

Science in the service of society: the Israel National Museum of Science

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Science as a cornerstone of nation building is a guiding principle of the Israel National Museum of Science, which caters to a culturally diverse public of all ages. Nitsa Movshovitz-Hadar is director of the museum and professor at the Technion-Israel Institute of Technology and former head of its Department of Education in Technology and Science. Since 1986, she has been academic director of the Israel National Pedagogical Center for Mathematics. For more than ten years, she was mathematics consultant to Israel Educational Television, which produced 'DraMath', a series of sixteen videotaped dramatic programmes in mathematics that won the 1985 Japan Prize International Contest of Educational Video Programs. Drora Kass, a psychologist by training, heads a consulting firm that assists institutions to enunciate goals, conceptualize programmes, devise strategies and raise funds. For more than thirty years she has been active in the promotion of peace between Israel and its neighbours and has won numerous awards on behalf of this work. Her previous positions include: director of Public Affairs and Resource Development Division, the Technion; special consultant to the Israeli Minister of Education and Culture; and director of the US Office of the International Center for Peace in the Middle East.

Israel can win the difficult battle of survival only by developing painstakingly, the intelligence and expert knowledge of her young people in the field of technology.

(Albert Einstein)

Scientific achievement, rather than military might, will determine the future of states and peoples.

(Shimon Peres, former Israeli Prime Minister)

In 1923 the father of the theory of relativity visited Palestine, where he planted a palm tree in the courtyard of the Haifa-based Israel National Museum of Science – then home to Israel's first institution of higher education, the Technion-Israel Institute of Technology. More than seventy-six years later, that palm tree still graces the magnificent landmark edifice, designed by renowned German Jewish architect Alexander Baerwald. It serves as a much-needed daily reminder of the assertion made by Albert Einstein many years ago.

At the gateway to the new millennium, Israel is poised at the technological cutting edge. Per capita, it is one of the world's five largest investors in research. Dubbed 'the second Silicon Valley', the country boasts more than 3,000 high-tech companies and has 135 engineers per 10,000 persons (compared with 85 per 10,000 in the United States).

Israel's need to develop its own defence systems has induced a massive leap in a broad range of areas, including electronics, image-processing technologies, radar and telecommunications. Years of defence needs have also resulted in an environment where innovation is the rule, and local research-and-development is reputed to have superior outcomes in a fraction of the time for achieving such results elsewhere.

There is no doubt that in an age in which, as former Israeli Prime Minister Shimon Peres has asserted, military prowess has given way to scientific and technological achievement, Israel's standing in the global marketplace will be determined by its ability to maintain an edge in development and innovation in these fields. But to do so, it must reach youngsters, spark their interest, inspire their creativity and help channel them, in ever increasing numbers, to careers in the sciences. This is no mean task in an era when students everywhere are increasingly shifting away from the exact sciences and engineering towards professions perceived to be more immediately lucrative, such as law, business administration and the media.

Moreover, analyses of the Third International Study, conducted by the International Association for the Evaluation of Educational Achievement (IAEEA), show that at junior-high-school level, Israel occupies a relatively low place in achievement in the sciences compared with other developed countries. Out of forty-five countries, Israel comes twenty-fourth in science achievements of eighth graders;¹ in mathematics, it ranks twenty-first.² While formal Israeli high-school curricula allow students to take up to ten to twelve hours of science studies a week (mathematics/biology/chemistry/physics/computer science), only 5 per cent of eleventh and twelfth graders pursue this fortified science curriculum. And given the high matriculation scores required by universities, students are prone to be exam-driven and teachers geared by the need to cover that curriculum.

