# TECHNION NATION

## TECHNION'S CONTRIBUTION TO ISRAEL AND THE WORLD

**AMNON FRENKEL | SHLOMO MAITAL**

*with ILANA DEBARE*

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We thank the foundation directors, and their representative Eric Stein, whose vision and goals mirror those of the Technion — to benefit Israel and the world through science, technology, and innovation.


Science and technology represent our collective tomorrow. And while poor in natural resources, Israel is rich in human resources that have positioned us at the forefront of global advances in the new scientific era through innovation, foresight, creativeness and daring. The seeds planted today will yield the breakthrough discoveries of tomorrow, making the world a better place.

It was lucky the Technion was founded prior to the establishment of the State of Israel, helping us prepare for the future.

**Shimon Peres**
President of the State of Israel

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# Preface

***Suddenly a man wakes up in the morning***
***He feels he is a nation and begins to walk***

This passage is from a 1953 poem by Amir Gilboa. It portrays Theodor Herzl, who envisioned modern-day Israel. It has become a popular song.

We believe it applies equally to Technion. A century ago, a handful of visionaries laid the cornerstone for a science and technology university. Technion awakens, feels it is the foundation for a nation (to be born 36 years later) and begins to walk, step by step. And its 67,000 graduates, holding over 90,000 degrees, indeed became the foundation for a nation – for Israel's startups, basic research, applied technology, high-tech industry, global management expertise, export sector and economic growth. Technion's aeronautical engineering department has spurred key breakthroughs for Israel's defense. Its electrical engineering and computer science departments have provided the talented graduates who drive Israel's electronics and software industry, which generates $20 billion of Israel's $40 billion in annual exports. Its architecture and civil engineering departments built Israel's roads and infrastructure. And three of Technion's talented faculty have won Nobel Prizes in the past eight years.

In this book we tell the story of *Technion Nation*, and of some of its citizens – with an emphasis on "some". This book was never intended, and could not possibly be, an exhaustive treatment of the many Technion innovators, inventors, entrepreneurs, visionaries and pioneers who have enriched Israel and the world in so many ways.

We were inspired by an earlier study about "MIT Nation" by Edward Roberts and Charles Eesley.[1] We also found inspiration in the bestselling book by Dan Senor and Saul Singer, *Startup Nation*.[2] As we undertook

*Laying the cornerstone for the "Technikum" (later, Technion), 1912*

the research for it, we ourselves were surprised by the magnitude of our findings – the quantitative and qualitative evidence showing how massively this "nation" of Technion graduates has contributed to the well-being of humanity. Between the two of us, we represent a total of 63 years at Technion, and believed we knew Technion well. Yet despite this, we were consistently surprised by what our research revealed about the enormous contributions of Technion graduates to every facet of Israel's economy and society, as well as to the broader world. We feel that this remarkable story shows not only how Technion contributes to the nation of Israel and to the world, but also demonstrates the key role that a great science and technology university can play, wherever it is located.

# Acknowledgements

We feel blessed to know and work with Ilana DeBare. If *Technion Nation* is lively, interesting and easy to read, it is only because of her skill as writer and journalist.

The initiative for this project came from the former director of the The Samuel Neaman Institute for Advanced Studies in Science and Technology, Professor Moshe Moshe. When shown the "MIT Nation" research, he offered support and funding for a similar project about *Technion Nation*.

We are grateful to Technion President Peretz Lavie, who supported the project from the beginning. Professor Lavie read several drafts with care and his suggestions improved our book signficantly. Many constructive suggestions were also contributed by Technion Senior Executive Vice President, Professor Paul Feigin; Executive Vice President for Research, Professor Oded Shmueli; and Vice President for External Relations and Resource Development, Professor Boaz Golany.

Neaman Institute staff Vered Segal, Tsipy Buchnick, Eran Leck, Golan Tamir and Bella Zalmanovic helped compile, organize and process the data that underlie this book. They brought expertise and tireless energy to the project. The Technion Alumni Association provided invaluable support in helping us to implement our email to over 20,000 members, asking them to complete a detailed questionnaire. We salute the 4,000 graduates who took the time to fill out our detailed questionnaire.

We doubt this book would exist without the organizational skills of Technion's Director of Public Affairs and Resource Development, Danny Shapiro. Danny's help was indispensable in bridging the gap between rough manuscript and finished printed book. The Public Affairs team chose the photographs for the book with wisdom and intelligence.

Chapter One:

# Technion Nation's DNA

"A country is the shadow thrown by a nation," novelist Arthur Koestler once wrote, "and for 2,000 years the Jews were a nation without a shadow." Today the Jewish nation has a country, Israel, and it casts a strong shadow. But 36 years before the country was born, the foundation stone was laid for a major science and technology university which began building its own nation of graduates.

Today – a hundred years after its start – the "nation" of Technion-Israel Institute of Technology includes some 67,000 graduates who hold a total of over 90,000 Technion degrees. Of these, nearly 60,000 are still of working age; a fourth are either CEOs or VPs, and another 41 percent hold management positions. Nearly 11,000 Technion graduates work or worked in startups, and a fourth of Technion graduates at one time initiated a business. These entrepreneurs extend across both genders: some 15 percent of Technion's female graduates have launched businesses. Over a third of Technion graduates work in industry, and 12 percent work in research and development. Thus, nearly half of Technion Nation works in jobs that produce, create or design goods and services. Two-thirds of the Israeli companies listed on the NASDAQ stock exchange were either founded by or are led by Technion graduates.[3] A typical Technion graduating class generates a social return more than double the additional investment required to produce it. We estimate that the annual output of Technion graduates in high-tech, communications, and research and

development alone exceeds $20 billion, which is greater than the gross domestic product of 85 nations.

This book is the story of Technion Nation, the remarkable people who comprise it, and the various ways they have changed Israel and the world for the better. We choose to tell this saga as a collection of stories, rather than a compilation of data.[4] In this and the following chapters, we recount the remarkable breakthroughs achieved by Technion graduates and the faculty who educated them.

We choose to begin with the story of a 73-year-old entrepreneur with a revolutionary cure for cancer, and a young Haredi (ultra-Orthodox) man from Bnei Brak who started at the Technion with very little knowledge of basic math, but who is about to receive a degree in civil engineering. In a sense, Yoram and Aharon are "bookends," reflecting each end of the age spectrum of Technion Nation.

* * *

## Yoram's Story:

It is quite possible, according to Professor Noam Gavrieli, a former Vice Dean of Technion's Ruth and Bruce Rappaport Faculty of Medicine, that a 73-year-old physiologist named Yoram Palti will one day win a Nobel Prize for inventing a revolutionary cure for cancer. If so, it will be partly because of his creativity and brilliance and partly because of his entrepreneurial drive – a crucial and pervasive characteristic of Technion's graduates and faculty alike.

Palti is an emeritus professor of physiology and biophysics, a far cry from the stereotype of a 25-year-old whiz-kid entrepreneur. He told us that long ago, his Ph.D. research focused on understanding the electric field distribution in human cells. Many years later, in 2000, it occurred to him from his early basic research that he could design electric fields that would damage dividing cells.

"Most normal cells rarely divide in adults," Palti explained. "But cancer cells divide all the time." It dawned on him that "this could be

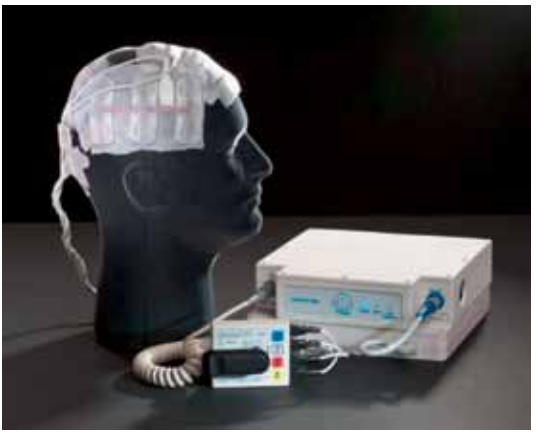
a tool to combat rapidly dividing, proliferating cancer cells." This was an entirely new direction for fighting cancer, utterly different from the current approaches of chemotherapy and radiation.

Palti founded a company called NovoCure in his basement to develop his invention. Today his device, the NovoTTF, is undergoing Phase 3 clinical trials in the United States and has shown great promise for halting the growth of glioblastoma brain tumors, the kind of tumor that killed Senator Ted Kennedy and composer George Gershwin.

How does Palti's invention work? Patients with glioblastoma brain tumors wear a kind of cap that generates an electrical field and destroys cancerous cells when they divide. It does this based on their shape – essentially, their geometry.

"A dividing cell has an hourglass shape," Palti told *MIT Technology Review*, "rather than a round shape of a non-dividing cell." The electric field generated by the NovoCure cap passes around and through non-dividing cells uniformly. But in a dividing cancerous cell, the narrow neck at the center acts like a lens. The electric field concentrates at the neck and tears the cell apart. The tumor stops growing.

Palti's device shows potential for treating some lung cancers as well as brain tumors. We asked him about the secret of his enduring creativity.



*NovoTTF-100A system slows or reverses brain tumors*

"Curiosity and dedication to find solutions to important issues may be the key," Palti said. "The wisdom and insight gained [with age] can be directed to a better utilization of the available capabilities. The main thing is to take advantage of this and keep pursuing [those solutions]."

## Aharon's Story:

Aharon D. makes his way through the Yitzhak Rabin Civil and Environmental Engineering building, glancing into one classroom and study hall after another until he finds a quiet spot to speak with some visitors. With rimless glasses, a black *kipa* and a merry gleam to his eyes, he could pass for a typical, slightly older student at any Israeli college or university.

But Aharon is far from typical. He grew up as one of 12 children in an ultra-Orthodox family in Bnei Brak. He spent 10 or 11 hours each day studying the purely religious curriculum of a yeshiva – no math, no science, no English, just intensive Torah and Talmud. His parents assumed he would become a rabbi.

Then, at the age of 25, with a wife, two children, and a third child soon to arrive, Aharon realized he would never feel fulfilled as a student of Torah. He left the yeshiva and enrolled in a university.

But not just any university – Technion–Israel Institute of Technology, Israel's premier institute for science and engineering.

Spread out along a slope of Haifa's Mt. Carmel, Technion's modern stone-and-glass buildings, clean plazas and shady groves give it the same techno-utopian feel as the images of Starfleet Academy in *Star Trek: The Next Generation.* That comparison is not as far-fetched as it sounds. Aharon had chosen a campus filled with rocket scientists, Nobel Prize-winning chemists, and cutting-edge software engineers.

And until the moment he arrived in Haifa, he had never even solved a simple equation like $2x + 4 = 24$.

"I had learned addition and subtraction, but not algebra," Aharon recalls, having finally found a quiet alcove on the fourth floor. "I had no clue what engineering even was. But I realized I had to learn to understand math the way that I had learned to understand Talmud."

*Technion campus today*

* * *

Every institution has its own unique personality – or in the case of a university focused on math and science, perhaps its own unique DNA. And we can glimpse a key piece of the Technion's genetic code in the determination underlying both Yoram Palti's anti-cancer device and Aharon D.'s leap from *yeshiva bucher* to engineering student.

Technion was born out of determination – the determination of early Zionist visionaries to create a high-level technical institute at a time when stones were still being hauled to construction sites by camel.

That determination continued through decades of state-building, as Technion engineers oversaw construction of the roads, buildings and water systems that would become the infrastructure of modern Israel. That determination fueled Israel's ability to defend itself against enemies, as Technion scientists served their country by helping to staff and inspire the research and development units for Israel's army and its nascent aerospace industry.

*Technion vision, built with mules*

More recently, the determination of Technion and its graduates helped create what many call the "Israeli economic miracle." Technion alumni led Israel's shift from an exporter of Jaffa oranges to a global technology powerhouse. If the revenues of the 49 NASDAQ-listed companies founded and/or run by Technion graduates were added together, they would amount to $12.7 billion – comparable to the gross domestic product of a small country like Iceland.

Meanwhile, the patient determination of scientists in Technion labs continues to spin off gifts to the rest of the world, from compression algorithms that are at the heart of the Internet, to medical advances that may help cure diseases like cancer and Alzheimer's. Three Technion professors have won Nobel Prizes in chemistry in the past eight years.

And Technion will now be bringing its gifts directly to the United States – through New York City's selection of a partnership between Technion and Cornell University to open a new 2,500-student engineering campus there.

"Technion has made a huge impact on society – of course on Israel, but on society in general too," said Levy Gerzberg, a Technion graduate and founder of Zoran Corp., a Silicon Valley electronics company that supplies the microprocessor "brains" for one out of every three DVDs and high-definition televisions.[5] "The revenues that have come out of Technion over the years are in the trillions. *Trillions*, not billions. Some of this is recognized, but some of it is not."

## What is the Value of a Top Research University?

As professors at Technion, we had long been curious about the financial impact of our university – those billions or trillions of dollars of value that Gerzberg describes. Over the past two years, we finally had an opportunity to study this through a survey of the careers, life choices and economic impact of over 4,000 Technion alumni, who responded to our detailed Web-based questionnaire.

As we moved forward, we realized that any account of Technion's role in society must go beyond dollars and shekels to include some less quantifiable contributions – things like basic scientific research, life-saving medical advances, promotion of an inclusive Israeli society with opportunities for everyone, and Technion's leading role in the security and defense of Israel.

The 2012 centennial of Technion's cornerstone-laying seemed to be an opportune time to share our research with the public – thus, this book. Along the way, we'll tell the story of how Technion has helped foster the Israeli economic miracle. We'll showcase a number of devices and technologies in our daily lives that you may be surprised to learn have roots in Technion. We'll make some guesses at how this one small university – whose resources are far more limited than Harvard, Stanford or MIT – came to win two Nobel Prizes (by three Nobel laureates) in less than one decade. We'll explain why high-tech leaders such as Intel, Google, Yahoo!, and Microsoft chose to open major research and development facilities just down the hill from Technion.

And we'll introduce you to the people who make up Technion – whose individual determination flows together, like many streams feeding a river, to create the collective determination that is this university's DNA. These are people like:

*Inbal Kreiss*, who received a bachelor's degree in chemical engineering in 1988. Today she oversees several hundred engineers designing a system to shoot down incoming long-range missiles– *above* the atmosphere.

While the rest of the world frets about the potential nuclear threat from Iran, Kreiss and her team at Israel Aerospace Industries – about half of whom are Technion graduates – are creating the next-generation technology to block enemy missiles before they get anywhere near Israel.

"We must be ready on time and we must be ready before our enemies," Kreiss says. "We are running very fast."

*The Arrow anti-missile missile*

*Technion graduate Inbal Kreiss, who leads the Arrow 3 project*

*Yoelle Maarek,* who received her Ph.D. from Technion in computer science in 1989 for a dissertation on computer search, before the World Wide Web existed. She opened Google's R&D facility in Israel. Maarek led the team that created Google's "suggested search" capability – the feature that offers several suggestions to complete your thought when you start typing a phrase into the search box. It was a challenging project that no one at Google headquarters thought was possible – but Maarek did it.

More recently, she changed jobs to run Yahoo's research lab in Haifa, one of only three such research facilities that the company operates outside California. She supervises about 20 computer science Ph.D.s, half of them Technion graduates.

"Here at Yahoo! we don't have the resources of Google, so we have to be smarter," Maarek says. "We don't have unlimited money so we have to have unlimited brains. It's a bit like Israel versus America."

*Ofer Vilenski*, a second-generation Technion entrepreneur who sold his first software startup for $107 million and is now working on a new one that aims to speed up online connections by using software to avoid Internet bottlenecks.

Not content simply to create a new software product, Vilenski first created his own proprietary computer program to manage the software development process more efficiently. He garnered an initial round of $7 million in venture capital funding without giving his investors any equity – just giving them an option to buy a discounted stake in the future.

Vilenski credits his time as an air force pilot with teaching him how to learn from mistakes – a critical skill for an entrepreneur. "You fly three sorties a day, so your day is a ten-minute briefing, study, fly, debrief," he said. "You get used to the cycle of it – brief, execute, debrief. You don't have to be perfect, just keep improving. It's totally unacceptable to make the same mistake twice."

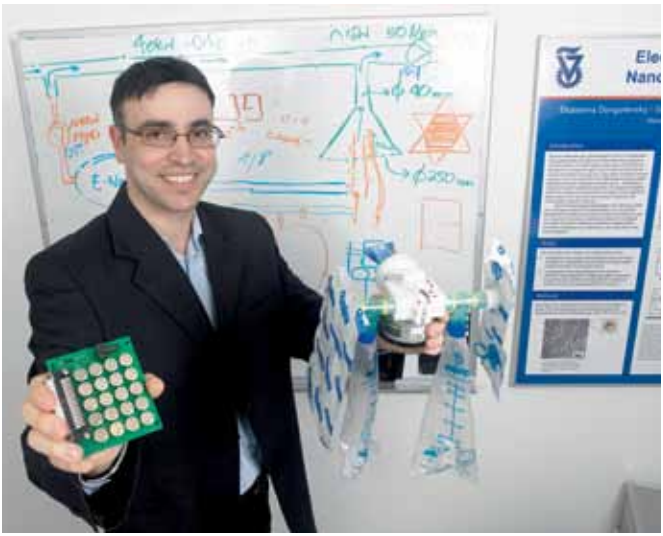
*Hossam Haick*, a 36-year-old professor of chemical engineering who is working on an artificial "nose" that can potentially diagnose cancer by detecting the odor of cancer molecules in people's breath.

