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THE S. NEAMAN INSTITUTE
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Human Resources Policy in an Age of Change

Progress Report No. 1

Professor Daniel Shimshoni

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The rapid technological changes now under way have major implications for the political economy, industrial organization, social institutions, and the availability and nature of work. Policies in response to them are critical for the quality of the society. Some developments include:

- a global economy, in which international trade predominates and in which managements headquartered in different countries use factors of production and research located wherever they see strategic advantage.
- the demise of Eastern European socialism, and the emergence of major trading blocs in the Eastern Pacific, North America, and Europe.
- communications that afford instant global and regional information and transactions
- convergence among the industrialized countries of the level of technological abilities and management skill; and yet a serious north-south gap between developing and industrialized countries (and between the conditions of the rich and poor within the industrialized countries).
- transformation of the mass-production paradigm and the nature of many jobs and skills, affording increased flexibility in organization, product mix, and location. These give new meanings to the concepts of economies of scale and comparative advantage.
- knowledge and the ability to use it become the principal resources; and people of quality and social organization that makes them effective become the key.
- unprecedented rapidity of change, so that a person in his lifetime may work and live in several unpredictable technological and social environments.

The aim is to study the implications of such changes for education and work, and to propose and assess alternative Israeli human resource policies, asking: What are the key issues? How can they be addressed, considering social goals and values as well as economic aims?. Noting that the methods needed more definition, the Neaman Institute decided on a preliminary study to that end. Visits and interviews in several industries were used to understand issues and changes and to plan for field work. A partial list of people consulted is given on Appendix "A". This report summarizes what has been learned thus far.

The areas considered were electronics and computing, metal working, and (briefly) textiles. These differ in technological rate of change and sophistication and in the levels of education and skill of the work force. Individual plants (and indeed industries) are in different stages of growth or even of down-sizing, a factor to be weighed in trying to learn from their personnel experience and approach. Also, the role of formal qualifications was found to vary with the length of time persons had been employed, the stage of growth of the firm, and the organizational philosophy of its management.

Preliminary Conclusions:

- The more an industry or firm is involved in "high technology", the more predominant is the role of the engineering graduate. While there is today a significant difference (especially in the higher technology areas) between the roles of most graduate engineers as compared to handassaim, the formal differences in qualification may in future be attenuated or disappear, as more people get first degrees. (This study is focussed on the roles, education, and capabilities of technicians: those who do not, at least at the start of their work life, qualify as graduates or handassaim.

- Technicians will need dexterity, as in the past; but it will form less of their total capability, and a more dominant need will be for conceptual abilities and systems thinking, since many workers will take less physical part in production and more one of overlooking and intervening in a process or function.

- The less the formal education associated with a role, the greater the importance of experience. Experience, however, tends increasingly to become obsolete, and perversely, with more experience (and usually age) it becomes more difficult for a person to learn a new field. Many tasks in which an elite depend on their experience, senses, and motor skills (those of a "meister") are being replaced or radically changed by CAM/CAD, ddc, etc.

- Learning throughout life will be a major need. The basis should be a core of knowledge and abilities on which to build. Despite similarities, this core will differ among technologies and be learned in different ways by people of varied abilities.

- Capabilities in the processes of innovation include: visualization in several dimensions; conceiving situations as dynamic rather than static; modelling, and going between models and reality; understanding synergism, or the interaction of different technologies; and the ability to take a critical look at the assumptions underlying a given way of doing things, and conceive of an entirely new approach, indeed of a new definition of the problem.

- Beyond probable major revisions in the methods and content of schooling, the scope of continuing education is rapidly expanding, and may be expected to become an important "growth industry", greatly facilitated by new technologies of education and communication.

- The nature of work and opportunities will depend on the role of Israeli industries and services in the world economy. The more sophisticated the products and services, the more scope and need there will be for individuals with technological capabilities. The political economy of the development of science, technology, and industry is thus the overriding factor.

- Taking all factors into account, the prediction of the numbers of people needed with differing qualifications in the medium and longer run is not considered to be feasible or wise. Efforts should therefor be devoted more to the means of identifying and enhancing core abilities.

