahum Finger  
Dr. Z. Bonen, coordinator

The research into the introduction and adoption of advanced manufacturing and automation systems by Israeli industry has two aspects: the implementation of such technology at the shop floor level; and, the optimal strategy based on this technology by management. This project integrates these two aspects. Its major objective is to determine practical measures to facilitate the introduction of automation equipment, in part by identifying obstacles to its widespread diffusion.

Professor Lenz directs the shop floor study, together with Professor Jacob Rubinowitz. Initially, a survey is being conducted in the metal and electronics industries. Visits to plants in various stages of automation were conducted, including Carmel Forge Ltd., I.M.I. "P" plants, Israel Aircraft Industries' Shahal Plant, Chromagen Ltd., (Kibbutz Shaar HaAmakim), and ISCAR Ltd. plants at Tefen and Maalot. A visit to Telrad Ltd. is also planned. The survey emphasizes the depth of implementation and the degree of systems integration of advanced manufacturing technologies, automation and computer integrated manufacturing. The survey team is interdisciplinary in nature.

Preliminary results indicate that the introduction of automation equipment is hampered by lack of investment funds and by problems related to technical assistance.

Professor Kenneth Preiss heads the management study. His recent sabbatical in the U.S. was utilized to survey state-of-the-art automation and related issues in that country.

## Technometric Analysis of Industrial Products

Professor Shlomo Maital, Amnon Frenkel



A/Prof. S. Maital



Mr. A. Frenkel

Technometrics is a technique developed by Dr. Hariolf Grupp, senior researcher at the Fraunhofer Institute in Karlsruhe, aimed at providing a quantitative measure of technological quality and excellence, for a single product or process, sub-branch or branch of industry. The method involves defining the key attributes of the product, quantifying them in relation to local or world standards, and constructing weighted averages of such attributes. Cross-country comparisons help determine where a nation's comparative advantage lies. Research has shown that a decline in the technometric index precedes a similar fall in sales and exports by two to three years, making it a useful "early warning indicator" for management and public officials.

Two main product groups were chosen for study: biogenetic diagnostic products and sensor instruments. Israel's technological level will be compared with that of West Germany and other nations. Software may be added at a later date. Emphasis will be placed on the development of technometrics as a management tool.

A detailed case study has been prepared on an Israeli high-tech start-up, and initial research results were obtained on the relation between the average level of technological excellence and the extent to which such technology is uniform or widely dispersed and diverse among various firms. Japan, U.S. and Germany seem to have very similar technological levels, over 43 different products, but surprisingly the degree of variance in technological level in Japan seems higher than elsewhere.

The research is performed in collaboration with the Fraunhofer Institut - I.S.I., Karlsruhe, West Germany and funded by G.I.F. - The German-Israeli Foundation for Scientific Research and Development.



Prof. J. Hagin



Mr. G. Segelman

## **Trends in Fertilizers and Fertilization**

### **Intensive Greenhouse Tomato Production as a Model For Fertilizer Development Recommendations**

Professor Joseph Hagin, Dr. Gershon Segelman

This study focused on fertilization practices in intensively grown tomatoes, with the objective of constructing an optimal fertilization strategy. Objectives of the strategy are: maximal fruit yield and fruit quality; minimal environmental pollution, minimal corrosion of the fertilizer distribution system and minimal fertilizer cost. Data were gathered by a careful search of the literature and by personal interviews with growers and researchers.

It was found that the following variables merit re-examination: the ratio of ammonium to nitrate in fertilizer formulations; use of urea in fertilizer solutions; phosphates and sulphate levels; osmotic potential (OP); and simple iron salts vs. chelated iron application.

Detailed data tables provide estimates of electrical conductivity, pH values, and estimated prices of various fertilizer solutions.



Prof. G. Czapski



Mr. A. Shoham

## Productivity and Impact of Israeli Science

Professor Gideon Czapski, Amnon Frenkel,  
Ing. David Kohn, Aner Shoham

The extent of cooperation between Israelis and foreign scientists has risen sharply in the past decade; joint authorship of scientific articles rose from 14 percent of all scientific publications to 30 percent. Analysis of published scientific research by Israelis for the years 1972-84 showed that research performed by Israelis abroad far exceeded in quality that done at home. This analysis was based on the number of citations for each publication, with "foreign" research defined as a publication having at least one foreign address for one author.

Two difficulties with this research arose: a listing of a foreign address often failed to clarify where the research was actually performed and what the reason for the foreign address was; and the I.S.I. database used was not comprehensive and failed to include some publications.

Hence, this project was undertaken to: identify the scope and type of works not included in the I.S.I. data; to examine the scope and motivation of research performed abroad; to determine financing patterns for research done in Israel and abroad; and, to check the location of actual research done by authors.

