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CREATING THE UNIVERSITY-INDUSTRY INTERFACE
IN A DEVELOPING COUNTRY

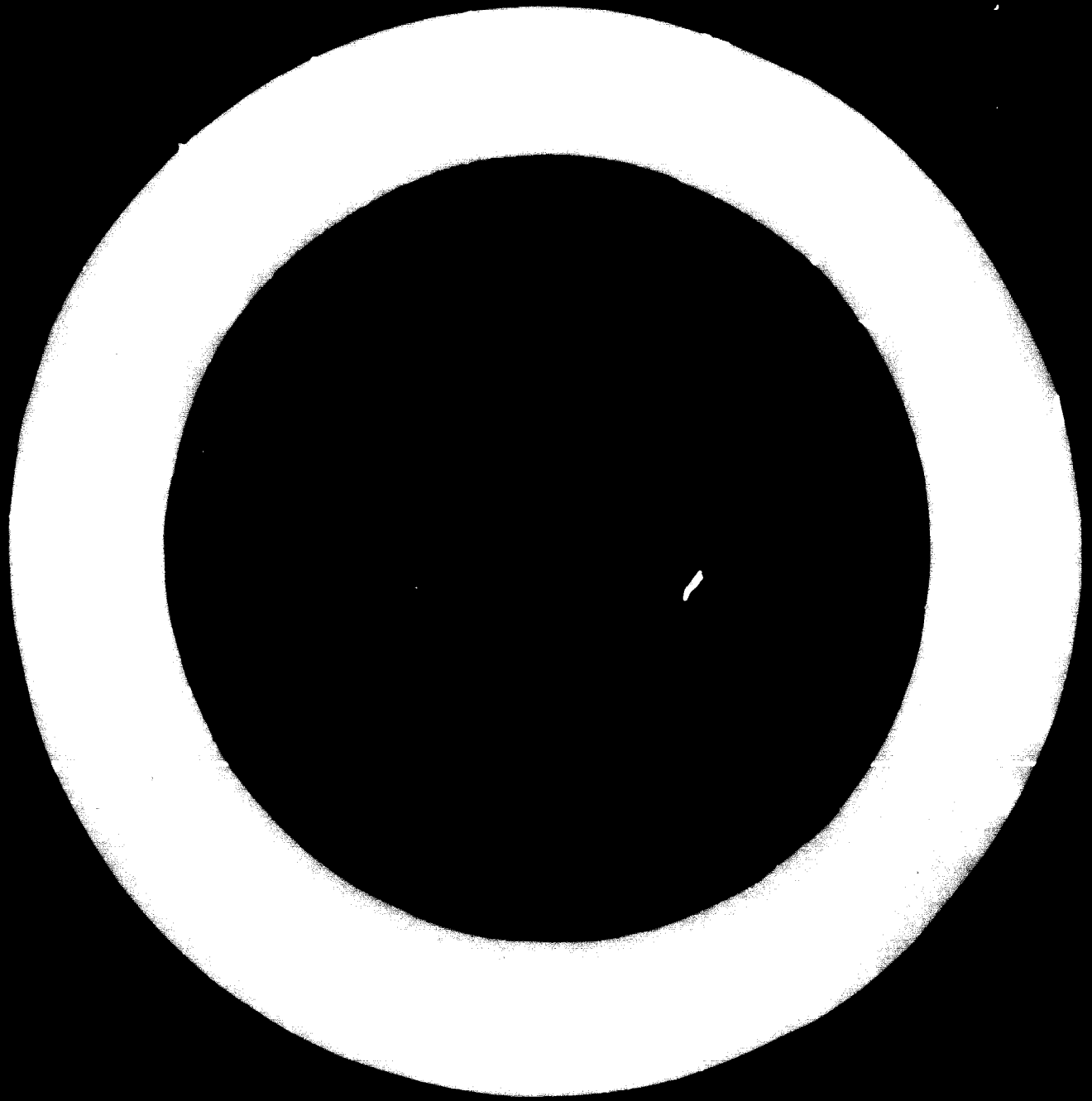
THE ISRAELI EXPERIENCE^{1/}

by

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I. The Technion-Israel Institute of Technology, Haifa