Spurred into action when a friend was diagnosed with cancer, Haick drew upon nanotechnology to create what Israeli President Shimon Peres dubbed the "NaNose." "Today cancer often develops without (noticeable) side effects until it reaches a crisis," Haick says. "This will bring help when people really need it, which is the early stages."

The NaNose is currently in clinical tests for diagnosis of conditions such as Parkinson's, Alzheimer's and kidney disease, as well as cancer. Haick, an Israeli Arab from the city of Nazareth, runs a lab of 42 researchers from nine different academic departments and more than a half-dozen countries. "You'll find Christians, Jews, Arabs, secular, religious, whatever you like – all working together here for science," Haick says. "This is the great power of science."

## Their Lives In Six Words

Today Technion has close to 13,000 students in its 18 faculties and departments, studying everything from physics and mathematics to



*Prof. Hossam Haick: Sniffing cancer*

architecture, biotechnology and aerospace engineering. It has 67,000 alumni spread throughout the world – about 95 percent in Israel but others as far afield as Europe, California and China.[6]

Alongside our quantitative research into the impact of Technion, we wanted to try something a little more qualitative and even poetic. So, as part of our Web-based survey, we asked the following question:

**Ernest Hemingway once wrote an entire story in only six words. It was:**

***Baby shoes. Never used. For sale.***

**Please describe your contribution to Israel and to humanity, in six words.**

To our surprise, more than 90 percent of our 4,000 alumni responded to this challenge. (A few declined, protesting that their writing skills were "not up to Hemingway.") The responses came from anywhere and everywhere, all walks of life.

Hebrew is a sparse, economical language; translating the graduates' answers into English often took us more than six words. Many graduates described multiple careers that changed over the course of their lifetime:

**Teacher. Inventor. Writer. Soldier. Educator. Scientist.**

Others stressed the ethical and moral values that drove their careers:

**Humanity. Friendship. Compassion. Honesty. Professionalism. Determination.**

Or:

**Dream. Focus. Dare. Learn. Believe. Be.**

One of our favorites, blunt and to the point:

**I came, I studied, I'm rich.**

And, at the opposite end of the spectrum:

**Birthed, raised five amazing caring children.**

Not all the six-word capsules were happy ones.

**Israel didn't care. Now U.S. citizen.**

The vast majority spoke to the nature of the skills that alumni had learned at Technion, and how they put them to use in the world:

**Provide poor countries with appropriate technology.**
**Consumer electronic chips, 500 million homes.**
**Innovative micro-encapsulation of food additives.**
**Developed treatments, drugs for cancer. Patented.**
**Green technologies, Israel's new growth engine.**
**Developed Intel's 8087 microprocessor.**
**Developed the Arava, first Israeli-produced plane.**
**Absorbed Ethiopian immigrants into industry.**
**New product changed photography, mobile world.**
**Zionism: Over $1 billion in defense exports.**
**Simulation software for unmanned drone aircraft.**
**Low-volume irrigation technology.**
**Twenty years in medicine, half serving Arab population.**

We were struck by the enormously wide range of contributions, both to Israel and the world. What would Technion's visionary founders make of these responses, and of this institution today? Their single cornerstone of white limestone has multiplied to a 300-acre campus with 90 buildings. Their opening class of 16 young men and one woman has mushroomed to today's student body of 12,800, of whom 40% are women and one-fifth are Israeli Arabs.

Today's Technion graduates still carry that founding DNA of determination. Like their predecessors, they continue to meet the engineering needs of a Jewish homeland, to the benefit of all its citizens.

But they also do so much more. From microprocessors to medical advances, Technion's contributions go further than even the most visionary founders would have imagined. They ripple around the globe.

*Unmanned drones: Israel leads*

## Interlude: A Day in the Life of Ordinary Citizen (O.C.)

O.C. lives in a mid-sized city very far from Israel. He is married, has two teenage children, and is trying to ignore the fact that he has reached middle age. O.C. loves soccer and baseball, enjoys cycling on weekends, and works as a mid-level manager for a global information technology company.

His alarm clock goes off at 7 a.m. O.C. hits the "sleep" button to let his wife catch a few more winks, then gets out of bed. He stretches luxuriously, feeling well-rested after an unbroken seven hours of deep sleep, and is full of energy for the coming busy day.

O.C. suffered for years from sleep apnea, a disorder marked by abnormal pauses in breathing that prevent deep restful sleep. Some estimates show that up to one adult in five worldwide suffers from it. But a breakthrough technology called WatchPAT helped O.C.'s doctors diagnose his problem and find an appropriate treatment.

> *WatchPAT originated in the sleep laboratory of Technion President Peretz Lavie. Named by Cleveland Clinic as one of the Top 10 Medical Innovations of 2010, WatchPAT enables ambulatory sleep testing. It's a small device that slips over the finger and attaches to a kind of wristwatch that records signals from the body's autonomic nervous system. WatchPAT means that many apnea patients no longer need to sleep in an uncomfortable, artificial laboratory environment in order to receive a detailed diagnosis of their condition.*

O.C. rises and steps into his study, where his computer awaits him. He looks out the window with pride at his garden, kept green and lovely by a drip irrigation system.

*Technion mechanical engineering graduate Rafael Mehoudar holds the original patent for drip irrigation – U.S. Patent 4210287, issued on July 1, 1980. Israel's Netafim company has exported drip irrigation systems all over the world.*

*Monitoring sleep, in comfort*

*Technion President Prof. Peretz Lavie*

O.C. inserts a memory stick to transfer files he brought from work the previous day.

*"Disk on key" – or memory sticks, as they are widely known – were developed by an Israeli company called M-Systems Ltd., which was founded in 1989 by Technion electrical engineering graduate Dov Moran. M-Systems patented the first flash drive, which it sold as DiskOnChip in 1995, and the first USB flash drive, which it marketed in 1999 as DiskOnKey. Today memory sticks are ubiquitous, found on millions of key chains and carried in millions of pockets. M-Systems was acquired by its competitor SanDisk in 2006.*

O.C. checks his instant messaging. He finds that his brother is on-line and coordinates a joint gift for their parent's upcoming anniversary.

*Instant messaging was invented by a company called Mirabilis, which offered free downloads of I.M. software known as ICQ ("I Seek You"). The developers were young Israeli computer students who wanted to know which of their friends abroad were online so they could chat. With help from one of their fathers – Technion*

*alumnus Yossi Vardi, a graduate of IE&M – they formed a company and provided ICQ to anyone who wanted it. Some 12 million people had downloaded it by 1998, when America Online bought Mirabilis for $408 million. At the time, it was the highest price ever paid for an Israeli software company.*

O.C. needs to check the quarterly financial results for the business unit he leads. He opens an Adobe Acrobat PDF (portable document format) file downloaded from his memory stick.

*The PDF format and other graphic file formats such as GIF and TIFF were based on a data compression method called the Lempel-Ziv algorithm, which was developed by Technion Professor Abraham Lempel (computer science) and Distinguished Professor Jacob Ziv (electrical engineering), together with a colleague, Professor Terry Welch. Data compression was crucial in the early days of personal computers, because computer memory was too limited to handle large amounts of data. The Lempel-Ziv algorithm allowed compression of a large English text file to about half its size – effectively doubling a computer's capacity. Starting with Unix systems in 1986, the Lempel-Ziv algorithm was a key element of computing worldwide for almost two decades.*

O.C. opens his online calendar, where he sees a reminder that he has a routine physical exam that afternoon. A good opportunity, he thinks, to stop in and visit his aunt who is being treated for cancer in the local medical center. It's now 7:15 a.m. – time to bang on the bedroom doors of his son and daughter.

When, he wonders, will someone come up with an app that painlessly gets teenagers out of bed and ready for school?

Chapter Two:

# From Stones to Semiconductors

The first building hadn't even been completed in 1914, but already the new Jewish technical institute in Haifa was enmeshed in an international controversy. *Would the budding engineers and technicians of Palestine be taught in German or in Hebrew?*

The German Jews who had led the organizing effort decided the school would have no official language, but technical subjects would be taught in German. Their decision set off a firestorm: *How dare the first institution of higher learning in Palestine – a symbol of Jewish pioneering hopes and dreams – teach in a language other than Hebrew?* Teachers throughout the early Zionist settlements called a boycott of German-run schools there. The Haifa craftsmen building the new institute chose a spokesman and demanded Hebrew. Demonstrations supporting Hebrew broke out in Jerusalem, only to be suppressed by Ottoman police; Jewish law students in Beirut and Constantinople sent messages of solidarity.

What became known in the annals of Zionist history as the "war of the languages" even spilled over into the staid pages of the *New York Times*.

"The (Haifa students) cannot become first-class engineers if their primary education in the exact sciences is in Hebrew, because there is not a single practical Hebrew textbook dealing with those branches," wrote Paul Nathan, the German Jewish leader of efforts to launch the institute.[7]

"We are firmly resolved to have no institute rather than one that will

hinder the development of the Hebrew language," countered Bernard Rosenblatt, Honorary Secretary of the Federation of American Zionists.[8]

The young technical school at the center of the storm was, of course, the institution today known as Technion. And the furor over its language of instruction shows just how deeply Technion's story is entwined with the story of the State of Israel.

Technion's evolution – from a single building on a rocky hillside to one of the world's top research universities – reflects the evolution of broader Israeli society over the past century. But Technion is more than just a mirror of Israeli society. Consider its contributions:

*Reviving the Hebrew language. Building a workforce with the skills necessary for true independence. Developing aerospace and defense industries to protect the young country against its enemies. Absorbing the massive Soviet immigration of the 1990s. Fueling the high-tech boom that has made Israel one of the most innovative countries in the world….*

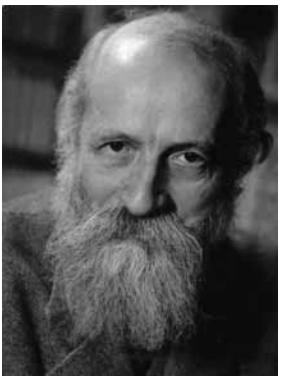

*Technion Nation: Born on a rocky Haifa hillside*

More than a mirror to Israel's history, Technion has proven to be one of its engines – furnishing the skills and vision to create the thriving, secure, technologically advanced society we see today.

## The Dream of a Jewish Technical School

The idea behind Technion was born in 1901, shortly after the Fifth Zionist Congress raised the idea of creating a Jewish university. Three young men including Martin Buber and Chaim Weizmann wrote a pamphlet decrying the exclusion of Jews from technical studies in Russia, and proposing the creation of a "Technikum" − an institute to prepare young Jews for university, as well as for technical and agricultural jobs.

Palestine's small Jewish community at the time attended primary schools run by French, English and German aid societies. It was the Hilfsverein – the German Jewish aid group – which moved ahead with the idea of a manual training school. Aided by Zionist philosopher Ahad Ha'am, the Hilfsverein won seed funding of 100,000 rubles (the equivalent of about $50,000 then, or $1.3 million in today's currency) from the estate of the Russian Jewish tea magnate, Kalonymous Zeev Wissotzky. American financier Jacob Schiff – appalled by the poverty he saw during a visit to Palestine – pledged an additional $100,000 to the project.



*Martin Buber (left) and Chaim Weizmann (right, dark coat): Proposed to found a "Technikum"*

Organizers picked Haifa as the site for the new school. It was a port with rail links to major cities like Beirut and Damascus, which would help graduates find work in the regional economy of what was then the Ottoman Empire. The Jewish community of Haifa was small – just 2,000 Jews in a town of 20,000 – and organizers figured that an educational institution would help it grow. They also saw Haifa's Jewish community as progressive and flexible – less wedded to religion than Jerusalem, less avidly Zionist than Jaffa.

Divisions over Zionism within the worldwide Jewish community put the new school at the center of a tug of war almost from the moment of its conception.

At the time, many wealthy German and American Jews opposed the idea of a Jewish state but wanted to improve living conditions in Palestine; they saw a vocational school as a way to help Palestine's Jews climb out of poverty. The young and growing Zionist movement, on the other hand, envisioned a technical university as an important building block toward statehood. This tension colored all of the school's initial planning – from who would own the land for the school, to the kind of curriculum and degrees it would offer, to the primary language of instruction.

It was barely a year after the cornerstone was laid with great ceremony on April 11, 1912 that the language war broke into the open. At first it looked like German would win the day: there were no Hebrew science textbooks, practically no qualified teachers who could speak Hebrew, and no Hebrew words for many scientific and technical terms. On top of that, the German consul – to whom the organizers had gone for financial support – was insisting not only that German be the language of instruction, but that the institute hire non-Jewish, German teachers.

Organizers offered a "compromise" position of using German for scientific and technical subjects while allowing two hours a week of electives in Hebrew, English or French. The small but growing community of Zionists reacted in fury – with boycotts, rallies, demonstrations, manifestos.

"The Technikum must become Hebrew or it will not exist at all," declared the Hebrew Teachers Association. "Technion will not open without bloodshed," warned Eliezer Ben-Yehuda, the intrepid creator of modern Hebrew. [9]

In the end, World War I decided the issue. Germany in defeat no longer had much influence in the Middle East. The Zionist movement emerged from the war stronger and more respected. With the institute's German-oriented board in financial disarray, Jacob Schiff purchased Technion's land and building and handed it over to the umbrella organization for the Zionist movement. By the time students signed up for the first classes in 1923 and 1924, there was no question that they would be taught in Hebrew.

The impact of this decision went far beyond the classroom experience of those first few dozen students. The language war had catalyzed support for Hebrew as the daily language of Palestinian Jewry – which in turn fed a new sense of national culture and peoplehood.

The dispute also turned the attention of the Zionist movement to the need for its own nationally oriented educational system. Six new high schools – all teaching in Hebrew – opened in Jerusalem, Haifa and Jaffa amidst the boycotts and protests. By the end of World War I, there were 27 Zionist-run schools throughout Palestine.

In 2011, the Haifa City Museum hosted a historical exhibition on the language battle and its significance for the society that would eventually become Israel.

"The 'War of the Languages,' ending in victory for Hebrew, was … one of the defining moments in the crystallization of Israeli cultural identity," wrote curator Svetlana Reingold.[10]

## Building a School and a Country

The first Technion students showed up in late 1923 at a building that grandly combined the scale and function of a European university with the domes and arches of Middle Eastern tradition. The initial classes were geared to the needs of a society just starting to urbanize and industrialize – evening sessions for workers in the construction, road-building and carpentry trades. A year later, the first university-level classes for aspiring construction engineers were held.

Technion's first fields of study were civil engineering and architecture. Their graduates built the nation – literally. The first dean of the Architecture Faculty was the German-Jewish architect and artist Alexander Baerwald, who designed the lovely original Technion building, then made *aliyah* to Israel with his wife in 1925.

Conditions were challenging. Three different armies had occupied the premises during the war; after the war, travelers used the vacant building as a *de facto* hostel while housewives "salvaged" large glass jars from the chemistry department to make pickles. When Arthur Blok arrived from England to serve as director in 1924, he found not only missing doors

*The original Technion building, now a science and technology museum*

but missing staircases. Roofs leaked. Classrooms had no furniture. Blok could find only one plumber in the whole country with the skill to set up a chemistry lab. Even the title of the school remained in flux.

### *How Technion Got Its Name*

Few universities have been named by poets and intellectuals. Technion is one. Initially, when German was still the front-running candidate for language of instruction, the working name was *Technikum*, the German term for a technical school. Later, the Zionist Congress proposed *Techniah*, a Hebrew version. The writer Ahad Ha'am suggested *Technicon*. Finally, the poet Chaim Nachman Bialik, widely regarded as the Hebrew language's greatest poet, suggested *Technion*. Bialik won. *Technion* it was, and is.

Faculty members – many of them new arrivals from Europe – faced the challenge of teaching students in a language they could not yet speak. One professor from Germany filled his lectures with scientific terms in Russian, thinking they were Hebrew. A chemistry professor from Kharkov had his lectures translated into Hebrew, which he then transcribed into Russian script and read phonetically to his students.

But interest in the new institute was intense – sometimes to a point of absurdity. The young Jews of Palestine were hungry for practical education. "Watchmakers wanted to study electricity, tinsmiths wished to learn stonecutting, and some people with no particular feeling about subject matter clamored to attend classes of any kind so long as they could hear lectures of some sort," Blok wrote.[11]

The new institute essentially forged the language for its studies. It created a committee on Hebrew technical terminology in 1924 that quickly developed lists of all the major words used in highway building and construction. Since the 1950s, Technion has housed Israel's Office for Technological Terminology, publishing 75 multilingual dictionaries

*The first Technion classroom*

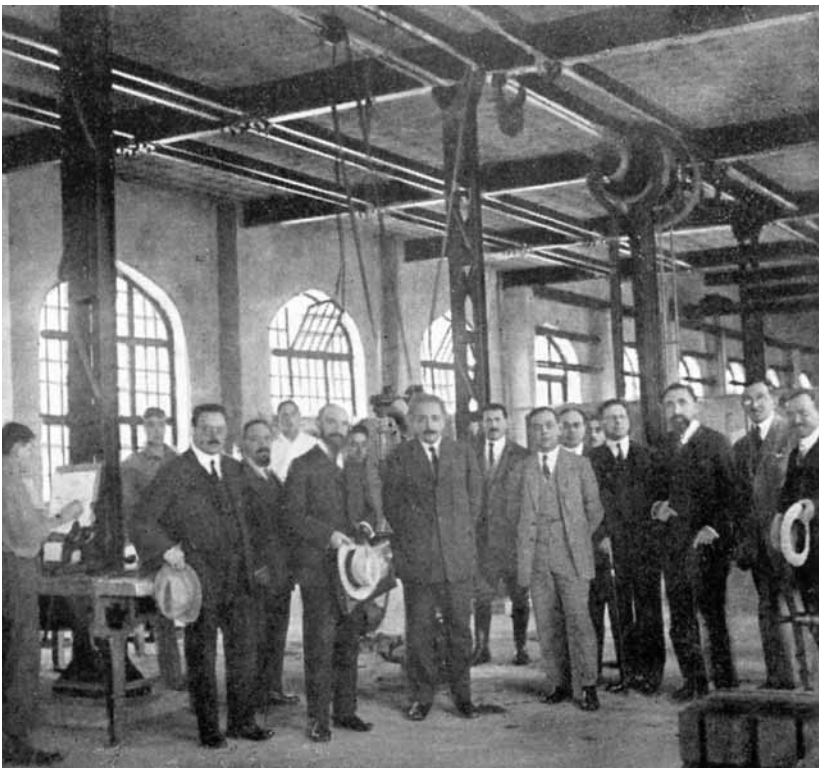
of science and technology, and managing a database of 100,000 Hebrew terms for fields such as chemistry, physics and computers.