- The policy then becomes one of the "supply side": ensuring that the human potential can develop to its full potentialities. Such a policy, and what can be observed of much industrial activity, can mean that a good part of the time many people will be doing work that does not use their abilities and knowledge to the full. - In parallel, however, it can be expected that developments in both organization and technology will present new challenges.

- There are thus two challenges: identifying and developing human potential (at all ages); and finding organizational concepts that can give it fuller scope.

Summary

Open-ended discussions were held with managers and group leaders, most of whom have technical responsibilities. The agenda included: (a) the nature of the technical problems faced in process and product development and innovation, or that arise in production and servicing; (b) the role of the capabilities and experience of individuals in the solution of such problems; (c) how these abilities relate to formal education; (d) how continuous learning depends on formal qualifications; and policies of the firm relating to continuing education; (e) employment policies and career patterns. (f) The views of the person interviewed relating to the general questions of the study.

Electronics and Computing

The firms visited included Israel Aircraft Industries and Scitex. IAI is contracting, while Scitex indicated some growth in sales, a general atmosphere of advance and learning, and a stable level of work force. In both, products are characterized by complex systems, and "systems thinking" was repeatedly mentioned as a highly desired capability, which was said to be correlated with higher formal education. As with other capabilities, however, this may be due in no small measure to the (presumed) generally higher intelligence of people who earn degrees. This view needs to be modified, however, because of social barriers to education and deficiencies in the school system. Several discussants saw motivation and effort as key elements in problem-solving, some of them believing that the length of studies that an individual had the will to pursue is a reliable indicator of these characteristics.

The primacy of engineers is seen in the employment figures of the Israeli electronics industry. As the industry suffers from the world decline of the demand for military electronics, hiring becomes extremely selective, and engineers receive higher preference; especially since the manipulative skills of technicians are needed less and conceptual ability is required more. These factors together markedly reduce the ratio of technicians to engineers (in some places where R&D is emphasized, even reversing from two or three technicians per engineer, to two engineers per technician). In the software industry per se, higher education is becoming the rule. Despite the notoriety of high-school age "hackers", people with degrees are sought, particularly where the applications are for real time. Because software is embedded in the complex military or instrumentation electronic systems and products, people who combine physical and engineering knowledge with computing skills are sought rather than specialized computer science graduates, many employers believing that programming is easier to learn on the job or in extension courses than are the basic physical technologies and sciences. Note that Scitex and IAI are at the "high end" of the technological spectrum, and further analysis of the industry as a whole is needed before drawing any strong conclusions.

Metal Working and Mechanical Engineering

A visit to the Technion Department of Mechanical Engineering production (Professor A. Ber) was a good introduction to modern automated metal working systems. Complex mechanical systems were observed at Scitex, involving the analysis of dynamic interactions, very high accuracy of manufacture, sensitivity throughout the systems to wear and tear or inaccuracy of specific components, and often the need to change a basic design concept.

Visits were made to Iscar and E.T.M., and discussions were held with the former manager of a metal working branch of IAI. Iscar invests substantially in market-driven product modification and development, and experienced technicians as well as engineers have made important contributions. The development process, like other Iscar functions, does not seem to be strongly compartmentalized, and staff functions have modest authority and proportions. E.T.M. is based more on an established product line. There is less change, and most workers are vocational school graduates. They receive continuing training, directed less towards "high tech" developments than to improving such basic skills as understanding drawings.(!) In IAI, production engineering is institutionalized, although their TQM program locates the offices of the production engineers on the work floor. As with electronics, consideration of the broader industry is needed, since smaller plants and sub-contractors would be expected to give greater scope to non-graduates than large establishments, and, at the same time, to need more technological knowledge in order to meet rising production standards.

Textiles

A meeting was held at the Shenkar College, and plant visits are being arranged with their cooperation. Major changes in color design and dyeing include: (1) computer-aided color and dye developments allow samples to be made within hours rather than the weeks that were formerly needed. (2) Automatic production and quality control (ddc) make the unusual sensory and process adjustment skills of the "meister" unnecessary, but do require conceptualization by those who monitor the processes. This capability, however, requires far less experience, and intelligent young people can acquire the necessary knowledge within a relatively short time; so that firms require few engineering or chemistry graduates. Fashion and tailoring cannot yet be automated significantly, and only spinning and weaving are highly capital-intensive. Despite advances in sewing and cutting machines, the cost of entry into clothing manufacture is low, so that the competitive entrepreneurial nature of the fashion industry continues. Eighty per cent of the textile work force, however, remains relatively unskilled and works for the minimum wage. The yearly sales per worker are only about $50,000, versus more than $100,000 in electronics.