The idea of setting up an institution of higher technical education in what then was Palestine, a remote and neglected province of the Ottoman Empire, was conceived at the beginning of this century by a few young scholars and scientists, members of the recently established Zionist movement, who believed that the country that had suffered centuries of devastation and neglect could not be revitalized without the establishment of institutions of higher learning.

The actual opening of the Technion in 1924 took place in the face of opposition maintaining that a cadre of locally trained academic engineers was not required for the first stages of development. It soon appeared, however, that this view was erroneous and that the ever increasing number of graduates were all absorbed by the national economy. With the latter's diversification more and more departments were added, thus providing manpower in fields such as civil engineering, mineral engineering, mechanical engineering, electrical engineering, chemical engineering, as well as architecture and town planning. After the founding of the State of Israel the need was felt for further diversification, and departments were established for aeronautical engineering, agricultural engineering, materials engineering, biomedical engineering, food engineering and bio-technology, and industrial and management engineering, so that the Technion now accommodates approximately 5700 undergraduate and 2600 graduate students who are instructed by an academic staff of about 1450. Simultaneously the broadening of the scientific infrastructure was assured by the founding

of degree granting departments of mathematics, physics, mechanics, chemistry, biology, (also serving the Technion's new Medical School), allied mathematics and computer sciences.

As in 1924, so also later on the decision to establish a new department very often preceded the express demand of the respective industry for graduates in its field, and it was the existence of well-trained engineers that led to the improvement of manufacturing processes and management procedures, to the enlargement of plants as well as to the setting up of new enterprises. An anecdote may aptly illustrate this: In 1947 David Ben Gurion asked the President of the Technion to open a department of aeronautical engineering, as he already then foresaw the need for maintenance and repair engineers to serve the national airline and the airforce of the State of Israel that came into being in May 1948. It was with the assistance of graduates of this department, that, several years later, Israel Aircraft Industries Ltd. was to be established. Today, with its 15000 employees, it is the country's largest industrial complex.

While the very intensive character of studies at the Technion does not allow for industrial practice during the academic year, this is encouraged in the course of the long summer vacation. The Technion, therefore, adhered in 1951 to the International Association for the Exchange of Students for Technical Experience (IESTE), so that Israeli students might broaden their outlook by working also abroad.

In recent years an increasing number of science-based industrial enterprises have been established by Technion graduates - B.Sc.'s, Masters and D.Sc.'s - of the engineering as well as of the science departments in cooperation with local or foreign investors, who rely on these graduates for their know-how and scientific prestige. One of the reasons for this situation is the express policy of the Technion to formulate its curricula, not according to current practices and requirements of industry, but rather in keeping with what is judiciously considered to be the need on the foreseeable future (technological forecasting). This policy is criticised

sometimes by conservative industrialists who want the young engineer to fulfill exactly the task allotted to him within the organization (and are actually ready to grant him generous scholarships during the last two years of study in order to assure themselves of his services). But it is becoming more and more evident that routine jobs can be carried out very well by highly trained technicians and foremen and that many of the assignments formerly performed by engineers can be taken over by the computer and by automation, thus releasing them for creative design, innovative processes and scientific management.