A sample of 413 researchers was drawn from several engineering and science departments at Technion and the Hebrew University. A detailed questionnaire was sent to each, eliciting information about additional publications during 1974-83 that did not appear in the I.S.I. lists. About half of the researchers responded. The data are currently being analyzed.

The research was partly funded by the Ministry of Science and Technology.

## Science Indicators

Prof. Gideon Czapski, Aner Shoham, Ing. David Kohn

This project takes a bibliometric approach to the measurement of the scope and quality of scientific publication output by Israeli researchers. It statistically measures the frequency, intensity and impact of Israeli science through an analysis of scientific publications in the leading international scientific press.

The output of this research project is used by several organizations in Israel as well as serving as input to other SNI projects, including the study of trends in science and technology in the Middle East, which utilizes the qualitative-quantitative evaluation of the status of Israeli versus Arab scientific output.

The Planning and Grants Committee of Israel's Council for Higher Education receives data relating to quantitative indicators of scientific publications divided according to academic institutions and departments in each institute. This information will assist them in determining scientific activity in each institute and each area.

The Israel Academy for Sciences and Humanities will receive data including qualitative indicators, such as the average number of citations per article published, according to scientific fields or institutions, in order to determine where high-quality research is carried out in Israel in each field.

In order to carry out this project, SNI has purchased an extensive data-base from I.S.I., including publication data relating to over 80,000 papers written by Israeli authors and published in the international scientific press during the period 1972-1988. A subsidiary data-base includes the same information relating to 40,000 papers published by researchers from Arab countries.

Transforming this kind of data into usable and enlightening information for use by the public bodies mentioned above, is a pertinent example of the potential role that qualitative and quantitative indicators in a bibliometric study can play in influencing the decision making processes, thus achieving one of SNI's major goals.

## Trends in Science and Technology in the Middle East

Professor Arnon Dar, Gen. (Res.) Amos Gilboa, Professor Gad Gilbar, Dr. Meira Itzkowicz, Professor Aviv Rosen, Professor Michael Yoeli, Michal Navot



Gen. A. Gilboa



Prof. G. Gilbar



Dr. M. Itzkowicz



Prof. A. Rosen

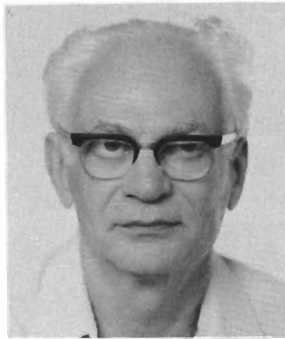
The purpose of the research program is to examine the significance of the developments taking place in science and technology in neighboring Arab countries and Iran, and to compare them to the trends in the same areas in Israel. The overall program is headed by Amos Gilboa and was launched in 1987 in collaboration with the Dayan Institute at Tel-Aviv University. It is partially funded by Israel's Ministry of Science and Technology.

The four main areas of focus for the study are: A) higher education; B) scientific output and productivity; C) energy and national infrastructure; and D) a study of technology intensive industries. These areas were chosen as intrinsic long range indicators of national development. Research in the first three areas has been launched, with their continuation, in addition to the fourth area, planned for 1990.

The studies outlined below are independent, but related topics, each having a contribution to make to the understanding of the dynamics of the "gap" in science and technology between Israel and the Arab countries and Iran.

### A. Higher Education

The first aspect of the project involved the collection and analysis of basic demographic and statistical data on the Arab countries and data on the quantitative aspects of the structure of higher education. Particular emphasis was placed on the number and quality of students at Arab universities, and trends in the "brain drain" from these countries to the West. The continuation and expansion of this research into the qualitative areas analysis will be headed by Prof. Gad Gilbar of Haifa University.



Prof. M. Yoeli



Ms. M. Navot

## B. Scientific Output

This aspect of the program involved a data intensive study to determine the quantity and quality of scientific publications by university faculty in Arab countries and Israel. Utilizing data from the Philadelphia based Institute for Scientific Information (ISI) the publications records of faculty were examined from some 3,600 scientific periodicals dating from 1973 to 1984, to determine the number of articles published by author and institution. Indicators such as the number of times a work is cited in the literature, were used as a measure of the quality of the output. This project will be continued bringing the data up-to-date with ISI materials from 1985-88 and is now headed by Aner Shoham of the S. Neaman Institute.

## C. Physical Infrastructure

The supply of inexpensive and reliable energy and electricity is a prerequisite for the scientific and technological development of a country. Development of electricity networks and electricity production capacity rate high priority in the development plans of all Arab countries.