The institute's work went beyond creating a language to creating the infrastructure of what is today the State of Israel. Technion's Building Materials Testing lab provided standards for construction as Jewish settlement expanded. Its field program provided technical help to kibbutzim and other agricultural villages. The hydraulics department conducted studies that helped launch aquaculture – fish ponds – as an Israeli industry.

The Great Depression hit Technion's finances as hard as it did everywhere else. Staff agreed to work without guaranteed pay: Some ended up working for as little as 25 percent of their previous salaries, while others went without pay altogether. "The big generous contributor is disappearing from a world reeling in economic crisis," lamented Director Shlomo Kaplansky after a frustrating fundraising trip to Europe in 1932.

But the institute still scraped together the resources to open its doors to Jewish scientists and scholars fleeing Nazi Germany. Albert Einstein,

who became president of the first Technion Society in 1924, helped raise funds to absorb émigré scholars. Technion launched a new department of industrial technology to train and employ the refugees. It offered classes in German to retrain engineers from various disciplines for construction-related engineering work, which was in perennial demand. Technion instructors also helped other white-collar Germans learn blue-collar skills so they could support themselves in their new country. One 1934 report noted that 13 university graduates, 26 merchants, nine officials, 20 unskilled laborers and 12 people with "miscellaneous" occupations had been transformed into 39 concrete mold and form workers, 22 iron workers, 10 carpenters, and nine plumbers.



*Albert Einstein (center), president of the first Technion Society, at Technion*

## *Einstein and Technion*

Albert Einstein may be history's most remarkable Jewish scientist. In a single amazing year, between June and November 1905, Einstein published four papers that changed the world – on the photoelectric effect, Brownian motion, special relativity and $E=mc^2$.

Technion's history is intimately bound up with that of Einstein.

In 1923, Einstein and his wife visited Technion and planted two cypress trees on its grounds. He heard a talk by Professor Aharon Tcherniavsky, a teacher at the Reali secondary school who opposed a movement to have Technion train only technicians, and insisted instead that it become a university to train engineers. Einstein recounted later in his diary how impressed he was with Tcherniavsky. In 1924 Einstein became the head of the German Committee for the Technical Institute in Haifa – the first of many Technion Societies around the world that have proven invaluable to the growth and success of the university.

In 1933, soon after Hitler came to power, Technion began negotiating with German-Jewish scientists and engineers who sought to emigrate. Funds were needed. Einstein wrote a supporting letter to the Central British Fund for German Jewry, saying, "this is a great opportunity for creating in Palestine an important center of Jewish technical science. …I appeal to your committee to [help] Technion …save for Palestine some of the best Jewish technical brains."

When the American Technion Society (ATS) was launched at a festive dinner in New York on May 8, 1940, Einstein was the keynote speaker. He called upon Jewish engineers, architects, scientists and industrialists to support Technion "with your advice and your funds." At the end of World War II, Einstein sent a message to the annual ATS dinner, noting that "Technion helped to bring victory by supplying the armed forces of the United Nations with technical trained personnel and modern research facilities."

A year earlier, in 1944, he stressed to ATS that "Technion… is indispensable for the rehabilitation of our people after the war."

When Israel's first president Chaim Weizmann died in November 1952, Prime Minister David Ben-Gurion offered the post to Einstein. Israel's ambassador to the United States, Abba Eban, explained that the offer "embodies the deepest respect the Jewish people can repose in any of its sons." But Einstein declined, writing that "he was deeply moved and at once saddened and ashamed" that he could not accept. One of the most brilliant scientists in history, Einstein said he could not assume the presidency because he did not have the abilities required for the position!

Einstein once said, "Israel can win the battle for survival only by developing expert knowledge in technology." For him, the well-being of Technion was intimately connected with the ability of the Jewish people to endure and to prevail.

*Prime Minister David Ben-Gurion, at the site of the new Technion campus*

Meanwhile, Technion's workshops supplied vital weapons and equipment for the Jewish self-defense fighters of the Haganah – everything from cartridge clips and gun parts to signaling keys for lamps and wireless radios. Through the 1930s and 1940s, almost every student at Technion played a role in clandestine military efforts. Students descended into the 100-meter well in the school's courtyard to test weapons out of hearing range of British authorities; they practiced firing pistols in a basement corridor where the sound would be drowned out by the clamor of industrial machinery.

During the 1948 War of Independence, Israeli fighters relied on "Ilioff cocktails" – mass-produced, hand-thrown bottle bombs invented by Technion's Professor Alexander Ilioff. This was just the start of a long, productive partnership between Technion and the Israeli Defense Forces that would provide the young state with everything from night vision goggles to an entire aerospace industry.

## Maturing into a University

The influx of German refugee scientists had helped propel Technion beyond its vocational roots into a respected academic institution. With establishment of the State of Israel in 1948, Technion embarked on decades of steady growth that included expansion into a true American- or European-style research university with graduate studies and a medical school. Although the government provided operational funding that kept tuition low, Technion relied on donors from abroad to build the laboratories, lecture halls and student facilities that made all the teaching and research possible. By the 1950s, its initial location in downtown Haifa was too small and the school moved to its current 300-acre campus in Neve Sha'anan, a Haifa neighborhood on the slopes of Mt. Carmel. Its original 1912 building is now home of MadaTech, the Israel National Museum of Science, Technology and Space. Its library – which had opened with 2,000 books in 1924 – mushroomed to 32,000 volumes by 1952, 80,000 in 1970, and about a million today. The tree-lined walkways

and gleaming white buildings of today's campus are a testament to decades of generous support from donors around the world.

### *Start Them Young: Technion's High School*

It is easy to forget that while talented Technion engineers and scientists create new products and services, they need skilled technicians to make them happen. Here, too, Technion Nation played a role. Bosmat (a Hebrew acronym for Vocational High School for Technicians) was the first technical high school in Palestine, founded by Technion in 1928. The mission of the new school was to create skilled workers for the burgeoning "Hebrew industry" and to prepare students for Technion studies. Specialties included architecture, chemical engineering, electricity, mechanical engineering, refrigeration and air conditioning, auto mechanics, radio and others. Initially, only boys were accepted. But in 1958 girls were admitted too, and they ultimately comprised up to a quarter of the student body.

A key role in founding Bosmat was played by legendary Technion Professor Franz Ollendorf, who emigrated to Israel in 1937. Ollendorf's vision was that a "Hebrew youth must encounter science at an early age." To this end, he worked tirelessly to establish vocational education. Ollendorf founded the Faculty of Electrical Engineering, and established electronics at Bosmat. He taught in the school, as well as at Technion, until 1975. "Bosmat is my home," he liked to say. Bosmat's 19,800 graduates could also be included in the ranks of Technion Nation. They include such distinguished

*Technion Professor Franz Ollendorf, founder of the Electrical Engineering Faculty*

figures as the late Yuli Ofer, a leading business magnate, and Eitan Wertheimer, chairman of Iscar, one of the largest toolmaking companies in the world, which was bought by Warren Buffet for $4 billion in 2006.

Technion's curriculum and program evolved as the nation's needs evolved. When Prime Minister David Ben-Gurion said the young country needed its own air defense industry, Technion created a department of aeronautical engineering (later renamed "aerospace"). "A high standard of living; a rich culture; spiritual, political and economic independence are not possible without aerial control," Ben-Gurion explained in his request to Technion in the early 1950s.[12]

Technion helped the Israeli Foreign Ministry reach out to potential overseas allies in the early 1960s with a program for students from developing nations. Technion students were recruited as the initial engineers for Israel's nuclear power industry in the 1950s and 60s.[13] And as Israel's population grew, Technion provided a model and standards for the science and engineering programs at other new universities being created around the country. When the University of the Negev (today Ben-Gurion University) opened in Beersheva in the late 1960s, Technion faculty helped teach the first postgraduate courses and supervised the first few years of the engineering program. "With the first graduating class at Ben-Gurion University, I signed their diplomas since they did not yet have accreditation," recalled former Technion president Amos Horev.

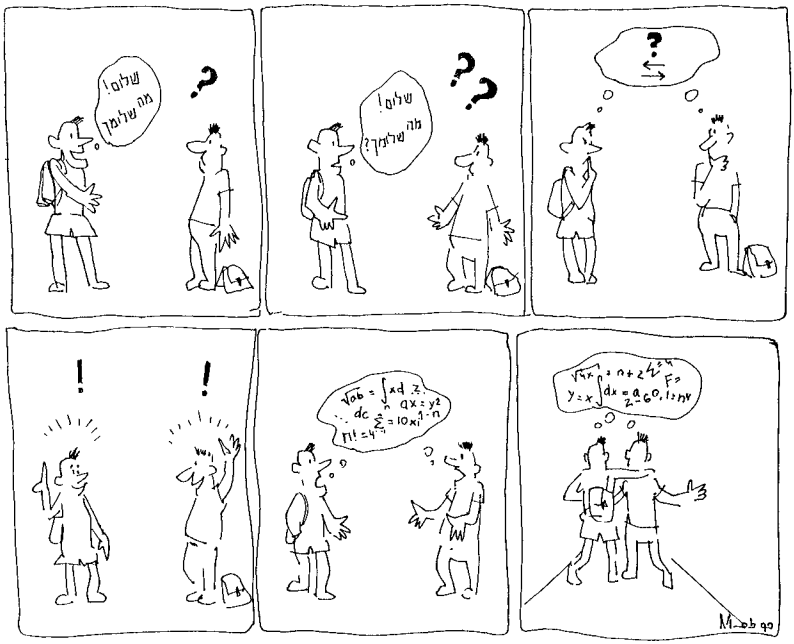
Technion created its computer science program in 1967, an era when a single computer still filled an entire room and people predicted that Israel would need at most 50 to 100 computer engineers. And later, when Israel became the eighth nation in the world to launch a satellite in 1988, nearly all the engineers involved were Technion graduates. Ten years later, Technion launched its own microsatellite – becoming one of just five universities in the world with a student-designed and constructed satellite.

## Absorbing Soviet Scientists and Winning Nobels

When Soviet communism collapsed in the early 1990s and Russian Jews suddenly were allowed to emigrate, Technion again played a lead role in absorbing a population of skilled refugees.

Some 11,000 scientists and 58,000 engineers were among the 800,000 Jews who arrived from the former Soviet Union. Technion expanded enrollment to accommodate 1,300 immigrant students – nearly all of whom needed remedial instruction in Hebrew and English. It also provided transitional employment for 260 immigrant scientists. Technion's Samuel Neaman Institute for Advanced Studies in Science and Technology published a series of textbooks on "Hebrew for Technicians and Scientists" that were used throughout the country to help integrate the new population.

"I was in New York meeting with the American Technion Society when it became clear there was going to be a large Russian immigration," recalled



*Math and physics bridge the language gap for new immigrants*

*Zehev Tadmor, former Technion President and Inventors' Hall of Fame member*

*Russian immigrants: Backbone of Technion space research*

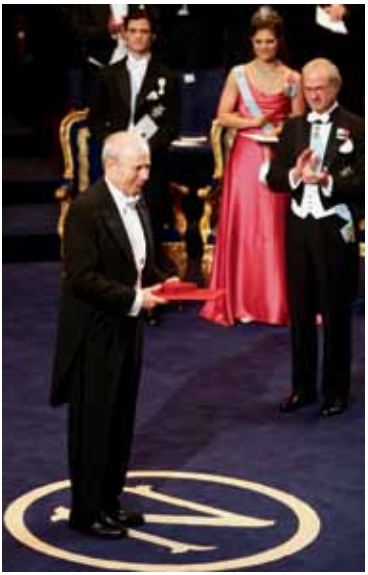
former Technion president Zehev Tadmor, now chairman of the Neaman Institute. "This was going to be a massive event, and we wanted Technion to be prepared. One of the issues was accommodations for all these new students. It has always been hard to raise money for dorms. But then Lenny Sherman (of ATS) got up and said, 'We are taking it on ourselves to build 1,200 units.' It was a huge number. But they offered donors the opportunity to pay for individual dorm rooms, and they sold like hotcakes."


*Leonard Sherman: Spearheaded building 1,200 dorm units*

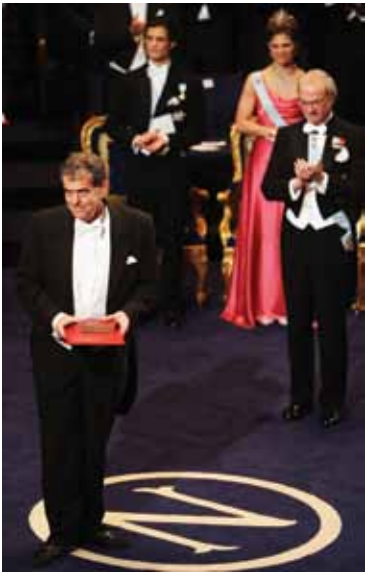
## *Technion's Urban Planning: Designing the Future*

Management guru Peter Drucker famously said that the best way to predict the future is to create it. With the massive wave of immigration from the former Soviet Union in the 1990s, Technion's urban planners in the Faculty of Architecture and Town Planning were enlisted to create Israel's future. Professor Adam Mazor led a massive research and planning project known as Israel 2020 that ultimately involved over 250 professionals, the top people in Israel's urban planning discipline, along with international experts. The project sought to outline economic, social and environmental guidelines for Israel's development in the 21st century and to identify key policy measures to implement this vision. The resulting document remains an important guide for all Israeli urban planners.

Through its second half-century, Technion intensified its commitment to scientific research, resulting in a string of path-breaking discoveries and two Nobel Prizes. In 2004, the Nobel Prize for chemistry went to Distinguished Professors Avram Hershko and Aaron Ciechanover for discovering ubiquitin, the mechanism responsible for disassembling protein in cells. In 2011, another Nobel Prize for chemistry went to Distinguished Professor Dan Shechtman for his discovery of quasicrystals.



*Nobel Laureate 2004 Prof. Avram Hershko*



*Nobel Laureate 2004 Prof. Aaron Ciechanover*

*Nobel Laureate 2011 Prof. Dan Shechtman*

## Two Paths to a Nobel Prize

The scientific breakthroughs behind Technion's two Nobel Prizes are very different. One involved crystals; the other, proteins.

But the paths that led to those breakthroughs were surprisingly parallel – both paved with perseverance and the willingness to pursue an unpopular line of thought.

Distinguished Professor Dan Shechtman was awarded the Nobel Prize in chemistry in 2011 for his discovery of quasicrystals, a type of matter that other scientists had concluded couldn't possibly exist.

Distinguished Professors Avram Hershko and Aaron Ciechanover won the chemistry Nobel in 2004, together with Professor Irwin Rose of the University of California, Irvine, for their discovery of the ubiquitin system for protein degradation – the process in which proteins inside a cell are selected for breakdown.

All three laureates spent years in the scientific wilderness – pursuing ideas that were tossed aside as impossible or irrelevant by leaders in their fields. Their achievements required not only insight, creativity and careful work, but a dogged determination to pursue one's own vision regardless of what "everyone else" is doing.

Shechtman's journey to the Nobel began as a visiting researcher in a Maryland laboratory in 1982, when he looked up from his microscope and said to himself, "There can be no such creature."

Shechtman had just seen evidence of a crystal with a rotational symmetry of five – symmetry that until then had been considered impossible. He followed up and eventually found this type of crystal in three different materials. But his colleagues were skeptical, to a point where the leader of his unit told him, "Dr. Shechtman, you are embarrassing the group and I have to ask you to transfer to another research group."

Upon his return to Technion, Shechtman found support from Professor Ilan Blech and eventually published his discovery. His paper caused an uproar: One leading authority charged that "Shechtman is talking nonsense… There are no such things as quasicrystals – there are only quasi-scientists."

Over time, Shechtman's discovery gained universal acceptance and sparked an entirely new field of study. Today, scientists can list hundreds of materials with the structure discovered by Shechtman; international conferences are held each year on the topic; 40 scientific books have been dedicated to the "impossible" kind of crystal he discovered.