In order to fulfil these tasks effectively and for a considerable number of years, while taking on ever-increasing responsibilities, the engineer, the industrial scientist, and the manager have to continue the learning process almost permanently. First of all, it is becoming clearer and clearer that the broad knowledge in a specific discipline acquired during four years of undergraduate study cannot answer the demands of modern sophisticated industry. Graduate work with its deepening and specialization is called for. This trend is encouraged by forward looking employers, both public and private, by means of salary increments for holders of master's and doctor's degrees. For reasons of economics and age (students begin studying at the age of twenty-one) after three years of military service) very few are studying full time towards a higher degree. Several hundred graduate students combine a half-time assistantship with half-time study. The majority are registered on a quarter-time basis while working in industry or in research establishments. These either attend lectures and seminars in the afternoons and evenings on the Technion campus in Haifa or at its Tel Aviv branch. Others are released by their employers so that they may devote one or two full days a week to their studies. This is particularly important in the various fields of experimental research that cannot be carried out on the employer's premises and when the time comes for the writing of the thesis. As an alternative, it recently has been decided to allow the replacement of thesis research by the earning of additional credit points towards the master's degree by way of study and examination.

With or without higher degrees, today's and tomorrow's engineers, scientists and industrial managers have to adopt the principle of life-long learning, if they do not want to fall behind or to forego the chance of professional advancement. The Technion therefore set up an Extension Division over twenty years ago. It runs refresher courses so that Technion and other university graduates may become acquainted with the latest advances in science, technology and the management sciences. The Extension Division, a full-fledged academic department headed by a senior staff member, organizes courses in various towns, in large industrial enterprises and in the highly industrialized agricultural areas. Concentrated 'weeks' of refresher courses or summer schools are organized on the Technion campus, frequently with the participation of lecturers from abroad. One- or several-day symposia and seminars are held in prestige hotels, thus also offering the opportunity for contacts with colleagues and for the exchange of experience.

Last year 10415 persons took part in one or more of the Extension Division's 256 different activities. The rather stiff fees for participation in the programmes of the Division, which has to be self-supporting, are carried by the employers in the majority of cases, a proof of the high value industry attributes to this phase of linkage with the Technion.

The Institute, often by way of this Division, also acts as host to the periodic meetings of various professional and scientific associations, both national and international, with members of its staff taking an active part in the proceedings by lectures on the latest results of their research. This constitutes another way of transfer of knowledge from university to industry.

A further phase of this linkage is to be found in the library and information services. The Technion must boast of the largest technological and scientific library in the Middle East with approx. 100,000 volumes, subscriptions to about 5000 periodicals and approx. 400 abstracting services and indexes. They are at the disposal of the industrial community, as are the services of a staff of experienced information officers. These carry

out literature searches in every kind of publication, such as books, periodicals, manuals, reports, theses, standards, patents and specifications in order to retrieve the pertinent information required. The customer is charged a modest fee for this service.

Certainly the most important single factor in the complex interface between the Technion and Israel industry is the senior full-time academic staff member. Besides his teaching and guidance activities in the undergraduate and graduate schools, in the extension division and besides academic research leading to publications in scientific journals, he puts his services at the direct disposal of individual firms in the form of consultation and applied research. He does this with the express encouragement of the Technion which, in its constitution and regulations, sets aside one out of six weekly working days for this very purpose. The staff member is free to utilize this time according to his wishes, provided his work is likely to advance his professional and scientific standard. As to remuneration, he has the choice of working either in the private capacity of designer, consultant, researcher, etc., thus earning the rates obtained on the professional scene, or to put his time at the disposal of the Technion Research and Development Foundation Ltd. (see below), which then pays him an additional third of his Technion salary. This choice is made according to individual wishes and circumstances. Architects, consulting engineers, well-known "trouble shooters" will choose the first alternative, while the research-minded and consultants who avail themselves of the services of the Technion laboratories will prefer the latter.

Another important personal link between industry and the Technion is the adjunct teacher, generally a senior employee of an industrial company or a member of a firm of consulting engineers. He brings to the classroom the wealth of his professional knowledge and introduces the student to the problem created by the confrontation of theory and every day practice, while he himself benefits from the need of re-thinking his experience in order to present it to his students in a systematic form.