## D. Analysis of Technologically Intensive Industries

The fourth main area of investigation of the "gap" focuses on the application of technology and the transfer of technology for use in the economic sector. This study, just getting underway at the Institute, will analyze three sectors chosen for their unique roles in the Arab world. The first is the technology intensive Aerospace industry (conducted by Prof. Aviv Rosen and Prof. Yoseph Rom of the Technion), which is of particular interest to Israel for defense reasons. The second is the Petrochemical industry (conducted by Dr. David Frenkel, an international consultant in this field), which is an example of how the Arab countries utilize technology when they have an abundance of natural resource and almost unlimited funds for its exploitation. The third area focuses on Computer Know-how and Use throughout the Arab societies (conducted by Prof. Michael Yoeli and Dr. Meira Itzkovicz of Technion).



Prof. S. N. Eisenstadt



Dr. S. Katz

## Centers for Scientific Excellence

Professor Shmuel N. Eisenstadt, Dr. Shaul Katz

This research project investigated the question of what scientific and organizational conditions best contribute to fostering centers of scientific excellence in small countries. The study focused on the Einstein Institute of Mathematics at the Hebrew University of Jerusalem, (EIM), a world center for research in mathematics.

Key results of the study include the importance of the emphasis placed by the institute on the recruitment of new talent, their selection of research topics, and the linkage between the institute and its local and international milieu. The autonomy granted to advanced research students in the selection of research topics is a vital mechanism for encouraging original work and for the selection of the most talented students. The implications of these findings for a small country and its ability to retain top people doing top work including specific policy recommendations, are elaborated in the final report.

The final report for this project was published in Hebrew and its publication in book form is planned for 1990. The work has been exceptionally well received by academic leaders throughout the country.





Prof. M. Yadin

## Law Enforcement System in the 21st Century

Professor Micha Yadin

This research seeks to define the objectives and expectations of the law enforcement system in future, and to specify the tools required to achieve those objectives.

In our rapidly changing world, only an organization capable of adapting to change can function efficiently. Without proper forecasting of the environment within which the organization will operate in future, timely adaptation is impossible. Simply extrapolating past changes to the future is highly questionable.

This research seeks to analyze important trends in all aspects of Israel's society and technology that relate to the law enforcement system. Such trends will be explored in a series of workshops. The research will be carried out by a panel of experts from each of the participating agencies and from academia. Along with experts in law and criminology, leading scientists in all relevant areas of the social sciences, management sciences and technology will take part.

Cooperation of law enforcement agencies outside Israel, involved in similar research activities, is anticipated.

The study will be funded jointly with the Chief Scientist of the Ministry of Police and various other justice system agencies.



Dr. A. Mandel

## A Comparative Study of Oil Prices

Dr. Abraham Mandel

An SNI study done in 1985 showed that domestic costs in Israel's fuel economy were significantly greater than those prevailing in Western Europe, owing to Israel's closed, non-competitive, government-controlled system (in contrast to Western Europe's open, competitive fuel economies).

The Ministry of Energy and Infrastructure in Israel is now implementing a major reform aimed at opening the fuel economy to competition, and at reducing government intervention. These reforms are strongly opposed by the existing large oil companies, who contend they already operate at maximum efficiency and that there is no need for reform.

This study, by completing the previous analysis of the price structure of petroleum products in Israel vis-a-vis Western Europe, will make possible an objective, reliable assessment of the efficiency of Israel's fuel economy, and thus will test the claims of business and government regarding the need for comprehensive reform.

Among the study's preliminary conclusions:

- ◆ Israel purchase crude oil at prices comparable to those paid by Western European countries.
- ◆ The price of petroleum products at the "refinery gate" in Israel is often greater than that in Western Europe.
- ◆ The price of petroleum products to Israeli consumers has in recent years been lower (in dollar terms) than to consumers in Western Europe.
- ◆ Domestic costs in Israel's fuel economy, including shipping, refining, land transportation, storage, handling and marketing, are higher in Israel than in Western Europe.
- ◆ Net taxes on petroleum products are lower in Israel than in Western Europe. Some of the taxes collected in Israel as a special levy through the Equalization Fund area actually paid back to the oil companies, through complex, non-transparent accounting between them and the Government Fuel Authority.

The study is funded by the Ministry of Energy and Infrastructure.

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## Visiting Professors

*Professor Sir Claus Moser*, President, Wadham College, Oxford University, U.K.

*Professor Kenneth H. Keller*, former President, University of Minnesota

*Professor Ed Dubinsky*, Professor of Mathematics, Purdue University

*Professor Reuel Shinnar*, Professor of Chemical Engineering, City University of New York

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Professor G. Czapski, Hebrew University: "Bibliometric Analysis of Israeli Science", April, 1988.

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Professor Kenneth K. Keller, former President of the University of Minnesota and Visiting Fellow, Woodrow Wilson School of Public and International Affairs, Princeton University: "Ethical, Economic and Technological Questions in High Cost, High Technology Medical Therapies", (jointly with the Faculty of Chemical Engineering), March 15, 1989.

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