For Hershko and Ciechanover, meanwhile, the path to a Nobel began in the early 1970s with the determination to answer an unpopular question. Nearly everyone in their field was trying to discover how cells grow and produce proteins; the process of protein breakdown was viewed as an uninteresting backwater. As if to symbolize that isolation, Hershko and Ciechanover spent a "temporary" 15 years working in an old two-story monastery building while the Technion medical school campus was under construction. A colleague from Jerusalem visited at one point and scolded Hershko that he "should not have most of (his) laboratory working on a hopeless subject."

Hershko wasn't fazed. "Isolation may at times lead to creativity, since one is not bothered by what others are doing and does not feel compelled to work on currently popular, 'fashionable' subjects," he wrote in his biography for the Nobel committee.

Hershko, Ciechanover and Rose ultimately showed that protein degradation is not random but takes place through a controlled process in which certain proteins are marked by a molecule called ubiquitin – a molecular "kiss of death."

Their work shed light on the causes of diseases such as cervical cancer and cystic fibrosis. It has already led to the development of an anti-cancer drug, Velcade, for use against multiple myeloma.

Hershko spent his career in basic research, not in developing applications such as drugs. But he recently saw the life-saving results of his efforts firsthand, after an 80-year-old friend from the U.S. visited him in Israel. Hershko showed him around during a relaxing two weeks. Then the friend returned home, fell ill, received a diagnosis of Stage 3 myeloma – and was treated with the drug that came out of Hershko's research.

"Stage 3 myeloma used to have a 20 percent survival rate," Hershko

said. "But he was treated with Velcade. He's now been in remission for a year and the doctors are giving him another five to seven years."

What has Hershko learned about scientific research from his decades of work? His answer might come just as easily from the mouth of Dan Shechtman.

"My advice to young people is to take a problem you believe is important, but that isn't in the mainstream – otherwise the big players will get to it before you," Hershko said. "Be very patient. Be persistent. Be lucky. Grab your luck and recognize your luck. Too many experiments get unexpected luck, and then tend to get thrown out."

Today scores of other faculty members are patiently, determinedly carrying out the research that could lead to more Nobel Prizes in future decades.

Take Hossam Haick, the chemical engineer who is developing the artificial "nose" to sniff out cancer from people's breath. Other scientists, including Nobel laureate Linus Pauling, had tried for years, unsuccessfully, to use breath as a way to diagnose illness. But Haick had the benefit of modern nanotechnology – a focus of Technion's Russell Berrie Nanotechnology Institute, which was created in 2005 – as well as computerized pattern recognition. He also had a personal affinity for bringing together different disciplines, an approach that would be difficult at some universities but that is encouraged at Technion.

Haick's research draws on so many different fields – biology, computer science, chemistry, engineering and more – that at first no one on his team could understand anyone else. "I would talk in the language of nanotechnology, and the people in mechanical engineering wouldn't understand what I was saying," he recalled. "It took two years to establish a common language. Once you bring together all these multidisciplinary subjects, you generate your own field."

The Russell Berrie Nanotechnology Institute, where Haick is affiliated, is just one of many cutting-edge programs that Technion has developed in recent years to respond to the changing, increasingly connected worlds of science and engineering. The Lokey Center for Life Sciences and

Engineering, launched in 2006, takes a multidisciplinary approach to developing new drugs and medical technologies. The Grand Technion Energy Program, created in 2007 and endowed by donors Nancy and Stephen Grand in 2010, brings together scholars from nine different faculties to work on alternative fuels, renewable energy, and energy storage and conservation.

## Technion in Defense of Israel

As Technion expanded its undergraduate enrollment and its research capabilities, it did not neglect Israel's defense research needs. Six of Technion's eight presidents held senior roles at some point in the Israel Defense Forces. Engineers and scientists constantly moved back and forth between Technion faculty and Rafael, the defense technology company established by the Israeli military.

Amos Horev had studied briefly at Technion in the 1940s before becoming a Palmach platoon commander under Yitzhak Rabin. After the 1948 war, Ben-Gurion sent him to study at MIT and he returned to set up a weapons development unit for the army. "I looked for engineers, and who were the first engineers I brought in? War of Independence veterans who had gone to study at Technion," said Horev, who later became chief scientist for the Israeli army as well as president of Technion.

Technion's creation of an aerospace engineering department in the 1950s at first brought ridicule. A cartoon from *Haaretz* sneered, "What do they think they are going to fly on top of the Carmel – kites?" But the department went on to provide the brainpower behind Israel's now-renowned military and civilian aircraft, missiles and satellites.

It was a defense contracting firm founded and largely staffed by Technion graduates – Elron Electronic Industries – that stepped in to fill the gap when French president Charles DeGaulle levied an arms embargo on Israel after the 1967 Six Day War. And it was Technion Microelectronics Institute that in the early 1970s laid the groundwork for Israel's advanced role in missile technology.

*"Iron Dome" anti-missile missile*

"In 1973 when Rafael started to get involved in air-to-air missiles, the most important element was the sensing device," Horev said. "Rafael turned to Technion because Technion had started to get into microelectronics…. Professor Yitzhak Kidron took it on himself. In a matter of two years, he came up with an infrared detector for missiles. You can't imagine how important it was to build our capability in that area."

Professor Kidron's legacy today is being carried on by hundreds of Technion graduates like Inbal Kreiss, who is overseeing development of the Arrow 3 missile for Israel Aerospace Industries (IAI). Israel is the only country in the world that sells missile technology to the United States – because of the work done by Kreiss and her colleagues.

IAI's missile work requires incredible precision in sensors and targeting. Missile-to-missile defense is like a Wild West gunfighter trying to hit a bullet with another bullet – only at higher speeds and much higher altitudes. And the organization's goal is nothing less than "hermetic defense" – meaning, enough layers of protection so that not a single missile will reach Israel's population. The difference between success and catastrophe can be counted in microseconds.

So Kreiss leads a high-pressure operation. "A few of my engineers run marathons. When they come back, I tell them they must run faster," she says, only half-joking.

Kreiss says her guiding principle is "to be first, to be excellent." And

*Prof. Yitzhak Kidron, microelectronics pioneer*

she learned it from Professor Yeshayahu Talmon at Technion. "Professor Talmon taught me to do things much better than everyone else – to be first, to be better," she says. "Technion has a very special atmosphere. You know the stories comparing it to a prisoner on top of a mountain? Once you get in, you do not get out for four years. You are studying, studying for four years with no breaks."

Kreiss' staff includes so many Technion engineers that they joke to each other, "You didn't leave the faculty yet." And that special Technion atmosphere – determination, refusing to settle for less than excellence – infuses her unit.

"How many countries in the world are doing what we are doing – launching satellites, developing exo-atmospheric defense?" she asks. "You can count them on one hand, and Israel is one of them. The answer to how we do it is here – the people, crazy people, with dedication and devotion to their mission. This is a story of crazy people who believe they can do something no one has done before."

## Seeding the "Economic Miracle"

The longstanding basic research on defense technology by Technion faculty and graduates contributed to the development of a vibrant Israeli high-tech industry.

"The huge investment in defense in Israel for 50 or 60 years matured and started to spill over into the civilian sector," Zehev Tadmor said. "The defense sector had created an infrastructure of companies that provided technology to the Ministry of Defense, which was useful for moving ahead with high-technology in Israel."

By the 1980s, Technion had produced thousands of graduates with world-class skills in electrical engineering. Many of these graduates had worked in advanced communications units during their military service, and some also had experience working at defense technology firms.

Top technology companies like Intel and Applied Materials began looking to Israel for sharp young engineering talent. A number of them opened research facilities in Haifa for easy access to the Technion community.

Dan Vilenski, who received his bachelor's and master's degrees in mechanical engineering from Technion, recalls meeting in California with executives from the semiconductor equipment firm KLA Instruments in the mid-1980s to discuss a possible Israel subsidiary.


*Dan Vilenski, pioneer entrepreneur*

"They were talking about bombings and so on, how it was too risky," said Vilenski. "Then, as soon as they finished the sentence, there was an earthquake and everyone went under the table. I said. 'Listen, I'm not sure I want to work with you – it's too dangerous from earthquakes here in California.'"

KLA ultimately did open an Israeli division that produced about $400 million worth of exports. And the reason they came was the skilled technical workforce. "It was people, people, people," said Vilenski, who managed KLA's Israel division and later was chairman of Applied Materials Israel. "Talking about the holy land didn't help. And at that point the infrastructure was not that advanced. But I told them about the people, and about converting military technology to civilian uses."

The Soviet immigration of the 1990s further strengthened Israel's budding technology sector. Young engineers from Technion and other Israeli universities caught the excitement of the Internet and began starting their own companies. Meanwhile, the Israeli government took steps to foster a local venture capital industry. The world started moving toward a single global marketplace in the aftermath of Soviet communism's demise. And the Oslo peace accords defused old anti-Israel boycotts, opening that new world marketplace to Israeli exports.

It all came together to create a new stage in Israeli history that some have labeled the "Israeli economic miracle" and others have dubbed "startup nation."

And Technion was at the center of it.

## Interlude: A Day in the Life of Ordinary Citizen (O.C.)

With sounds of life finally filtering out of his kids' rooms, O.C. heads to the kitchen where his wife has made them both toast and coffee. She sits across from him and takes the daily medication that keeps the symptoms of her early-stage Parkinson's disease in check.

> *Rasagiline (Azilect) is a leading drug for treating early-stage Parkinson's, developed by Technion Professors Moussa Youdim and John Finberg, and marketed by a branch of Israel's Teva Pharmaceuticals. Driven to study biochemistry by his father's depressive illness, Youdim spent 30 years developing what has become a standard treatment for Parkinson's, which affects 1-2 percent of all adults over age 65. Teva today sells more than $300 million worth of Azilect each year, and analysts say the potential market for the drug could be $1 billion or more.*

O.C. promises to pick up some groceries on his way home that night, kisses his wife goodbye, and heads off to work. O.C. is handy with home improvements, and as he backs out of the driveway, he looks with pride at the solar panel he recently installed on the roof. It's a cloudy morning, and he wonders if there will be enough hot water to provide showers for six teenage girls at his daughter's upcoming slumber party.

> *Technion chemistry professor Efrat Lifshitz is using nanotechnology to greatly improve photovoltaic cells. She discovered that nano material – consisting of nanocrystal quantum "dots" – can absorb infrared and ultraviolet light as well as visible light. Photovoltaic cells based on Lifshitz's technology will be far more effective than conventional solar panels like O.C.'s since they can absorb a larger range of the sun's energy. Her work is part of a large interdisciplinary program, Grand Technion Energy Program, which seeks to reduce global dependence on fossil fuels.*

O.C. listens to the radio on his commute, mildly intrigued by a report

about an Israeli electric car company that is rolling out a nationwide network of battery-swapping stations so it will be as easy to refuel an electric car as a gas one.

He doesn't realize that his own city – mid-sized but trying hard to be green – is engaged in its own innovative experiment to produce energy from traffic. As O.C. drives down the highway, the pressure of his wheels on the road is actually generating a small amount of electricity.

> *When certain solid materials are squeezed, the mechanical strain produces a kind of electricity called piezo-electricity, from the Greek word "piezo" or "squeeze." A Technion-affiliated startup called Innowattech has found a way to place piezo-electric generators under roads, railways and airport runways. Although it's still in the trial stage, this technology may be able to generate up to 100 kilowatts of energy from a single half-mile of highway – enough to power 40 houses. And that Israeli electric car company? O.C.'s radio show didn't mention this, but Better Place also has a Technion connection – through its founder and CEO, Technion alumnus Shai Agassi.*

O.C. pulls into the parking lot, grabs his attaché case and heads into the office.

He has back-to-back meetings all morning. Somehow, between all those meetings, he will have to figure out how to get some work done.


*Better Place: Running cars without gasoline*

Chapter Three:

# A Startup Nation Built on Technion Innovation

The Tel Aviv showroom of Better Place electric cars glows in the dusk as neon lights highlight the curved lines of its site in a former oil-company water tank. Inside, glossy sedans nuzzle up to electricity "pumps," and two life-size holographic images of company founder Shai Agassi greet visitors in a small theater.

*Left to right: Reuven Agassi, Better Place founder Shai Agassi, and Technion President Peretz Lavie*

It all feels like a sleek space colony from the future. And in some ways, Better Place is truly a vision from the future – a company built around plug-in electric cars and a national network of roadside service stations to swiftly swap their batteries.

More than any other "cleantech" startup of the 2000s, Better Place grabbed international headlines while raising capital and gearing up to launch its first cars and battery stations in 2012. Its vision was dramatic and audacious – skipping hybrid vehicles and going directly to all-electric plug-ins, while solving the problem of battery life by creating an entirely new infrastructure to replace drained batteries with fresh ones in the amount of time needed to fill up a gas tank today. The company was not merely creating a new kind of car; it aimed to reinvent an entire industry and business model.

Would Better Place succeed as it rolled out its first battery-swap networks in Israel and Denmark? Or would the company fall on its face, scattering to the winds the $2.25 billion it had raised from venture capitalists? The high-tech, environmental and automotive worlds were all watching.

And much of their attention was focused on Agassi, Better Place's charismatic CEO – and a graduate of Technion.

"The biggest advantage of my Technion education was the ability to pick a new topic, study it thoroughly, and analyze it," said Agassi, 44. "I learned problem-solving, a way of getting to the crux of what will be the solution. With Better Place, that meant getting from the problem of charging cars to the solution of switching batteries."

* * * * *

Better Place may be unique in its high profile and massive venture capital backing, but it is far from the only ambitious, innovative Israeli startup. There are more firms from Israel listed on the tech-heavy NASDAQ stock exchange than from France, Germany and the U.K. put together.[14] Israel has the highest density of startup companies in the world – 3,850 high-tech startups, or one for every 1,844 Israelis.[15] It's fourth in the world when it comes to the number of international patents filed per capita.

If ancient Israel was described as a "light unto the nations," modern Israel might be described as a LED (light emitting diode) unto the international economy – using high-tech innovation to shine far more brightly than its small size would warrant.

"Israel leads the world in terms of per capita venture capital investment, and is second only to the U.S. in terms of number of startups," wrote Dan Yachin and Oren Raviv, analysts for International Data Corporation, a global technology intelligence firm.[16]

How did such a small country with limited natural resources become a global powerhouse in technological innovation?

In their 2009 book *Startup Nation: The Story of Israel's Economic Miracle*, Dan Senor and Saul Singer answered that question by pointing to the Israeli mindset. "It is a story not just of talent but of tenacity," they wrote, "of insatiable questioning of authority, of determined informality, combined with a unique attitude toward failure, teamwork, mission, risk and cross-disciplinary creativity."[17] Senor and Singer also highlighted some of the institutional factors behind Israel's tech explosion, from the highly skilled technical units within the Israeli military to the immigration of Soviet engineers and computer scientists in the 1990s.

Those points are all on target. But there's another big institutional reason for Israel's plethora of startups – Technion.

As Israel's first and most prominent engineering school, Technion has played a key role in Israel's startup explosion. Technion faculty members were responsible for some of the basic research on which the past two decades of technology startups have been built, not just in Israel but around the world. For instance, Professors Abraham Lempel and Jacob Ziv developed an algorithm in the 1970s that became the first widely used data compression method on computers – paving the way for our ability to send large amounts of data over the Internet. Without their work, we might not have effective computer modems, graphics files like GIF and PDF, or even the Internet itself. "If there were a Nobel Prize for communications, Lempel-Ziv would have received it for sure," said Amos Horev, the former Technion president.

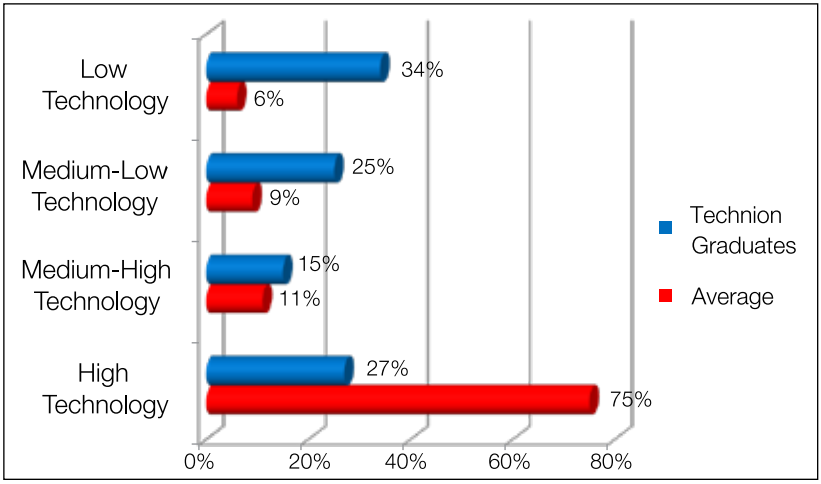
Technion has also provided logistical support for startups through Dimotech, a holding company that helps connect commercially viable research with investors, and through the Technion Seed business incubator.

But by far the university's greatest contribution to Israeli innovation has been its graduates – the highly skilled technical professionals who are the most important building block of a successful knowledge-based economy.

*Retalix. Jacada. Orckit. Cimatron. Pluristem Therapeutics. Mellanox Technologies. EZ Chip Semiconductor…* These are just a few of the 49 NASDAQ companies started or run by Technion graduates (see Appendix). In fact, two-thirds of the Israeli companies on NASDAQ in 2010 had Technion alumni as founders or senior managers.

When we conducted our survey of Technion alumni, we discovered that almost three-quarters of Technion graduates who work in industry are working in high-tech business sectors. Technion alumni are also 13 times more likely than the average Israeli to be working in research and development.