In conclusion of this Chapter, I submit that the fathers of the idea of establishing the Technion, i.e. an institut of technology or a technical university, as distinct from a faculty or school of engineering that is part of a comprehensive university, were wise indeed. They thus brought about the creation of an academic institution which always has seen its primary task in the training of high-level technical and scientific manpower and in disseminating the knowledge required for the industrialization of Palestine, and for the last twenty-five years, of the State of Israel. The authorities of the Technion never had to cope with the competing and often conflicting requirements of other departments which, in the traditional university, are likely to be considered as equal to or of even greater importance than the engineering sciences. As an independent institution, moreover, they always enjoy direct access to Government and other sources for their budgetary requirements. The fact that the President of the Technion has almost always been an engineer and that a considerable number of the members of its International Board of Governors are competent and successful industrialists, engineers and professors of engineering from Israel and abroad also constitutes an important factor contributing to its success in furthering Israel's fast economic development.

II. The Technion Research and Development Foundation Limited

In spite of all the links established between industry and the Technion - as described above - it still remains true that it is no easy task to bring about the full utilization of its resources by industry. For it is two strange worlds that have to meet here, worlds of different outlook, of different roles in society and of different aims, viz. the satisfaction of material needs as against the transmission of knowledge and the expansion of its frontiers. This is true everywhere, but the more so in a developing country where, in spite of all advances, a large part of the industrial community still is quite unsophisticated, especially so in the numerous smaller enterprises which are understaffed as regards engineers, not to speak of research personnel. On the other hand, many younger academic teachers, who, in the years of their postgraduate studies and research, have concentrated on basic problems, lack direct intensive

experience of the industrial scene.

It thus became clear already even to the very beginning that there existed a need for an organized link so that these two worlds might meet. This was created in the form of a separate organization called the Technion Research and Development Foundation Limited. The title is long, but expressive of its character. The Technion's name lends it prestige and indicates that the institution's brainpower and extensive laboratory installations are at the firm's disposal and that a public, non-political body is its sole owner. The words "research and development" point to the principal areas of activity the Foundation is intended to operate in. These include:-

- a) Testing, a primary activity required by any industry the products of which have to meet officially-set standards or to stand up in competition with similar local or foreign products.
- b) Ad-hoc investigations for the improvement of industrial processes or products, their adaptation to local resources and manufacturing conditions or for the design of new products.
- c) Research in the literal sense of the term, aimed at solutions to scientific or technological problems which may or may not lead to commercially exploitable results.
- d) Development and detailed planning of a prototype design up to the stage of manufacturing or of a laboratory process until its large-scale production.
- e) Extending inclusive consulting services to industrial enterprises with the aid of the overall resources of the Technion.

The word "foundation" connotes that it is an organization whose profits are either ploughed back for the enlargement of staff and the acquisition of additional equipment or go to the Technion to help it balance its budget.

Lastly, "limited" conveys the fact that the Foundation is a business firm that is not supported by public funds, but rather has to earn its

keep and is even expected to bring in profits to its owner, viz. the Technion.

From the above it will be understood that, if it is to be successful, the Foundation's management has to be completely separate from the administration of the Technion and has to be run on different principles. Its general policy, of course, is determined by the Technion's authorities whose representatives constitute the Foundation's Board of Directors who, in turn, appoint the Managing Director. Experience has shown that for this post an engineer or scientist with considerable experience of the industrial scene is preferable to a member of the academic staff, no matter how outstanding, as the engineer will find it much easier to sell the Foundation's services to the business world.

The Foundation's testing laboratories are designed exclusively to serve various branches of Israel's industry and are working in closest connection with them, i.e. advances in industry are reflected in testing programmes, while results of testing in turn are analysed and fed back into the plant so as to bring about changes and improvements. Problems that do not find their immediate solution become the subjects of ad hoc research. If an industry develops testing facilities of its own (mostly under the guidance of the Foundation) or if other private or public laboratories are opened which can do the job on an equal level, the corresponding Foundation facility closes down without any need for a decision by an academic body. Personnel are hired and dismissed on the same basis as in any other commercial or industrial enterprise, i.e. they enjoy all the social rights Israeli labour has won in the course of many decades, but not the special privilege of tenure extended to full-time members of the Technion's senior academic staff.