Education

A central concept is that of a core of knowledge and abilities on which an individual will base continuing learning. We saw some impressive efforts to provide continuing learning, including individual and group use of multimedia sources. In electronics, because of system complexity, miniaturization, the seeking of infinitesimal time constants, and the automation of production and testing - ills that facilitate teamwork, communication and perseverance. This raises the following questions: (a) how can the potentials of an individual in these directions be assessed? (b) what is the needed core of technical understanding, and to what extent does its acquisition depend on mathematical competence? Many aspects of mechanical engineering also require systems thinking, with perhaps more ability to conceptualize in three dimensions than is needed in electronics. Both require cognitive processes of model building, but the nature of the relations of the model and analyses to reality is often different in these two cases. Also, tangible and tactile experience should contribute more to the ability to solve mechanical problems than in electronics, where mathematical ability would be expected to count for more. In sum, such cognitive capabilities as a feeling for synergism (as between biology and electronics), model building and analogy, and logical thought, together with the imagination to consider a problem along new and different dimensions - are involved in creativity. While creativity may be rare, its unusual characteristics need to be combined with a substantial understanding of the physical or biological world. This adds up to a core of knowledge and skills plus affective characteristics and imagination. We then need to ask what the core might be in different areas and for persons of different interests and capabilities.

The "high end" and the Political Economy

Most of the firms visited make high technology products and/or use sophisticated methods of design and manufacture. The example of the large difference in sales per employee between textiles and electronics (and the related wage differences) fosters the ambition to make Israel a high-tech center, leaving to others more prosaic and less rewarding work. Attempts to forecast the relative role of such industries in Israel are beyond the present scope, as are the policies that may be needed. We are, however, concerned with human resources policy that might further or hinder the achievement of such goals. Since forecasting in any detail may not be feasible, a "supply side" approach remains, that is, to afford each individual as good a core education as possible, together with ongoing learning facilities and stimulus throughout life. If this succeeds, human potential will not be the limiting factor in economic and social advance; but its motivation and liberation may be. That is because many individuals, as today, will work at tasks that do not require or indeed encourage them to use their capabilities. A central question will then be organizational: how to give scope to this potential.

Daniel Shimshoni
Herzlia
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The investigator has previously surveyed the general world background and issues (see the attached bibliography), but those data (circa 1989) need to be brought up to date. The Weizmann Institute program for "Noar Shocher Mada" reported that the selection of pupils is no longer based mainly on grades and tests, but on the motivation of pupils to take part and to persevere. This resulted in many fewer drop-outs.

See the Neaman Institute reports: Eng. David Cohen, Megamot Bikush leMahandessei Electronica veBogrei Madaei Hamechashev, July 1993; Dr. Uri Shimoni, Ta'asiyat Ha'electronica beOlam ubeIsrael..., 1991; and Dr. Eran Weiss, "Hataasiya haElectronit beIsrael", Achuzim (Betucha Co.) Feb. 1993 e.g., Hadassah in Jerusalem reports that its Computer Handassai graduates do well; but in administrative computer applications rather than in real time or operating systems. We are not yet concerned with such policy questions as the future of Handassaim, B. Tech., etc. Indications are that popular desires and the response of politicians to them will lead to a large growth in the numbers of people studying for degrees (which will vary greatly in their intellectual requirements). A second trend for future study is the reform in secondary technological education that will provide greater individual flexibility; but which has raised important questions of content and method.

According to Joe Gillis, programming success depends on mathematical ability more than on mathematical knowledge. (It would seem probable that efforts to gain knowledge are important in developing ability.) Experiences in the relation of creativity and analysis appear to differ. Some found that, while technicians could invent (especially in mechanics) it required high level engineering science to refine and perfect the inventions. Others reported experience in which high-level consultants or R&D scientists introduced changes that were then refined by more "practical" engineers. This belief was reinforced by observing the examples used in the Open University courses in Creativity.