**Sectors of Employment for Technion Graduates and Average Israelis, by Technological Intensity**




*Source: 2010 survey of Technion graduates by Amnon Frenkel and Shlomo Maital.*

Seventeen percent of Technion graduates are working in high-tech startups – three times the general Israeli rate. And that figure is even higher, 20 percent, for those who have graduated within the last 20 years.

## Using New Technologies to Do Old Things More Efficiently

Ofer Vilenski is one such graduate – a serial entrepreneur currently deep into his second startup despite efforts to "retire" after his first success.

Vilenski enrolled in Technion's computer science program after completing service as an Air Force pilot. He had an entrepreneurial bent even as an undergraduate, taking the discovery that he could build a bed for 100 shekels instead of buying one for 800, and turning that into a business selling futons to other students.

"High-tech is about doing the same thing that people have been doing for thousands of years in a new way – more efficiently," Vilenski said. "How do you exploit new technologies to do old things more efficiently?"

After graduating in 1996, Vilenski worked for Check Point Software Technologies, one of the first Israeli software firms to be listed on an American stock exchange. Then he and a partner launched Jungo, a company providing software for broadband Internet to the home. They built Jungo up to 170 employees before selling it to NDS, a subsidiary of Rupert Murdoch's News Corp., for $107 million in 2006.

Vilenski swore he would never work another day in his life. But then, he recalled, "we had this really good idea that with different software you can get Internet 50 times faster than what we have today, without changing the hardware."

Vilenski was back in business – although now back to just 10 employees and the requisite office dog. "We keep him here just to show the V.C.s (venture capitalists)," he joked from the Netanya office of Hola!, his current startup.

### *Technion & Kitchen University*

Technion is indeed a great university. But often it combines with another, unrecognized university known as "kitchen university." And the combination is exceedingly powerful.

Take technology executive and Technion alumnus Dan Vilenski. Vilenski and his wife Judith, a nurse, have five children. All five have started businesses. And while only one child is a Technion graduate, all five have graduated from Vilenski's "kitchen university."

Kitchen university, at the Vilenski's home in Haifa, has two simple rules. First, enrollment is one-on-one. In other words, the entire family does not gather collectively to manage the affairs of one of its members. Instead, a Vilenski child meets with father Dan in the kitchen to discuss a key issue.

The second rule is, father Dan does not offer advice unsolicited. Dan may have been chairman of Applied Materials Israel, but the meeting at kitchen university has to be requested by one of the Vilenski children.

We have already mentioned son Ofer, who sold his startup Jungo and is now working on a new one, Hola. Daughter Sigal owns and runs a graphic design firm, Strudel Design, that creates highly unusual, striking logos for companies. Sigal purposely limits the intensity of her business activities, so that she can be available to pick up her children from day care and kindergarten in the afternoon. Another daughter Yael runs a business called Ooga-Ooga! that sells cake art. (*Ooga* means "cake" in Hebrew.) Daughter Irit's Inside Out Studio does interior design, mainly for coffee shops. And daughter Noa is a fashion designer.

There are a great many kitchen universities all over Israel. The generation of entrepreneurs from the 1980s and 1990s had children, and their children are now starting businesses of their own, benefiting from their own versions of kitchen university.

Better Place's Shai Agassi, for instance, doubtless had the benefit of his father Reuven's kitchen advice. Both father and son are Technion graduates.

Shai Agassi of Better Place is another of those young alumni entrepreneurs. The son of Iraqi immigrants, Agassi describes himself as "a computer geek from a very young age." He started programming at age seven and quickly decided he wanted to build software for a living. At 15, Technion gave him the opportunity to enroll early. Agassi attended one semester on an unofficial basis to see if it would work out, and when it did, he joined the rest of his class as a regular – albeit younger – computer science student. (His skill in software would later prove invaluable, when he solved complex problems related to the Better Place batteries with clever software.)

After graduating in 1986, Agassi started several software firms, including two that were acquired for more than $400 million by the global giant SAP. At SAP, Agassi oversaw the company's overall technology strategy and execution, sat on the executive board, and was being groomed to become the firm's next CEO. He grew his division from 20 to 800 people – including a high number of Technion grads. "I wasn't being prejudiced or biased, they were just great people," he recalled. "Engineering discipline was embedded in them."

Then, in 2005, Agassi attended a meeting of an elite group of young executives and political leaders where attendees were challenged to "make the world a better place" by 2020. Agassi was assigned to climate change, where he started looking for ways to make more than an incremental difference.

He came up with the idea of electric cars for the masses – not hybrids like the Toyota Prius, not ultra-expensive roadsters like the Tesla, but cars that could be used by everyday families. The challenge that had stymied all previous efforts was battery life: batteries are heavy and expensive, typically run out after about 70 to 100 miles, and take hours to recharge. So Agassi came up with a new business model where electric car owners would

essentially buy a battery-service plan, which would allow them to swap drained batteries for fresh ones at a network of battery-changing stations. Agassi asked an audacious question (in Hebrew, audacity is *Chutzpah*, a far juicier word): "How can we make cars that run without any gasoline at all?" Now he is well on his way to supplying a practical answer.

Will Better Place succeed? It's too soon to say. But if it does, Agassi will have solved a technical problem that stymied the best minds of Detroit, created an entirely new industry with the potential for thousands of jobs, and dramatically reduced the world's dependence on oil.

"Electric vehicles are software-driven vehicles," Alan Salzman, Agassi's main American investor, told the *New York Times* in 2009. "You need a software-industry guy (like Agassi)…. He's the Steve Jobs of clean energy." [18]

## A Startup to Help People Walk

Just as Agassi created a startup to solve a global-scale problem, Technion graduate Dr. Amit Goffer created one to solve an individual-scale problem.

Goffer had worked for Elscint, a medical imaging business, and later started a company to provide real-time MRI (magnetic resonance imaging) images for brain surgery. But after a terrible ATV accident left him paralyzed and dependent on a wheelchair, he, like Agassi before him, asked an audacious question: "*How can I create a device that enables people who cannot walk, to walk by themselves?"*

Goffer came up with a concept, built a prototype himself, and later launched a startup called Argo Medical Technologies to produce it. The ReWalk is an exo-skeleton (outside-the-body skeleton) that uses electronics to allow paraplegics to stand on their own feet and walk at a normal pace of two kilometers per hour – even to climb stairs. It has potential both as a "walker" and as a rehabilitation device to help patients recover from strokes or injuries.

We saw a demonstration of the ReWalk at Argo's office in a small industrial park in Yokneam, outside Haifa. Attached to a disabled person's

*ReWalk lets paraplegics stand – and walk*

legs, it uses an electronic sensor on the user's wrist to move each leg forward when the user leans forward. Its battery power is carried in a small backpack, and it makes an unobtrusive whirring noise. The ReWalk integrates software, electronics, physics, mechanical engineering and ergonomics – requiring state-of-the-art technology and knowledge in all those fields. Goffer himself cannot use the device, as he is quadriplegic. But he estimates that 500,000 of the two million wheelchair users in the United States could benefit from the ReWalk. With venture funding and 15 employees, he has started marketing the device both in Europe and the U.S., where it is in use in a Philadelphia rehabilitation center and a New York Veterans Administration hospital.

"The number one benefit of ReWalk will be on users' self-esteem," Goffer told us. "ReWalk users will no longer be seen as disabled but as 'just another guy on crutches.' It can improve their quality of life, health, acceptance by society, and ability to return to work."

## Basic Science, Interdisciplinary Thinking

What is it that innovators like Goffer, Vilenski and Agassi got from Technion?

Today the university encourages a startup mentality: Nobel Prize-winning materials scientist Professor Dan Shechtman teaches a wildly popular class that brings entrepreneurs onto campus to share case studies from their own real-world experience. But that wasn't the case 25 years ago, when Shechtman launched his entrepreneurship course. Instead, the common denominator across generations has been a way of thinking and approaching problems.

### *Nobelist Inspires Entrepreneurs*

Nobel Laureate Dan Shechtman is widely known for his scientific breakthrough involving the discovery of quasicrystals. He is less well known, however, for another important achievement. Shechtman is an entrepreneur with deep involvement in several startups, some of them seeking to commercialize his research on "Shechtmanite". And he is also deeply committed to inspiring and creating Technion entrepreneurs.

In 1987 Shechtman joined with Shlomo Maital, one of the co-authors of this book, to launch a General Studies course at Technion called "Technological Entrepreneurship." The core idea of the 14-week-long course was to have entrepreneurs tell their stories – their failures as well as successes. We wanted to inspire Technion students to launch startups by showing them that ordinary people do extraordinary things with new technology-driven products and businesses, Shechtman recounts.

The course requirement was simple. Participants had to attend each week's lecture and write a short summary of the week's talk and what they learned from it. Each year for a quarter of a century, hundreds of students enrolled and filled the auditorium.

> In total, thousands of Technion students have heard the gripping tales of startup veterans, and many have been inspired by them to follow in their footsteps. They come from not only electrical engineering and computer science, but from each of the university's 18 faculties and departments. A few have returned as entrepreneurs to share their experiences with new generations of Technion engineers. Today the course continues. It is now assisted by technology, each lecture is videotaped and made available online, with the aid of facilities of Technion's Carasso Video Studio. [19]

The alumni entrepreneurs we interviewed spoke of the university's emphasis on basic science, its willingness to bridge disciplines, and its efforts to teach students to solve real, unexpected challenges. "They didn't want you to just regurgitate material, but think about it for real," said Ofer Vilenski.

Shai Agassi, meanwhile, praised the basic science he learned at Technion.

"Everybody who has been through Technion knows you spend the first year getting a lot of general background, things you think you'll never use," Agassi said. "But my broad base in science ended up being tremendously useful as I shifted from the world of software to electric cars…. Methodical problem solving is ingrained in every student, and you lean on that method as you go through your career. I am still able to use it, 20 years down the line."

Eli Pasternak, who got his bachelor's degree in electrical engineering from Technion in 1973 and his master's in 1976, agreed that the basic science he learned there has proved invaluable in his career as an innovator and entrepreneur.

"Technion taught me the methodology of how to approach engineering problems – go deep into the basic science and physics behind the problem," Pasternak said. "The focus is on the fundamentals rather than on learning techniques and procedures."

Pasternak is chief technology officer and senior vice president at BridgeWave, a 100-person wireless communications company in Silicon Valley that he co-founded in 1999 with another Technion grad, Amir Makleff.

Pasternak's love of engineering began as a radio hobbyist at age 12, and he deliberately chose to stay on the technical side of his company rather than move into finance and administration. "When there is a technical problem, I become obsessed with it, but happily obsessed," he said. "It's like a game to me."

The lobby at BridgeWave is lined with a dozen plaques showing patents in Pasternak's name – just some of the 20 patents he has registered. Our survey found that 58 percent of Technion alumni are, like Pasternak, working in some kind of innovative development – 49 percent of them developing new products, 12.6 percent improving business processes, and 7.6 percent creating new business models. (There is overlap in those figures since some were developing new products, processes, *and* models.)

We also found that one out of every four Technion graduates has filed or registered a patent – a number that is particularly striking when you consider that some graduates work in professions such as urban planning, architecture and medicine that don't typically file patents.

Multiple filers like Pasternak were common. Among those graduates with patents, the average number registered was five. Ofer Vilenski is working on a project that involves *70* patents. "Everything around here is extreme," he said with a smile.

* * * * *

Along with its focus on the fundamentals, Technion wins praise from alumni entrepreneurs for its encouragement of interdisciplinary thinking.

Shai Agassi said Technion's interdisciplinary training was critical when he turned his attention to creating energy-saving cars – drawing on biology to consider biofuels, then physics to learn about batteries, and finally systems integration to create a new business model. Eli Pasternak

made the same point on a smaller scale, recalling a time in the 1980s when he was a young engineer with small children and invented a machine to print images on cakes.

With a budget of $150, Pasternak used a record turntable, a video camera and a 50-cent photo transistor to create a workable cake printer. But he discovered that chocolate was too brittle: Chocolate frosting would crack under the pressure of printing.

"So I had to invent a new chocolate. That was food engineering!" Pasternak said. "I got some books and read about it. I remembered at Technion, they taught me the strength of materials, how when you build with concrete, you reinforce it with steel. That's civil engineering! And they bothered to teach me that even though I am an electrical engineer."

Pasternak ended up blending marshmallow into the chocolate, to serve as the steel inside his concrete. After three months, he succeeded.

"Technion teaches a multidisciplinary approach, and real life problems are always multidisciplinary," Pasternak said. "In other places, people become experts in a 'field.' But you have to solve the problem that needs to be solved, rather than problem you were trained to solve."

## Inventing Business Models, Not Just Products

Say the words "creativity" or "innovation." What springs to mind? Generally, it's a novel product. But management guru Gary Hamel argues persuasively that the greatest innovations are those that create new ways to do business, such as Dell Computer's "direct-sale-to-the-customer" model for selling computers. Technion electrical engineering graduate Yehuda Zisapel created just such a new model with his brother Zohar when they founded the RAD Group, a leading cluster of high-tech companies with annual revenues of about $1 billion, employing some 4,000 workers. The magazine *Business 2.0* calls the group "the world's most successful incubator" of telecom-related startups.

Zisapel started his entrepreneurial career in the mid-1970s with a small company, Bynet, that eventually became Israel's leading systems

*Leading entrepreneurs Yehuda (left) and Zohar (right) Zisapel, with President Peres (center)*

integrator and spawned eight other companies. At the time, there was no Israeli high-tech industry and no Israeli venture capital. Electronic components were typically purchased from abroad.

Nonetheless the Zisapel brothers decided in 1981 to launch an export-driven company, RAD Data Communications, to manufacture the kinds of devices, such as modems, that Bynet had been buying and distributing. Yehuda Zisapel told us that his explicit goal at the time was to start not a company, but an industry. RAD's modem was revolutionary. While other modems of that era were the size of pizza boxes, the RAD modem could fit in the palm of one hand. It didn't need an independent power source, operating from power flowing through the phone line. RAD was profitable within two years. By 1987 it reached $10 million in annual sales and by 1996 was at $100 million.

RAD's most successful creation, though, was not its modems but a string of successful new startups that it spun off. Altogether, RAD has generated an amazing total of 88 companies and funds. A chart on the wall of Zisapel's office shows RAD and its offspring as a cloudlike swarm of

companies, with RAD at the center, hundreds of lines linking the various companies, and different colors representing different generations of entrepreneurs.

*The RAD Ecosystem*

Bynet, Rad BioMed Incubator, Radguard, RUN, Jetworking, Radway, Ceragon, Infogate, Radwin, Avissair, Sanrad, Sneh & Co, RND, RadLan, RadView, Radnet, RadVision, RadWiz, Sequoia Capital, RadLinx, RadWare, NICE, Genesis Partners, DiskSites, Tissera, Crescendo, Nexus, Spearhead, Nexus Global Partners, Riverhead Bitband, Mercado, Poalim Ventures, Ad4ever, QoS, Go Networks, Jerusalem Venture Partners, PowerDsine, Celltick Software, Mobile Economy, NextNine, MaxPO Home Networks, TeraChip, Walden Israel, MobileAccess Networks, CellGuide, Ezchip, Ozicom, Gemini Israel, Venture FCivcom, Partech Int., Niragongo, cVidya, NUR Macroprinters, Mobile tornado, Arel Communications, Bamboo Media, InfoCyclone, XaCCT Technologies, Voltaire, Utopy, Viola Networks, Star Ventures, TechnoPlus, LocatioNet, Broadlight, Red Bend, Volovelsky, G-Connect, Go-Net Channels, Oblicore, Babylon, Comsys, SeRIOA Networks, Zend Technologies, TeraSync, Runcom Technologies, Legra Systems, Pitango Venture Capital, Paragon Communications, Wanway, Novanet Semiconductors, Sheer Networks, Breezecom, Allot, Alvarion, Unwired Express

The Zisapels developed a distinctive model for launching new businesses. They choose an industry niche, identify an unmet need, and hire a CEO to create a business plan and start R&D. Each company they create has the flexibility of being an independent entity, yet can tap into the markets and resources of other RAD companies.

One example is Radvision, a seller of Voice Over Internet Protocol (VOIP) gear. Zisapel spotted a burgeoning market for videoconferencing

products. He assigned one of his video experts, Eli Doron, to find unmet needs in this market. He raised $8 million from outside investors and took Radvision to market in 1993. Today it is listed on the NASDAQ exchange with a market value of $146 million.

"We were self-financed," Zisapel told us proudly, "with no venture funding back then and with no bank money. Our companies network with one another and help each other. But each RAD company has a different personality. We find a need. We find a CEO. And we start a company."

Zisapel credits his Technion training with helping develop the ambition, flexibility and independent thinking necessary to create 88 companies and a new business model.

"All the time [at Technion] there are challenges," Zisapel said. "You can study and do exercises and write all the lectures very nicely, but then in the exam, you are given one or two questions you didn't learn about and you have to solve. It's a way to solve for the unexpected. They are teaching you to face challenges in unexpected situations. They are teaching you the capability of self-learning. And all the time, there is a drive for excellence."

* * * * *

Yehuda Zisapel is an example of how Technion engineers don't just furnish the innovative workforce for Israel's technology startups – they also provide a lot of the business leadership.

Our survey found that 23 percent of Technion graduates founded new companies, many of which were in high-tech. Twenty-four percent of Technion alumni at startups are the CEO, while 15 percent are vice presidents and another 13 percent fill the critical role of managing research and development. Technion in essence serves as a kind of startup "manufacturer" – taking raw technical talent and passion, honing and developing it with rigorous training, and sending it out into the world, where graduates turn new ideas into new businesses.