The Foundation's industrial testing laboratories operating at present are the following:-

Building Materials Testing Laboratories
Hydraulic Testing Laboratories
Soil and Road Testing Laboratories
Geodetic Research Institute, i.e. surveying work that cannot be
carried out by regular means and instrumentation
Israel Institute of Metals (materials and products), partly
supported by the Ministry of Commerce and Industry
Chemical Testing Laboratory
Industrial Psychology Testing Laboratory.

An interesting recent development is the setting up of Research Centres. The initiative for establishing them sometimes comes from outside the Technion, and they are generally created by several members of its academic staff, often from different departments, but administered by the Foundation and expected at the very least to cover their own expenses. Their co-operative, often inter-disciplinary research projects are funded by industrial or governmental bodies, local or foreign foundations. Several of these Centres already have proven particularly successful. The following partial list shows the different areas that are covered by them:-

Building Research Station
Material Processing and Machine Tool Centre
Electrical Engineering Research Centre
Food Industries Research and Development Station
Agricultural Engineering Research Centre
Aeronautical Engineering Research Centre
Centre for Urban and Regional Studies
Automotive and Internal Combustion Engineering Research Centre
Coastal Engineering Research Centre
Centre for the Biomedical Engineering Sciences
Institute for Transportation
Road Safety Research Centre (supported by the Ministry of Transport)
Mineral Engineering Research Centre
Stone Technology Centre
Chemical Research Centre

Chemical Engineering Research Centre
Laboratory for the Technology of Plastic Materials
Physics Research Centre
Solids Mechanics Research Institute
Computer Sciences Research Centre
Nuclear Science Research Centre
Operations Research Centre
Centre for the Study of Man at Work

There are of course areas of scientific endeavour relevant to industry, which by their very nature do not lend themselves to cooperative research, and there are researchers in every field who prefer to work alone. But their work as well, in so far as it is sponsored by bodies outside the Technion, is administered by the Technion Research and Development Foundation which also does the canvassing for new contracts.

The Israeli Government, well aware that it is only by continuous advances in design and quality that products can hold their own on both the local and foreign markets, strongly encourages industrialists to devote an increasing part of their means to research. As only very few enterprises are large enough to set up their own research and development departments they avail themselves of Government, public and university laboratories, with the major share going to the Technion. The Ministry of Commerce and Industry supports short term research aimed at the improvement of products and processes by "matching funds", viz. contributing the same amount put up by the enterprise. The National Council for Research and Development even is ready to cover ninety per cent of the cost of research and development leading to new lines or production.

The Technion Research and Development Foundation also accepts major industrial consulting assignments which may call for specialists from various departments of the Technion and possibly for the support of various laboratories and of the Technion's Computer Centre which may boast of the largest computer in the country. The principal areas of this type of activity hitherto have been:-

Mineral Engineering
Environmental Engineering (Air Pollution)
Electrical Engineering
Chemistry
Chemical Engineering
Industrial and Management Engineering
Architecture and Townplanning

Lastly, the Technion Research and Development Foundation acts as the official owner of the spiritual property of the academic and other staff members of the Technion in so far as patents, author's rights, licensing, sale of instruments developed by them, etc. are concerned. While safeguarding the right of the individual to his share in the profits, it thus saves him the cost and the risks usually involved.