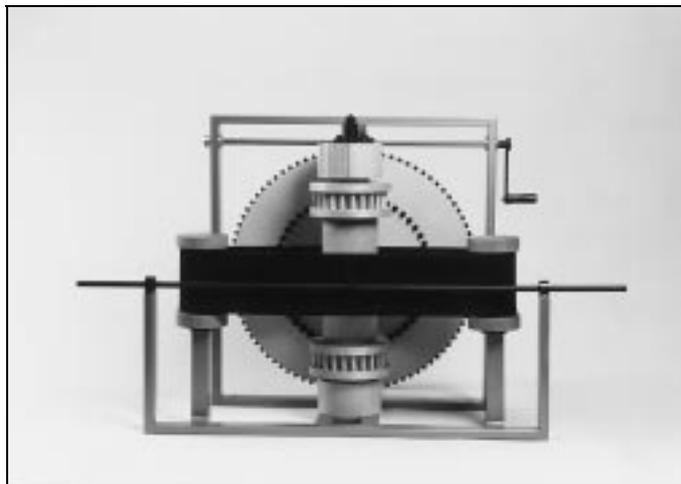
Demystifying science

Founded in 1984, the Israel National Museum of Science seeks to alter the

perception expressed by Arthur C. Clarke, that ‘sufficiently advanced technology is indistinguishable from magic’. By demystifying science and unravelling the complexities of technology, the museum is strengthening a more rational approach to science and fostering interest by young and old alike. Our motto is, ‘From seven to seventy’. Through a vast assortment of interactive scientific exhibits – almost all manufactured in-house – we want people to grasp basic scientific concepts on subjects from mechanics, electricity and magnetism to optics, acoustics, aeronautics and communication; to understand how items they use daily – radios, televisions, CD players, microwave ovens and cellular phones – function; and to experience an intellectual surprise, expressed by ‘Wow!’ followed by ‘Why?’ or ‘How?’ and finally, an insightful ‘Aha!’

About 200,000 visitors (100,000 of whom are elementary- and high-school students) of all ages, backgrounds and geographic locations take part annually in museum activities. Youngsters who spend time in hands-on experiments in museum laboratories and demonstration rooms and operate its more than 250 interactive exhibits, leave with an enhanced desire to master given areas of science or technology, even if they have no previous background in the field. By taking home items they have made to share with their parents they immerse their entire family in an exciting science venture.

Many potentially exciting scientific subjects, such as chemistry, for example, are often negatively perceived or avoided. The museum tries to alter these attitudes through popular lectures and stimulating exhibitions. Its recent *Matter of Chemistry* exhibition features twenty interactive exhibits on chemistry and chemical phenomena. Aimed at the broad public



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through demonstration of chemical processes and their use in everyday life, it includes an odour laboratory to illustrate our sense of smell, blood pressure in chemistry, and the like.

A device to convert motion with a friction belt. From the interactive exhibit Leonardo da Vinci – Scientist and Engineer.

The vital interaction between science and society is highlighted through broader cultural exhibits, including *Radio – The Early Days*, marking the centenary of the first Marconi transmissions; *Santiago Calatrava – Structures and Movement*, featuring models of the renowned architect’s work; *Jewish Vienna through Life-size Holograms*, depicting the life of the Jewish community in Austria. Popularized one-day seminars and public lecture series explore intersections between science and society on issues such as *Avoiding the Ageing Process: Illusion and Reality*, or *Can the Brain Understand the Mind?*

The museum is dedicated not only to the universal mission of spreading the word of science, but also to a national mission: laying the foundation for the fulfilment of Einstein’s vision by fostering a love of science among children and youth of all ages, backgrounds and geographic locations. It strives to cultivate excellence in science among young people, by rendering scientific and technological topics attractive and interesting, within a unique environment that facilitates effective transmission of scientific messages. In a multicultural country which continues to be built on immigration – 15 per cent of the population has emigrated to the coun-



The Curta calculator, a four-function, pocket-size universal calculator, developed by Curt Herzstark during his years in the Buchenwald concentration camp. Sold in large quantities worldwide, it was supplanted in the 1970s by the advent of electronic calculators.

try within the last ten years – the museum seeks to contribute to the immigrants' successful integration through subjects that are not language-bound. It is also sensitive to the existence of Arabic-speaking communities in Israel and to the need to reach out and nurture excellence in science among both Jewish and Arab youth from disadvantaged backgrounds and peripheral locations, whose families or educational authorities may not accord priority to science education. The latter have to be convinced of the importance of encouraging participation in such programmes and of identifying and nurturing students who exhibit special talent for the sciences. Finally, the museum desires to narrow significant gender gaps in science achievements among students.

The Museum Science Education Center develops unique curricula, teaching aids and laboratory experiments. Well-equipped laboratories – sorely lacking in most formal educational frameworks in Israel – form the centre's core learning environment. Every year, more than 2,000 classes of third- to ninth-graders participate in morning sessions of demonstrations and experiments in chemistry, physics and biology. More than 500 elementary school-children – half from Israel's northern development towns, half from new immigrant communities – take part in intensive, year-long weekly afternoon workshops. Under expert guidance by museum personnel, children and youth glean first-hand knowledge of how colours come into being. They gain insight into computers, investigate the operation of electric motors, explore magnets, learn how sound waves travel and much more. Designed to meet their specific academic requirements, these activities enrich subject-matter taught within the formal education system. In order to reach

children in their early formative years when they are first able to give voice to their natural curiosity, the centre will soon open a Toddler and Young Children's Wing. Here, kindergarten staff, accompanied by parents or teachers, will take part in science-made-fun enrichment activities.