High-tech startups are important to a country's economy as seeds of future growth in jobs and income. They attract overseas capital investment,

which is particularly important for a small country like Israel. As signs of an innovative technological work force, startups help create a business climate that is attractive to large international employers.

But startups alone do not support a national economy. For that, you need larger companies that can employ thousands of people and bring in export revenue from around the globe. "Don't measure just the number of startups, but the number of successes, including how much they increase jobs," said

*Technion students enjoy Spring sunshine*

*Haifa's Matam Science Park, initiated by Uzia Galil*

Uzia Galil, a Technion graduate who, as founder of Elbit Systems, is one of the founding fathers of Israel's high-technology industry.

*Elbit. RAD Group. Intel. Teva Pharmaceuticals. Israel Aerospace Industries.* Large knowledge-based companies like these have been the backbone of Israeli industry, and here too Technion graduates and training have played a large role. Now a surprising new development has brought Technion into the field of petroleum and gas as well – into resource development, not just knowledge-based startups.

## Israel Finds Gas, Technion Enlists to Help

"If Moses had turned right instead of left when he led his people out of the Sinai Desert," goes an old joke, "the Jews would have had the oil and the Arabs would have ended up with the oranges." But we can't tell that joke any more. Two major gas fields named Tamar and Leviathan were discovered offshore in the Mediterranean in late 2010. The latter is said to be the biggest gas find in the world in a decade. And, as it has done frequently in the past, Technion has acted rapidly to supply the core competences needed to exploit this huge windfall.

Leviathan means "whale" in Hebrew and indeed is a whale of a find. New estimates show Leviathan has some 17 trillion cubic feet of gas, worth over $160 billion at current European market prices of one cent per cubic foot. It's estimated that the Tamar field has an additional nine trillion cubic feet of gas. Leviathan is located 78 miles (126 kms) offshore and Tamar is 54 miles (87 kms) offshore; its gas will reach Haifa in 2013. Many experts believe that in addition to the gas, there is also offshore oil.

Israelis have been fiercely debating what to do with this incredible new windfall. Liquefy it and export it? Use it for gas-based industries like petrochemicals? But first they face a more pressing dilemma: *Where to find the hundreds of petroleum and natural gas engineers needed to bring the gas to shore safely and efficiently, and then process it optimally?* This is a huge, difficult and extremely costly challenge. Perhaps because

Moses made that wrong turn, Israeli universities do not teach petroleum engineering.

That is, until now.

At the initiative of Technion President Peretz Lavie and Senior Executive Vice President Paul Feigin, Technion moved with alacrity to launch a Master of Engineering program in Energy Engineering, with specialization in natural gas and petroleum engineering. The program is open for enrollment and formal studies began on December 28, 2011. For 18 months, some 25 engineers will study drilling engineering; production, transportation and storage engineering; or reservoir management, at their choice. The University of Haifa is an active collaborator through its Department of Marine Geosciences.

"The efficient, safe and environmentally responsible exploitation of [Israel's] natural gas reserves is the major engineering challenge facing the State of Israel in the coming decades," Feigin said. "Technion, as it has done throughout its history, is taking the lead in providing the education and developing the know-how in order to meet this challenge."

The director of the new program is Professor Yair Ein-Eli of the Faculty of Materials Engineering. When we asked him where the graduates of the program would be employed, he pointed to exploration companies, drilling groups, consulting companies, entities that process, transport and distribute the gas, and of course, governmental ministries such as Energy and Water Resources, Finance, and Industry.

Finding top experts suitable to teach in this program was not easy. Technion found them within its own campus and at the University of Haifa, as well as at America's University of Houston and Colorado School of Mines, and Norwegian Technological University. Both the U.S. and Norway have vast experience in exploiting oil and gas reserves.

Technion has a long history of anticipating Israel's needs for engineering skills, and with vision, supplying them. In November 1950, Professor Sydney Goldstein, then head of the Aeronautical Research Council of Great Britain, arrived in Haifa to become dean of Technion's fledgling Aeronautical Engineering Faculty. For a nation with barely a million

*Prof. Sydney Goldstein: Founder of the Aeronautical Engineering Faculty*

people, and per capita GDP of $1,500, some thought this department was folly. But 38 years later, on September 19, 1988, Israel became the eighth country in the world to launch a satellite. The effort was led by Technion aeronautical engineers and students. Today space is a potential growth industry for Israel.

Technion petroleum and gas engineers will bring home the gas. Technion chemical engineers will show Israel how best to exploit this resource. And Technion graduates in management will lead the businesses that do so.

We owe Moses an apology for that tired joke. He knew precisely where he was going after all. In the end, we got the oranges, and the gas and oil as well. And Technion Nation is on the spot, even before the gas starts flowing.

Consider the government official in charge of development and exploitation of the gas fields. Uzi Landau, the Minister of Energy and National Infrastructure, is a systems analyst by profession who received his Ph.D. from M.I.T.… and his bachelor's and master's degrees from Technion.

## Interlude: A Day in the Life of Ordinary Citizen (O.C.)

O.C.'s first two meetings of the day go smoothly – his team's project is on schedule, his boss is in a good mood, and someone even brought in a bag of homemade muffins. The best part, though, is hearing that his officemate Jim has finally solved a mysterious and long-running intestinal problem.

"Spare me the details, okay?" O.C. asks. He's already heard too much about Jim's digestive system over the years.

"Okay, no gory details," Jim says. "But I've got to tell you about this technology they had. You know those little PillCams? Where you swallow a camera the size of a pill and it transmits images of your intestines? That's what they used. Didn't hurt a bit. After about a day, the PillCam came out in the wash, so to speak. And they finally found out what was going on with me! Amazing!"

*The PillCam was invented by Gavriel Iddan, who received his bachelor's, master's and doctoral degrees from Technion and was a 2011 finalist for the European Inventor award for his work. Manufactured by Israel's Given Imaging, the PillCam weighs just 1/7 of an ounce and is the size of a large pill. It contains a color video camera, tiny LED lights, a radio transmitter, and enough battery power to transmit 50,000 color images as it makes the eight-hour journey through a patient's digestive tract.*

*Given Imaging's PillCam: Videotaping the digestive tract*

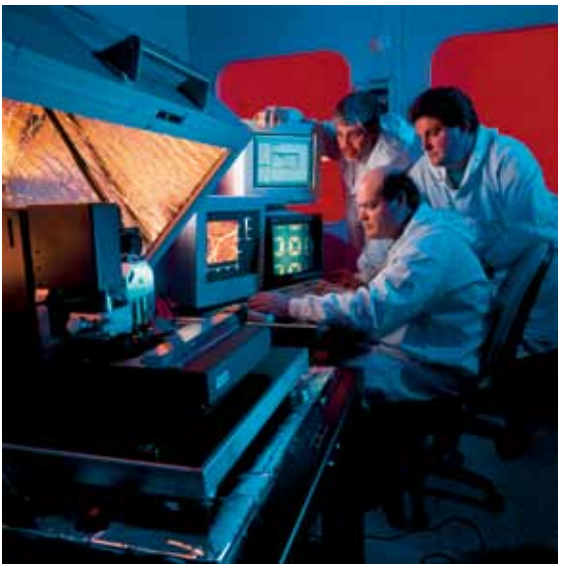
The home movies from Jim's last Hawaiian vacation were bad enough, O.C. thinks. He crosses his fingers and hopes that he won't now be forced to watch video footage of his workmate's innards.

The rest of the morning goes quickly. O.C. joins his boss for lunch and an informal brainstorming session: Part of O.C.'s job is to think about long-term technology road maps and how his company can leverage them. Today his boss tells him about a remarkable new DNA-based technology that ultimately will produce very small transistors.

> *In 1998, Technion scientists Professors Uri Sivan, Erez Braun and Yoav Eichen succeeded for the first time in fashioning a tiny transistor comprised of a long gold-coated DNA strand, a short DNA strand, a carbon nanotube and a protein molecule. When placed on a silicon bed, just like an ordinary transistor, the nanowire can conduct electricity and be turned on and off. The practical implications of this research are vast. It opens the door to more powerful and smaller electronic devices – microprocessors that can hold many more transistors than before, or miniature computers that can be embedded in thin, small objects or perhaps even into the human body. Sivan's breakthrough built on earlier Technion research that found a way to turn DNA strands into electricity-conducting "cables" by coating them with silver or gold.*

O.C. is intrigued by his boss's description, and back at his computer he decides to do a Google search for "nanowire." He has barely typed in the first five letters – *n-a-n-o-w* – when Google offers him a list of possible search terms. *Nanowire. Nanowire battery. Nanowire transistors without junctions. Nanowire LED. Nanowire solar cells…*

Exactly what he was looking for! Without a moment's thought as to how Google produced those suggestions, O.C. clicks on "nanowire transistors without junctions" and peruses the list of Web sites that pop up on his screen.



*Profs. Sivan, Braun and Eichen: DNA transistor*

*Google's "suggested search" feature was developed by Technion graduate Yoelle Maarek, leading a team that included a number of other Technion alumni at Google's research facility in Haifa. Google had developed an early version of the feature, but no one thought it could work on a mass scale – until Maarek and her team took it on. The challenge was finding a way to provide suggestions that were relevant to the individual user, up to date, and faster than typing in the rest of the phrase manually. Today Google's suggested search is used daily by tens of millions of people around the world.*

O.C. takes notes about what he's discovered, bookmarks some particularly interesting pages, and returns to his afternoon's work.

Sooner than he knows, it's time to leave for his doctor's appointment.

Chapter Four:

# Executives, Not Just Engineers

*Uzia Galil, Elron founder, Father of Israeli High-Tech*

Long before people rattled off terms like "startup" or "Internet", Uzia Galil had a vision for the role that knowledge-based businesses could play in building up the young State of Israel.

Galil had fled the Nazi takeover of his native Romania and arrived alone in British-run Palestine as a teenager in 1941. He had hoped to become a doctor but was placed in a farm training program. "I saw I had two alternatives – one was agriculture, and I had no attraction to agriculture, so I decided to study engineering," he said.

Galil maneuvered his way into a technical school in Tel Aviv, sold his only possession from home – a Leica camera – to pay for university preparatory classes, and in 1943 enrolled in Technion in electrical engineering. After the War of Independence, he worked in communications in the Israeli navy, which gave him an opportunity to do post-graduate studies at Purdue University in Indiana.

Galil's eyes were opened. Working at Purdue and then at Motorola, he saw how universities, government and business could collaborate for mutual gain. He witnessed the first industrial parks and early technology

corridors like Route 128 outside Boston. And he realized he needed to bring those ideas home to Israel.

"In Israel we had research in the Ministry of Defense that was very good, and research in the university that was very good, but they wouldn't talk to each other," Galil recalled. "What I saw in the U.S. was totally different – how the military gave work to the university, and part of their knowledge came from that collaboration. At Route 128, I saw what it meant when MIT started new companies. I said, 'When I go back, it is essential that I bring this message and try to implement it.' "

Upon his return, Galil taught at Technion and started a small electronics business called Elron. He had to buck the prevailing ethos that foreign-made technology was superior to anything that could be produced in Israel. But gradually – assisted by Technion aeronautics professor Moshe Arens, who later became Foreign Minister and Defense Minister – he started attracting outside investors. When France imposed a potentially crippling arms embargo after the 1967 war, Elron was ready to help fill the gap in military production. Gradually it grew into a large holding company with global sales and international partners such as Monsanto, Scientific Data Systems, and Control Data Corp.

A spin-off from Elron – Elbit Systems – built one of the earliest microcomputers. In 1972 another spin-off – Elscint, which produced medical devices – became the first Israeli firm to be traded on Wall Street. Along the way, Galil convinced Haifa's mayor to open the country's first industrial park, which today is the flourishing Matam Scientific Industries Center, home to R&D offices of Intel, Yahoo!, Google, Philips and Microsoft.

With 50 years under its belt and scores of spin-offs numbering tens of thousands of employees, Elron has been one of the pillars of the Israeli economy and its high-tech "miracle." And Technion graduates were key to its success – not just as engineers but as managers and executives.

"If you look at our companies – the engineering teams, the software people – the majority are Technion graduates," Galil said. "That was key and still is today. If you look at Elbit, or when we established Elscint, the majority of the people came from Technion. Many of them became

managers…. And hundreds of companies grew from people who left Elron." Among other breakthroughs, Elbit pioneered the unmanned drones now widely used throughout the world.

### *Technion and Biotech*

For a long time, pundits predicted that biotechnology – the use of living organisms and biological processes to create innovative products and services – would be Israel's "next big thing" in High-tech. For a variety of reasons, that has not turned out to be the case.

But a number of individual biotech ventures have proven successful exceptions to this rule – and some are outgrowths of Technion Nation. One example is Insightec, a privately held firm that developed the first FDA-approved magnetic-resonance-guided ultrasound technology for treating uterine fibroids. Founded by Technion graduate Kobi Vortman, Insightec uses focused ultrasound to dissolve fibroids or other targets without invasive surgery or damage to surrounding tissue.

*Insightec: Surgery without incision*

All over the world, universities grapple with the prickly issue of how to transfer basic research to commercial endeavors, a process known as technology transfer. The Alfred Mann Institute at Technion (AMIT) provides a creative solution. Funded by a $100 million grant from the American entrepreneur Alfred Mann, who founded over a dozen successful aerospace and biomedical companies, AMIT was launched in 2007 and has as its mission the commercialization of biomedical technology. Under the AMIT model, the principal investigators, their research teams, the AMIT team, consultants and external experts all collaborate to choose and develop new winning biomedical technologies. Mann recently told business daily *Globes*, "We're constantly enthusiastic about our work (at AMIT). The people there are talented and skilled." Some AMIT technologies will soon be undergoing human clinical trials.

## No Business School, But Many Business Leaders

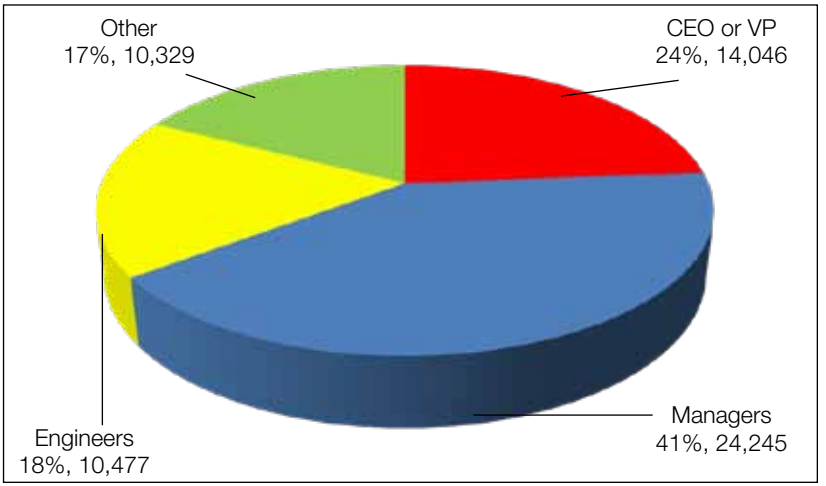
Technion has been known through the years primarily for the scientific and technical prowess of its graduates rather than for their business expertise. Unlike universities such as MIT, Technion doesn't have a separate business school, although its William Davidson Faculty of Industrial Engineering and Management has offered a successful technology-oriented M.B.A. program for many years, and its Master of Industrial Management graduate degree program was one of Israel's earliest management programs. Nonetheless, most of Technion's engineering students go forth into the work world with no formal training in management or business. Some graduates in fact complain that they could have used a little more education in how to manage people.

Yet Technion alumni today successfully captain many of Israel's largest companies – and some, like Uzia Galil, have done so for decades. In addition, more than a thousand Israeli executives have benefitted from Technion programs that offered non-degree, mid-career management training. Although it largely goes unrecognized, Technion plays a

significant a role in providing Israel with business leadership as it does in providing engineering talent.

Our survey of Technion alumni showed that 24 percent have served as CEOs or vice presidents of companies. Another 41 percent have served as other kinds of executives or managers.

## Most Senior Roles Held by Technion Graduates




*Source: 2010 survey of Technion graduates by Shlomo Maital and Amnon Frenkel.*

Meanwhile, of the top 125 Israeli executives listed by Dun & Bradstreet, 41 are graduates of Technion degree programs.[20] That's *one-third* of the country's top business leaders, even though Technion is just one among seven Israeli research universities and 30 institutions of higher education.

Twenty-eight of those 41 Technion-trained executives run publicly-traded companies – putting them in charge of combined annual revenues of about $34 billion, net profits of more than $1.6 billion, market capitalization of $14 billion, and total employment of more than 74,000 workers.[21]

Even more striking is the leadership provided by Technion alumni in Israel's top export companies. Exports are a particularly important source of jobs for a country like Israel whose small population limits

the purchasing power of its domestic market. And Technion grads held senior management roles in 2010 in 10 of the 12 largest exporters – ICL Fertilizers, Intel Israel, Oil Refineries Limited (ORL),[22] Israel Aerospace Industries, Elbit Systems, MA Industries, Rafael, Elta (a subsidiary of IAI), Strauss, and Elco. Some snapshots:

*ICL Fertilizers*: Technion electrical engineering graduate Dani Chen is president and CEO of ICL Fertilizers, one of the world's largest fertilizer companies and a major component of the ICL Group, a top Israeli exporter with 11,000 employees and about $5.4 billion in overseas sales. ICL's sales of fertilizer to India – led by Chen – helped turn that country into Israel's second largest export customer in early 2010.