The Foundation's turnover in 1972/73 totalled over IL.28 million (approx. \$ 6.7 million) of which amount IL.12.7 million were income from testing and IL.15.3 million from research, consulting and other activities. Its net profit to the amount of IL.500,000 was transferred to the Technion, a small, but nevertheless significant contribution to its annual operating budget of IL.124 million. Of considerably greater significance, however, than the material profit resulting from the activities of the Foundation are the benefits accruing to the academic staff from their participation in them. It enables them, first of all, on the basis of their familiarization with industrial problems and their close contacts with men holding key positions in production and management, to transmit to their students a realistic picture of the industrial world which eighty per cent will join on completion of their studies. Secondly, it directs them to areas of research which are of relevance to the national economy and thus likely to enhance the satisfaction they derive from their work.

In conclusion, it may be said that the Technion, together with other Israeli institutions of higher learning, plays an increasingly important part in the development of the country's economy by means of activities as described in this paper. The impact on industry, due to the continuously

growing number of graduates, is perhaps even more significant, for they translate into practice the analytic as well as the synthetic ways of tackling problems they have been taught. They are aware, moreover, of the necessity to update continuously their knowledge, of the resources in information and active cooperation offered to them by the Technion, and they are alert to the need for continuous innovation and improvement of products, production processes, and of management and marketing methods. In recent years an increasing number of engineering and science graduates have been appointed to leading positions in industry, particularly in R&D based companies, and taken their place at the side of the entrepreneurial type of manager. This personal linkage augurs well, I believe, for the future of Israel's industry.

A d d e n d a

Two more institutions located on the Technion's main campus on the slopes of Mount Carmel ought to be mentioned in order to transmit a complete picture of the possibilities of the industry-university interface.

1. Science-Based Industry Complex

A group of buildings recently has been constructed with the aid of a donation, for the purpose of short term renting of comparatively small areas to newly established science-based industries. These units are equipped with all modern facilities and supplies. The personnel of the plants, in several cases graduates and former staff members of the Technion, enjoy the vicinity of the experienced Technion staff, both academic and technical, as well as of testing, library and information services. The income from the rent goes to the Technion for the purpose of student scholarships. Successful enterprises are expected to outgrow the accommodation offered them on the campus and to transfer to other locations, amongst them an extensive science-based industrial estate on the outskirts of Haifa, which has been established jointly by the Municipality and the Technion.

2. 'Industrial Research Administration' Institute.