The museum's annual OlympiYeda international science competition – open to ninth- and tenth-graders – aims to identify, inspire and nurture young people with a particular interest and inclination for science. The four-stage year-long competition, for Israelis and youth from North America, the United Kingdom, Australia and South Africa, opens with two screening stages – an aptitude test and one based on specially prepared study materials. Those eligible for the semifinal stage are invited to take part in a two-week, all-expenses-paid, science summer camp in Haifa. Participants enjoy a full range of scientific activities: lectures by prominent scientists and researchers, and visits to innovative research, technological and industrial facilities. Recently the OlympiYeda focused on 'Scientific Breakthroughs of the Twentieth Century'. Past topics have included energy, science in sports, sound and hearing, communication, chemistry and the secrets of the elements, and space science. A special OlympiYeda Headstart Programme is offered to high-school students from disadvantaged neighbourhoods and outlying towns – Jews as well as Christian and Muslim Arabs – who exhibit special potential for science. The programme enhances their knowledge, and self-confidence, boosting their chances of success by stimulating curiosity, facilitating learning and motivating them to pursue scientific subjects.

The museum also provides widespread

outreach activities for children who are not able to visit because of their location or the priorities of their educational frameworks. These currently comprise five extensions throughout Israel, use of museum-produced mobile exhibits in outlying towns and villages, and a mobile science laboratory, the first of its kind in the country. Fully equipped with demonstration and teaching aids, the laboratory stimulates interactive presentations, to students and teachers alike, on a broad variety of scientific phenomena and their underlying principles: how metals combust; the way air is liquefied; what goes into creating plastics, and the like. These activities have proved effective in producing significant improvement in children's performance at school and over time have resulted in a marked shift in declared role models. A survey conducted at Givat Olga – a development town with a high proportion of new immigrants – following a series of museum-initiated science programmes illustrates the change. When asked what they wanted to be when they grew up, the initial reply among boys tended to be 'a driver', and among girls, 'a nurse'. Following the science initiatives, boys tended to reply 'an engineer' and girls, 'a doctor'.

Science education: the great equalizer

In Israel the gap between the achievements of boys and girls in the sciences is one of the highest in the developed world and is growing. In fact, Israel is one of the few countries in which gender differences are statistically significant, even at a young age.² There are many reasons for this, not the least of which is a lack of female scientist role models in textbooks, among university faculty members³ and in top-level managerial positions in industry.⁴

While there is no dearth of foreign literature on women in science, there is not one textbook in Hebrew on the subject.

Museum experts believe girls need to be exposed to science in a positive way, before fear sets in. Its Science Education Center has served as a laboratory for a year-long experiment in which fourth- to sixth-grade girls took part in a single-sex science class – proven to be a venue for the enhancement of motivation, self-confidence and the desire of girls to continue in the sciences. The outcome was a higher percentage of girls than in mixed classes expressing enjoyment of the material learned and opting to continue. The centre has also introduced affirmative action elements which promote and encourage girls to join its programmes and competitions. In the offing is a data bank on women in science which will comprise scientific achievements and life stories of women scientists whose work has enhanced our understanding of the world – from the dawn of civilization to the present. This will be used as a motivational tool, combining biographical information on women scientists with a host of classroom activities and problem-solving experiences.

The museum operates on the premise that Russian and Ethiopian immigrant children have a greater chance of competing successfully with their peers on subjects that are free of linguistic constraints. Enrichment programmes for smaller groups provide informal educational settings that are less threatening than formal ones, in which immigrant children and their veteran Israeli-born peers can overcome social inhibitions and psychological barriers. What is more, the success of these young people in scientific fields and competitions undoubtedly radiates upon their entire community, and goes a long way



A touch of electricity: getting a sense of electrical conductivity using a plasma ball in the museum's Dark Room.

toward effacing a negative self-image, strengthening their confidence and generating a feeling of parity with their more privileged peers.

The same holds true for Arab youth. Like disadvantaged groups elsewhere, Israel's Arabs, who constitute almost 20 per cent of the country's population, are trying to change their marginal status through educational achievements. However, laboratories and physical equipment in Arab schools are, on the whole, far inferior to those found in Jewish schools. Dealing effectively with this population implies multilingual explanations, cultural adaptations and specially devised headstart programmes.

Science: aeons of cumulative knowledge

We feel it is vital that current and future generations be exposed not only to the worlds of today and tomorrow, but also to the past, so that students can understand that science developed over many years,

on the shoulders of scientific giants. The museum's *Leonardo da Vinci – Scientist and Engineer* exhibition, to take one example, displays thirty interactive exhibits, designed and produced on the basis of Leonardo's specifications. The highly aesthetic large exhibits, made of wood and set on granite bases, expose Leonardo's scientific and technological curiosity and ways in which he developed ideas pertaining to machines, automation, hydrostatics, hydrodynamics and flight and their underlying principles, broadly applied to other machines.