*Israel Aerospace Industries*: This government-owned company is one of Israel's largest industrial employers, with 16,757 workers and tens of thousands of additional jobs at its Israeli suppliers. IAI's sales of advanced defense technology and civilian business jets generated $2.2 billion in overseas sales in 2009. About a half dozen Technion graduates fill its vice presidential ranks. And its recent turnaround was spearheaded by Yair Shamir, a 1975 Technion electrical engineering graduate who served as board chairman from 2005 until 2011. The online magazine *Defense News* wrote:

> *When Yair Shamir took over as IAI chairman in mid-2005, Israel's largest aerospace and defense firm was rudderless, bloated by inefficiency and drifting in decades of red ink…. After years of dithering over the politically plum post, ministers charged with IAI oversight turned to Shamir – an accomplished business executive and unbeholden son of a former prime minister – to impose order from the chaos. And the results are self-evident. IAI now operates at a profit under new, financially accountable reporting rules. Perhaps more significantly, IAI has found a way to work with its notoriously obstructionist labor union to ease out nonessential employees, raise capital and otherwise solidify its standing for the long march toward privatization.*[23]


*Israel Aerospace Industries' Arrow 3 anti-missile missile*

Shamir said his Technion education helped prepare him for the challenges at IAI by teaching him "the systematic approach to every search for the solutions of (a) problem…. Always look for the simplest solution, even if you have a complex one that works."

Shamir's long business career has also included leadership of some non-high-tech companies like Elite Foods, for which an electrical engineering degree might not seem the most relevant preparation. But there, too, he found his Technion training invaluable.

Technion taught "the analytical approach that enables you to look on factories as big and complex systems that could be described by some mathematical equations that present long series of processes," Shamir said. "Once you do this as the first step, then you start the process of simplifying the equations and then the processes."

*Intel:* With major fabrication plants in Kiryat Gat and Jerusalem and a research facility in Haifa, Intel employs almost 7,000 workers in Israel and generated $3.5 billion in exports in 2010. It was a Technion electrical engineering graduate, Dov Frohman, who launched Intel's R&D operations in Israel in 1974 with just five employees. And today two Technion graduates are among Intel's top managers: Shmuel (Mooly) Eden, senior vice president, and president of Intel Israel; and Executive Vice President David (Dadi) Perlmutter, who was recently promoted to chief product officer, while continuing to head the Intel Architecture Group and reporting to CEO Paul Otellini.

Perlmutter gained fame in technology circles when, as a young junior engineer, he and fellow Technion graduate Uri Weiser flew to Intel's headquarters and persuaded Intel managers to reverse a major decision about semiconductor technology. The result was the Pentium chip, one of Intel's most successful offerings. Later Perlmutter led the Israeli research team that shifted Intel away from its strategy of developing ever more powerful chips and toward a lower-power but longer-battery-life chipset that anticipated the spread of Wi-Fi and mobile devices.


*David (Dadi) Perlmutter's creativity drives Intel innovation*

Perlmutter says that his Technion education – combined with four and a half years as an Army paratrooper – fostered his curiosity and his refusal to accept conventional wisdom. Those qualities were essential as he rose to the top ranks of one of the world's biggest and most admired technology companies.

"When I was at Technion, most of the other students wanted to know how to solve problems that had defined 'canned' answers, but I thought this wasn't very smart," Perlmutter recalled. "If the solution exists, then the problem is not very interesting. I wanted to learn how to solve problems that *did not* have canned solutions."

## Technion's Management Training

Although Technion never had a business school, it has long operated divisions and programs focused on cultivating business leaders – such as its Faculty of Industrial Engineering and Management, and Technion Institute of Management (TIM).

TIM lasted for only a decade, from 1998 to 2009, but in that time provided mid-career, non-degree training to over a thousand senior managers. In one of its initiatives, TIM invited companies to send five of their senior managers for nine months of periodic workshops and executive coaching about real bottom-line projects. Another TIM initiative helped large companies increase their global marketing through training that was custom-designed for the unique needs of their management teams. Two of Israel's biggest exporters – the food company Strauss-Elite and the drug company Teva Pharmaceuticals – both took part in custom Technion programs. Some 75 Teva executives participated in TIM programs between 2003 and 2007, a period during which the company's revenues ballooned to $14 billion from less than $1 billion.

Technion's Faculty of Industrial Engineering and Management began turning out managers and executives in the 1950s – before there were any MBA programs in Israel.

Arie Ruttenberg – a serial entrepreneur who built one of Israel's

biggest advertising agencies – studied economics in the Faculty of Industrial Engineering in the late 1960s. Along the way, he also took classes in psychology, sociology, commercial law and financial analysis, and worked as publisher of the student newspaper. After graduation, Ruttenberg stayed on at Technion to teach marketing, a new concept in Israel of the early 1970s. Soon he went into advertising himself, starting at a small agency and eventually opening one called Kesher Barel.

Ruttenberg brought his Technion analytical skills to a field that, at the time, was not particularly rigorous.

"Good advertising is not only a brilliant idea, but it should come from analysis of the company, the market situation, the consumer," he recalled. "You should define your goals, and then find the idea to service those goals. I was the first person (in the firm) to come from economics and management and do what is today called planning… We showed we could get very good results by working in a rational way in an area that worked irrationally and called it 'creativity.'"

Ruttenberg ran high-profile ad campaigns for figures like Menachem Begin and Yitzhak Rabin that redefined political advertising in Israel. He built Kesher Barel up to more than 150 employees and $150 million before selling it to McCann-Erickson in 2005. Then he went on to start a completely different kind of business, a company called Club 50 that offers activities and services to 200,000 Israeli members over the age of 50. Recently he started his third entrepreneurial venture – a small technology startup in the digital e-book space.[24]

Ruttenberg says his Technion education has been relevant throughout his multiple careers, none of which were stereotypical "engineer" jobs. His story underlines how – for a technical university that never made business education a core part of its mission – Technion has trained or touched an astonishing chunk of Israel's business leadership.

"Technion gave me the tools to make real things in the real world," Ruttenberg said. "They took me to a very high-level analysis of economic models, while at the same time understanding the reasons for things like the economic crisis in the 1930s.

"I didn't need to go to business school," he added, "because Technion gave me everything I needed."

## Technion Business Leadership Abroad

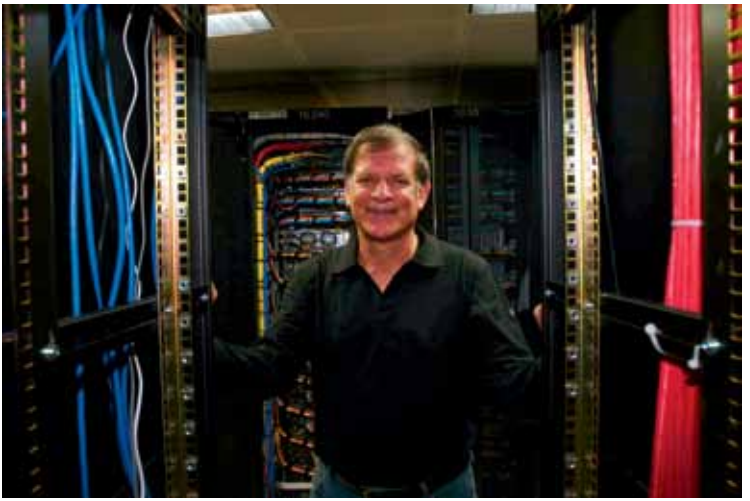
"Technion has a great contribution to make to Israel's future prosperity," the British leader Winston Churchill once remarked, "and Israel's prosperity cannot but be of great benefit to other countries as well." Indeed it has, in part through Technion Nation.

It is perhaps not surprising that Technion Nation engineers would lead Israeli startups. But it is less well known that they have made vital contributions to startups in the U.S. and other countries as well. An example is the leading American data storage company EMC2 and its former vice president, Technion graduate Moshe Yanai.

Yanai, who received his B.Sc. from Technion in 1975, arrived at EMC in 1987 and led development of that company's pioneering data storage product, Symmetrix. His work there helped create the entire industry of data storage devices, which in 2011 had revenues of over $20 billion.

One of Yanai's early innovations was to install modems in EMC's data storage products. The company had been struggling with how to provide first-rate service for EMC products, which were sold all over the world. EMC couldn't afford to be constantly flying engineers to customer sites from Australia to Saskatchewan. The solution? Install modems in the storage devices that could contact EMC headquarters and alert EMC to possible failure of one of the hard disks at the core of the devices. This enabled EMC to contact the client and report that a replacement part was on its way, even before the client was aware there was a problem.

Symmetrix took off, and so did EMC. Company revenues ballooned from $132 million in 1989 to over $7 billion in 2001. EMC surpassed larger, older rivals IBM and Storage Technology to lead the data storage market, making mass data storage faster, easier and, above, all highly reliable. EMC became the fastest-growing stock on the New York Stock Exchange in the 1990s, climbing from six cents per share in 1989 to $82 per share in 2001.



*Moshe Yanai led EMC2 to greatness*

Yanai led the company's development engineers, a team of several thousand people, and recruited heavily among Technion graduates. His team, working at EMC headquarters just outside Boston, became known as the "kibbutz". It was famous for the 6 p.m. dinner bell. When it sounded, the whole team sat down together for supper, like at a kibbutz… and then continued working late into the night.

Sarah Zohn, one of those Technion alumni hired by Yanai, described him as a rare executive who excelled at both technology and personal leadership. "He is generally known for creating a huge industry segment, but for me his greatness was even larger on the people skills," said Zohn, who spent 15 years at EMC and today advises small and mid-size tech companies on "go to market" strategies. "Moshe knows how to mobilize people from all corners of his ecosystem and extract greatness from all. To me, he exemplified true leadership composed of technology and marketing vision as well as support of his people."

Yanai's career as a business innovator continued after he left EMC in 2001. He funded and led a cloud computing data storage startup called XIV that was acquired by IBM for an estimated $300 million in 2008,

and then another storage company, Diligent Technologies, that was also acquired by IBM.

Although Yanai was named a Distinguished Fellow of the Technion's Faculty of Electrical Engineering in 2011, he does not recall his days of study there fondly. Like many Technion graduates, he found the rigorous, demanding studies far from happy. (As Inbal Kreiss noted earlier, current Technion students sometimes describe themselves as "prisoners on the mountain.")

"Technion gave me an entry ticket to the world of computers, and I owe it much of my success," he said. "However, I remember the period of studies as difficult and demanding. I agree that Technion must not compromise on anything less than excellence, but I am certain that much can be demanded of the student without this detracting from a pleasant study atmosphere."

The stressful high-pressure atmosphere that characterizes study at Technion is also the case at other top technological universities like MIT and Stanford. But unlike many other graduates, Yanai decided to take action. He made a gift of more than $10 million to Technion to support excellence in teaching and improve the manner in which faculty members relate to students.

Yanai's legacies went beyond money to include family. His son Itai is now a Technion faculty member, a senior lecturer in the Faculty of Biology.

* * * * *

Our research showed about four percent of Technion graduates living outside of Israel. Some of these include Diaspora Jewry – young people from abroad who came to Technion to study and then returned home to play leading roles in their countries. A good example is Victor Asser. His mother, Rozina Pardo, founded WIZO (Women's International Zionist Organization) in Greece. His father, David Asser, played a crucial role in facilitating the immigration of Egyptian Jews to Israel. Rozina and David sent their son Victor to Technion, where he earned his B.Sc. *cum laude*,

in Industrial Engineering & Management. On returning to Greece, Victor became a partner in one of the first stock brokerage firms on the Athens Exchange, and established the Telesis Group, which quickly became the country's leading independent investment bank. He joined Technion's Board of Governors in 2004.

Other far-flung members of Technion Nation include native Israelis who have moved abroad for work, advanced study or other reasons. While certainly some might echo the survey respondent whose six-word life summary was "Israel didn't care, now U.S. citizens," others retain deep ties to Israel and to Technion.

Kalman Zeff was a civil engineering student in the 1940s whose studies were interrupted by army service in the War of Independence. He graduated from Technion in 1951, did graduate studies at the University of Colorado, and in 1960 founded Geotek Consultants in Colorado. He later built a thriving real estate company there with more than 300 employees and established a hydroelectric power plant in Idaho. Zeff was unable to attend the golden jubilee reunion for his Technion class in 2001, but he made a major gift to the university.

"I view my Technion studies as a springboard for the achievements I've amassed," he told Technion, "and this [gift] is my thanks to you."

*Victor Asser: Technion knowledge for Greek finance*

## Interlude: A Day in the Life of Ordinary Citizen (O.C.)

O.C. figures he'll have to sit in the doctor's waiting room for a while – *why else would they call them waiting rooms?* – so he brings his Dell laptop with him from the office. He is happy to find free Wi-Fi in the reception area, and takes advantage of the time to continue searching for information about nanowires.

*O.C.'s computer is powered with Centrino technology by Intel – initially designed by a team at Intel's Haifa research facility led by Technion graduate David (Dadi) Perlmutter. Back in 2003, Perlmutter pushed for a major change in Intel's technical approach that anticipated the demand for mobile computers and wireless devices. The Wi-Fi access and longer battery life of today's Intel-powered computers have their root in the company's Technion-fueled Haifa workforce.*

O.C.'s doctor puts him through a battery of tests – some familiar, some new. (His medical center prides itself on being cutting-edge.) In one test, a probe is put on O.C.'s chest, right over his shirt, and he sees his own beating heart and blood flow on a computer monitor.

As a computer scientist, O.C. thinks with admiration about the sophisticated image-enhancement software that made this device possible. "And," he adds to himself with a grin, "if Jim tries to show me home movies of his bowels, I'll just threaten to show him videos of my heart."

*O.C. was being examined with an ultrasound device that creates a real-time sharp image of the beating heart and its blood flow at a fraction of the cost of conventional computers. It was developed by a group of Technion graduates led by Alex Silberklang who launched a Haifa startup called Diasonics that was later acquired by General Electric and became GE Ultrasound.*

*Silberklang persuaded GE to permit his team to develop an ultrasound cardiology diagnosis device based on the personal computer (PC) – even though GE itself had tried and failed, and*

*even though the PC at the time was far too weak to enable such a device. Their invention is now widely used throughout the world, and has evolved into a laptop-based device.*

"You're fit and healthy," O.C.'s doctor tells him. "Keep up the biking. See you next year."

Before leaving the medical center, O.C. stops off to visit his aunt in the cancer unit. She has a brain tumor, a particularly nasty kind known as glioblastoma that traditionally was considered untreatable. But she recently started a new treatment regimen approved by the FDA in 2011. O.C. finds her looking chipper, although wearing a weird kind of headgear that resembles a large white skullcup. "Auntie!" he says. "What in the world is that thing on your head?"

*Technion professor Yoram Palti developed a novel approach to fighting cancer after years of basic research on the electric fields in human cells. Palti realized he could design electric fields that damage dividing cells – such as cancer cells, which tend to divide rapidly. Dividing cells take on an hourglass shape, and Palti's device uses an electric field to explode the cell at its narrow "waist" before it splits, while leaving ordinary cells intact. In 2000 Palti established NovoCure ("new cure") literally in his basement, to treat cancer with electrical fields. Patients with brain tumors wear a cap that provides an electric field around the brain, with components that generate the field in a kind of briefcase carried by the patient. This approach has proven outstandingly successful against certain brain cancers in clinical trials, and is now being tested as a treatment for lung cancer.*

"I told her to hold out for something more fashionable, maybe a French beret or something along the lines of Lady Gaga, but would she listen to me?" pipes up his aunt's roommate, a woman who appears to be in her 30s. O.C.'s heart breaks to see someone so young in the cancer ward. She turns out to have multiple myeloma, the second most prevalent form

of blood cancer. But she tells O.C. that she is feeling optimistic due to treatment with a new drug, Velcade.

*Velcade is one of several drugs developed from the work of Technion professors Avram Hershko and Aaron Ciechanover. Together with Irwin Rose, they discovered a protein called ubiquitin that targets proteins for destruction. This became the basis for a new class of anti-cancer agents known as "proteasome inhibitors," including Velcade, and earned Hershko, Ciechanover and Rose the 2004 Nobel Prize in chemistry.*

After chatting for a while, O.C. bids goodbye to his aunt and her roommate, feeling he's had quite enough medical conversations for one day. On the way home, he remembers to stop at the supermarket for groceries – salad ingredients, milk, maybe some Ben & Jerry's for the kids.

In the produce section, O.C. picks up lettuce and peppers and is about to reach for some sprouts when he vaguely recalls a news story about a salmonella outbreak. Did it involve sprouts? Or was it spinach? It's hard to keep all the food safety warnings straight these days.

*Food safety in the future may benefit from the work of Ester Segal, a professor of biotechnology and food engineering at Technion. Segal and her research group have developed a new way to detect harmful bacterial contamination using porous silicon chips. Their technology would allow inspectors to test and quickly identify possible contaminants in the field – in this case, in a supermarket or warehouse – rather than in the laboratory. Although still under development, it could be useful not only in food safety but in identifying environmental contaminants and biological terror agents.*

At home, O.C. and his wife prepare dinner together and the teens do the dishes. After dinner, O.C. settles into his favorite armchair to watch a baseball game on TV but his daughter interrupts him to show off some artsy photos she took with her new Nikon digital camera.