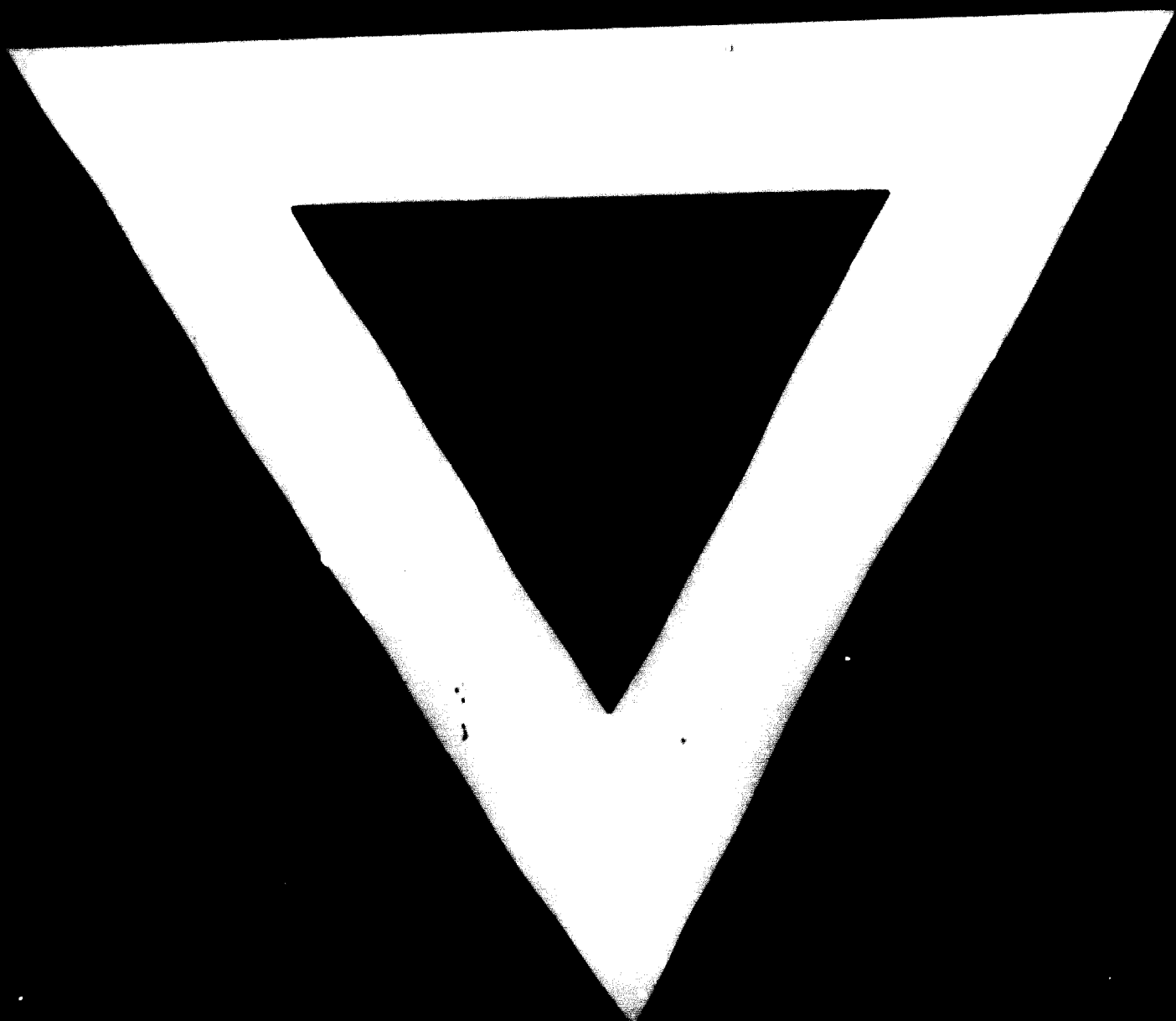
Certain branches of Israeli industry felt the need for joint research and testing facilities as early as the beginning of the fifties. They

established research associations, three of which, viz. of the paint, the rubber, and the silicate and ceramics industries set up their laboratories on the Technion campus. In 1966 Government recognized the important prospect of the food and plastics industries and reached an agreement with the United Nations Development Programme - with UNIDO acting as the executing agency - on the establishment and initial operation of a Centre for Industrial Research in these two fields. The building for the Centre was erected on the Technion campus with the generous aid of one of the latter's supporters.

In 1971, on the recommendation of a committee under the chairmanship of Professor Ephraim Katzir-Katchalski, now President of the State of Israel, which formed the basis for a "Law Concerning Organization and Administration of Government Research", an Industrial Research Administration (IRA) was set up in the Ministry of Commerce and Industry. It is headed by a Chief Scientist, a university professor on part-time release, and is directed by a Board composed of scientists and representatives of industry and government. Besides sponsoring industrial research at the universities and the Technion, as set out above, the IRA has taken over responsibility for the administration and guidance of the country's industrial research institutes, including the four located on the Technion campus. All of these have on their Advisory Boards Technion professors, and several of their senior staff serve as adjuncts on the Technion's teaching staff. The institutes avail themselves of the Technion's services, as e.g. computer, library and purchasing facilities, as well as of chemical and general stores, and they invite foreign experts and advisers, often in cooperation with the Technion.

We thus are witnessing the interesting phenomenon of two types of industry-university linkage on the same location, one in a way that can truly be determined as interface and the other in the form of an intermediate link, that is independent of the administration and supervision of the Technion and, for better or for worse, not guided by its senior academic staff. Only the future will tell whether one type is preferable to the other or if both have their specific advantages in specific situations and are viable side by side.





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