The museum's Historic Collection also provides visitors with a sense of scientific continuity. Dubbed Israel's 'National Archive for Historic Scientific Instruments', the collection comprises a broad variety of scientific equipment that has served functions now rendered obsolete: Edison's first phonograph with matching cylinders (1904–08); a Swedish Baltic radio receiver (1927); a British manually operated vacuum cleaner (*circa* 1900); a Mignon pointer-type typewriter with Hebrew characters (1920), and more.



© The Israel National Museum of Science

The collection is of interest for its historical value, for the learning it affords and as a reservoir for specific exhibitions.

The premises also create a balance between old and new. In restoring its building, the museum has remained true to the architect Baerwald's original turn-of-the-century design, an approach that called for inventive, often unconventional solutions, imposed by the structure's original features. It is one that has allowed the museum to offer its multitude of visitors an environment in which the past and the future merge, providing a taste of science and technology tinged with a historic flavour emanating from a site that has come to be synonymous with higher education in Israel. The museum has refurbished an original Technion classroom within its major building, 'selling' the 108 seats to Technion graduates. The brass name plaques on each seat read like a veritable *Who's Who* of the Israeli economy and high-tech industry, people who have become partners in the vital task of promoting scientific education among youth.

The museum also features exhibits of Israeli technological breakthroughs, such as Elscint's computerized tomograph (CT), and Simigon's computerized flight simulator – used to train both military and civilian pilots. With the unfolding peace process in the Middle East, the museum aspires to show that innovations developed under military exigency have broader civil applications. A Merkava tank and a Kfir jet fighter, both situated in the courtyard, are two prime examples of Israeli scientific ingenuity with general high-tech applications. They boast novel features, such as night vision and an ability to move on rough, rocky terrain. In recognition of the growing role of industry, especially in high-tech fields, in promoting science education, a number of co-operative ventures have been undertaken, such as a futuristic communications centre, with Bezeq-Israel Telephone & Telecommunication Company, and the *From Calculations to Computations* exhibition courtesy of Intel, to name but a few.

In our bid for universal accessibility, we have opened a unique 'Science, Light and

Children unravelling the mysteries of sound.

Sound' Project – interactive exhibits adapted for the sight- and hearing-impaired. Several displays which require sight or sound to experience their results have been altered, replacing visual elements with auditory ones or auditory features by optic components. For example, a meter measuring the electric current in one's hand has been hooked to a buzzer with variable pitches and Braille explanations have supplemented printed ones.

Finally, given Israel's world record in road accidents and the museum's high number of visitors, we feel we have a contribution to make in this regard by focusing on saving lives as well as enhancing minds. A soon-to-be opened exhibition on accident prevention, comprising twenty-five interactive displays, will enable children and youth, young drivers and seasoned ones, to experience first-hand how diverse safety apparatuses function and to take an active part in accident reconstruction.

All special adaptations, as well as the broad range of interactive exhibits, scientific instrumentation and prototypes, are developed, designed and produced in museum workshops. These afford visitors a behind-the-scenes look at how the permanent and changing displays come into being.

The transition to a new millennium is not merely chronological. It calls for the adoption of new mental structures and societal norms, in line with the meteoric speed of technological and scientific advances. We believe that societies that succeed in internalizing this revolution and using it for the well-being of all their citizens will be able to skirt the dangers of escalating

polarization whereby a growing number of people, unable to understand or reap the benefits of technology, will necessarily feel left out. Conscious of disparate cultures in Israel which call for sensitivity of language and approach, the Israel National Museum of Science strives to reach Israelis of all backgrounds with the wonders of science and technology to make them feel that they, too, have a direct stake in these developments, and that they can and should partake as equals in the country's bid for position in the global economic marketplace. ■

Notes

1. Findings published by Professor Pinchas Tamir of the Hebrew University's Department for Science Education.
2. Findings published by Professor Nitsa Movshovitz-Hadar, museum director and former head of the Technion Department of Education in Science and Technology.
3. A recent study (1994) by Hebrew University sociologist Dr Nina Toren demonstrates that while the percentage of women faculty members at Israeli institutions of higher education has risen, their number in the sciences has declined. Of the Technion's 250 full professors, to take one example, only eleven are women.
4. A survey conducted for the Israeli Manufacturers' Association reveals that out of 633 senior managers in the electronics field, only nine are women; in 74 per cent of these companies, there is only one woman at middle-management level.