*Both O.C.'s TV and his daughter's digital camera rely on chips made by Zoran, a semiconductor company founded and run by Technion graduate Levy Gerzberg. Zoran was shipping 100 million chips per year – including chips for 1/3 of all digital TVs and DVDs on the market – when it was acquired by wireless chip maker CSR for about $484 million in 2011.*

His daughter goes off to her room to "do homework." O.C. gets a beer, returns to his chair, and puts his feet up. Then his cell phone rings. It's his old friend Adam.

"Hey, O.C.," says Adam. "I'm going to an interesting talk. Thought you might want to join me. It's by someone from an Israeli university. President Lavie or something. Place called Technion. It's about sleep disorders. How have you been sleeping lately?"

"Like a rock," O.C. says. "Anyway, I'm pretty comfortable right now here in my big armchair. Why don't you just go and tell me all about it?"

Adam agrees. O.C. settles back in, happy not to accompany his friend. His sleep is just fine these days. The baseball game is on. The armchair is comfy.

*And besides*, he thinks, *what has this "Technion" place ever done for me?*

Chapter Five:

# Technion's Value, Today and Tomorrow

*How do you determine the value of a university education?*

This is a question most middle-class American parents put to themselves in one form or another as their kids near the end of high school. *It will cost me xx thousand dollars to send my child to college*, they say silently. *Is it worth it?*

Invariably they decide that it is indeed worth it. Usually it's an emotional calculation, maybe even an unconscious one. But economists have approached this question in a more scientific, statistical fashion. And they've consistently found that on an individual level, college does pay off – in spades.

American college graduates earned a median salary of $1,152 per week in late 2011, compared with $636 for high school graduates.[25] The college advantage shows up even among workers in similar kinds of jobs: Brookings Institution researchers found that managers and professionals with bachelor degrees earn median salaries that are 45 percent higher than those with only a high school degree.

"On average, the benefits of a four-year college degree are equivalent to an investment that returns 15.2 percent per year," wrote Brookings researchers Michael Greenstone and Adam Looney. "This is more than double the average return to stock market investments since 1950, and more than five times the returns to corporate bonds, gold, long-term

government bonds, or home ownership. From any investment perspective, college is a great deal." [26]

We found a similar – even stronger – salary advantage in our survey of Technion graduates. The respondents to our survey had a median monthly salary of $5,200 to $6,500. That's two to three times the average Israeli wage of $2,100. It's also significantly more than the average wage for Israelis with 16 years of education, which is $3,100.[27]

So the results are pretty clear when it comes to the financial value of a Technion education on the individual level – especially when you consider that the annual undergraduate tuition for Israeli citizens is less than $3,000.

But we were still curious about the value of a Technion education on a broader societal level.

Approaching this as economists, we created a formula to estimate the value of the human capital generated by Technion – in other words, the added value that its graduates bring to the Israeli economy.

*Human capital blossoms at Technion*

### *Human Capital: Karl Marx vs. Theodore Schultz*

Why are some nations wealthy while others are poor? This issue has preoccupied economists and political leaders for centuries. One answer was supplied by Karl Marx. Countries grow wealthy, he wrote, because they save and accumulate vast amounts of physical capital (machinery, factories, etc.), which drives industry. A competing answer was supplied by Professors Theodore Schultz, Jacob Mincer and Gary Becker. Countries grow wealthy, they argued, mainly because they build human capital – the stock of competences, knowledge and skills that together create the ability to generate economic value. Both physical and human capital generate a stream of future benefits (income, or output) that can be summed and valued. Hence the rate of return on investment in both physical and human capital can be calculated, measured as the ratio between the value of human capital and the value of the resources invested to create it. A variety of studies show that the return on investment in human capital is significantly larger than the return on investment in physical capital. [28]

We started with the assumption that Technion graduates' average wages follow the same pattern as Israeli college grads in general – 46 percent higher than the average Israeli wage. (This was a conservative assumption since engineering/science students tend to earn more than other college graduates, and our survey showed Technion alumni earning more than other college grads.)

Then we assumed that Technion graduates' contribution to GDP (gross domestic product, a common measure of national prosperity) is proportional to their wages – 46 percent more than their non-college counterparts.

Carrying out and discounting those assumptions over an estimated 45-year work life, we found that the 65,361 men and women who graduated from Technion since 1960 have contributed $35 to $60 billion to the

Israeli economy. The 2,828 members of the class of 2010 alone will create a net present value of between $1.76 billion and $2.97 billion over their working lives.[29] Meanwhile, the cost of educating one cohort of Technion graduates such as the Class of 2010 is about $1 billion, at the most.[30]

This means that a Technion education brings a return on investment of somewhere between 76 and 197 percent – or $1.76 to $2.97 of value added to the Israeli economy for every dollar spent on Technion undergraduate education. That's well beyond the typical risk-adjusted return on other kinds of investments such as stocks or bonds. And that figure is conservative: It doesn't take into account the added productivity of Technion engineers relative to general undergraduate degree holders. Nor does it count the economic value created by Technion startups, entrepreneurship, innovation and initial public offerings of stock. The true return on investment of a Technion education could be as much as *double* our estimate of 79 to 197 percent.

In summary, it's clear that no financial investment – other than a rare strike-it-rich stroke of good fortune, such as buying Microsoft stock the year it went public – can come close to the rates of return generated by human capital investment and specifically, investment in Technion-generated human capital.

## Benefits Beyond Dollars

Of course, the benefits that Technion brings to Israeli society go far beyond dollars and shekels to include:

*Opportunities for social mobility and advancement.* While all universities offer opportunities for advancement, the sciences have a tradition of being particularly meritocratic. Technion's rigorous training and meritocratic culture have opened doors for all sorts of Israelis, from children of recent immigrants to Israeli Arabs.

*Defense.* Israel's history has shown that it must continue to tap the most advanced and cutting-edge technologies to defend itself, and it cannot rely on even the friendliest allies to give it this technological edge. There

is no substitute for home-grown engineering expertise that can support the research and development capability of the Israeli defense forces.

*International reputation and goodwill.* The achievements of Technion faculty and researchers – from Nobel-prize winning basic research to the development of life-changing drugs – are the best kind of publicity for Israel. Technion scientists build collaborative relationships with colleagues around the world. Anyone who visits Technion's vibrant campus, or who meets Technion scientists at a conference, learns there is more to Israel than the conflicts and controversy that so often fill the news.

*Fueling the Israeli economy of the future.* With relatively few natural resources, Israel's future prosperity depends on a knowledge-based economy. The country needs to continue creating skilled, high-paying jobs in order to give young Israelis a future, and counter the pull of economic centers like New York or Silicon Valley. But a knowledge-based economy requires a stream of engineering talent. Technion turns out the skilled workforce that attracts global employers, generates startups and new industries, and is essential for a healthy economic future for Israel.

The benefits created by Technion don't stop at the Israeli border. The university's own mission statement cites its dedication to the creation of knowledge "for the advancement of the State of Israel and all humanity."

*Spine Assist robot assists in back surgery.*

Technion faculty publish some 2,000 scientific papers each year in refereed journals; as of January 2012, faculty members had 919 patent applications pending. From the development of drugs like Rasagiline (Azilect) for Parkinson's disease, to advances in skin transplants, cancer treatments, and renewable energy, Technion scientists are quietly, persistently making the world a healthier and more livable place. A good example is Technion Professor Moshe Shoham's unique robotic tool for back surgery, called SpineAssist, developed by Shoham and the Israeli company Mazor Robotics. The need to avoid damaging senstitive nerves makes back surgery particularly delicate: "SpineAssist [ensures] there is no damage to the surrounding nerves when implants are being placed in the spinal cord," Shoham told CNN.

## Challenges for the Next Century

Along with its achievements, Technion faces a variety of challenges as it enters its second century. One of these is the aging of its faculty. Some 46 percent of senior university academic staff in Israel are 55 or older, far higher than the proportion in other developed nations.[31] Over the next few years, Technion will need to invest in hiring younger faculty to replace those retiring – an opportunity to bring in new knowledge, but also a challenge to ensure that the university can continue to recruit the best.

"We have to compete with places like MIT and Stanford," said Technion President Peretz Lavie. "In 2011, we had faculty come here from CalTech, Stanford, MIT and Berkeley. The quality is simply incredible. What brings many of them is a desire to raise their children here rather than abroad. They're ready to give up salaries that are twice what they can get here. But we need to provide the labs and facilities they need for their work."

At the same time, Israel's economy could benefit from even more engineers. The wave of Soviet immigration that fed Israel's technology industry has subsided. That raises the question whether universities

like Technion should expand their enrollment to provide more skilled computer scientists and engineers.

"If you have more engineers, you generate a demand for even more," said RAD Group's Yehuda Zisapel, who is also chairman of the Israel Electronics & Software Industries Association. "They create new knowledge and new applications, which leads to a need for more people writing and developing applications. The limit is how many engineers we can train in quality and quantity.… If today we had 40,000 good quality engineers, we'd be second in the world in High-tech. And there would be a need for even more."

These challenges come after a decade in which, paradoxically, the Israeli government ratcheted back its support for research universities, including Technion. After the 2001-2002 economic crisis and the bursting of Israel's dot-com bubble, the government instituted austerity measures that included cuts to university R&D funding. The number of senior teaching and research staff in all Israeli higher education institutions fell from 5,137 in 1999-2000 to 4,722 in 2008-2009.[32] Government spending per student in Israel's higher education system dropped by 34.2 percent between 1996 and 2008.[33]

Recently, those cuts have been reversed. But the government's apparent lack of commitment to Israel's research universities remains troubling. The latest World Competitiveness Yearbook ranked Israel 17th in the world in economic competitiveness – with key reasons being its "scientific infrastructure" (ranked 4th in the world) and its technological infrastructure (5th in the world). Treating R&D funding as an optional frill, or as a spigot to be turned on and off with the political winds, is a sure-fire way to erode Israel's long-term economic strength and independence.

In fact, rather than cutting university research funding, the government should be increasing it. Several years ago, one of us undertook a study tracking economic performance and higher education spending among European countries. We found that increasing Israeli R&D spending to the level of Sweden – a leader in R&D as a proportion of GDP – would have a major economic payoff.

"Increasing R&D per student in Israel's research universities will cost $374 million a year, and will result in an increase of $600 million a year in gross domestic product," the study said.[34]

Technion is the locomotive driving Israel's high-tech sector, which in turn drives much of Israel's economy. But how long can a locomotive continue to pull the train if it is being fueled on a stop-and-start, barely adequate basis?

## A Global Vision

From his office at the center of campus, Technion President Lavie takes in all these challenges and more. It's a big change from his days as a sleep researcher at the medical school, but he relishes the work of steering this multi-faceted institution – which can take him in any single afternoon from chatting with first-year architecture students, to learning about a professor's new stem cell breakthrough, to connecting with an overseas supporter who just discovered her late father's name on a list of Technion's earliest, most farsighted donors.

"My vision," Lavie says, "is to see Technion not only as a world-class university but as a global university. Both Israel and Technion should be a light unto the nations. I would like to see the influence of Technion go even further beyond the borders of Israel."

Today's Technion is home to a plethora of initiatives aimed at sharing its knowledge with the world. The university operates joint Ph.D. programs with Italy's Politecnico Milano, Germany's Technische Universitat Berlin, Singapore's Nanyang Technological University and Sweden's Royal Institute of Technology. It has agreements with five Chinese universities that will bring young scholars from China to Israel for sabbaticals and study. Technion researchers are collaborating with their Singaporean counterparts on research into cardiac tissue regeneration, and with Japanese colleagues on developing a platform for creating blood vessels and blood cells from embryonic stem cells.

Meanwhile, the Technion chapter of Engineers Without Borders is

teaching villagers in Nepal to build biogas digesters – devices that use animal waste to produce fuel for cooking and heating – as a greener alternative to burning wood from nearby old-growth forests. Technion ב ivil engineering Professor Mark Talesnick, who emigrated from Canada in 1982, founded the chapter – along with Israel's national ice hockey team.

And the mechanical engineering faculty recently created a new lab focused on the engineering of prosthetics, led by industry veteran Professor Reuven Katz, which may bring direct benefits to disabled people around the world. "Students will learn mechanical engineering by developing these devices," Lavie said, "but they will learn something more – values – as they are helping the disabled."

*Technion's Engineers Without Borders: Helping the world*

## Tackling Social Challenges in Israel

On the national level, Technion scientists are working closely with the Israeli military on critical issues such as cybersecurity, helping develop defenses against computer threats to the country. The university is steadily increasing its support for turning faculty research into commercial products – an area where it historically lagged behind some other universities – through Technion Technology Transfer office, an arm of Technion Research and Development Foundation. According to data supplied by the AUTM (American University Technology Managers Association), Technion's $20 million annual income from technology licensing would rank 20th (just behind Duke University.), if Technion were an American university, even though Technion's research budget is much smaller than the top 20 U.S. licensers.

Technion is also working to improve science education in Israeli schools and reverse a troubling decline in the number of young Israelis prepared to study science at the college level. Among other initiatives, it recently started a fellowship program for graduates who choose to return for an additional degree in science education.

"The 21st century version of Zionism is to be a science teacher," Lavie said. "We're telling our students that before they join Intel or IBM or start a high-tech company, they should give several years as a teacher. The quality of education here may be more important to our future than what is happening in Iran."

Technion is also involved in another initiative that will be key to Israel's future – integrating its Haredi (ultra-Orthodox) citizens into the productive work force.

Since the founding of the state, the ultra-Orthodox have been exempt from army service in order to continue their yeshiva studies, and relatively few ultra-Orthodox men hold paying jobs. That wasn't a problem when they constituted a small percentage of the Israeli populace, but the Haredi population today is growing far more rapidly than Israelis in general. While the ultra-Orthodox today make up about eight or nine percent of

Israel's adult populace, by 2028 they are likely to account for more than one-fifth of all Jews in Israel – a crushingly high number for the rest of society to support.

Reuven Gal, a researcher at Technion's Samuel Neaman Institute for Advanced Studies in Science and Technology, is spearheading a national study of how to better integrate the ultra-Orthodox into the labor market and society. And Technion itself is venturing into technical education for ultra-Orthodox students.

It recently created an 18-month-long preparatory program for the ultra-Orthodox that sent 12 young men, the initial class, to enroll as full-fledged Technion students. And together with the government agency in charge of mapping, Technion has opened a training program at the Haredi College in Bnei Brak that will offer a bachelor's degree in Mapping and Geoinformation, along with an accredited surveyor license.

"This program takes into account cultural and political constraints, and provides these young people with the tools needed for entering the job market, including core studies to which they were not exposed in school," said former Technion Civil and Environmental Engineering Dean Arnon Bentur. "By following these core studies with education for a profession, we will boost Israel's technological sector."

Along with its outreach to the ultra-Orthodox, Technion is making more active efforts than ever before to ensure the success of its Arab students. Many Israeli Arab students come from underfunded high schools with less rigorous math and science programs. They often arrive with poor Hebrew skills and little practice interacting with Jewish Israelis – making the already tough Technion experience even harder. As recently as nine years ago, 28 percent of Arab students dropped out before completing their studies.

With funding from Israeli donors Patsy and Benny Landa, Technion launched a program in the early 2000s to support its Arab students. The university created mentorship and tutoring programs, orientation sessions and other programs targeted to Arab students' needs. Today the number of Israeli Arabs at Technion has risen from 11 percent to 18 percent of

undergraduates, which is close to their percentage in the Israeli population generally. The increase in Arab women students is particularly dramatic, from 78 incoming students in 2003 to 196 in 2011. While before, Arab students were concentrated in civil engineering, they are now spread more evenly through all of Technion's departments – including ones that feed into upwardly mobile high-tech jobs. Most importantly, the Arab student dropout rate has been reduced from 28 percent in 2003 to 12 percent in 2011.

Zuhoor Marai, 23, is among the students who have benefitted from these initiatives. She enrolled in a special year-long preparatory program run by Technion, similar to the one for Haredi students, and attends Technion on a full scholarship.

*Technion Electrical Engineering student Zuhoor Marai*

Marai opted to major in electrical engineering – even though there are only two other Arab women and about a half-dozen Jewish women in her year in the department. She wants to work in High-tech and someday start her own company, but takes some ribbing from her family about her studies. "When they hear about a female studying electrical engineering, they think you are studying to be an electrician," she said.

For Marai, who grew up in a mixed Jewish-Arab neighborhood of Haifa, the challenge hasn't been interacting with her Jewish peers. The challenge has been handling the academic pressure.

"At home, you have teachers who know you for 12 years – who know

who you are, how you will manage." she said. "At Technion, no one knows you and there is a lot of pressure to prove yourself. But if I want to be the best at what I'm doing, I have to enter the best university. And I think that in the engineering fields, Technion is the best."

## Technion Comes to New York

For all its work on challenges like integrating non-traditional students, Technion's boldest step into the future by far is its partnership with Cornell University to open a new interdisciplinary engineering campus in New York City.

In December 2011, Mayor Michael Bloomberg announced the selection of the Cornell/Technion team to build an 11-acre campus focused on applied sciences and engineering on Roosevelt Island in New York. The campus – which will be given free land and $100 million worth of infrastructure improvements by the city – will ultimately include 2 million square feet of classrooms, labs and other facilities, accommodating up to 2,500 students and nearly 280 faculty members by 2043.

The project will make history in many ways. It's an ambitious play to turn New York into a global leader in technological innovation to rival Silicon Valley or Boston's Route 128. It will also create one of the most environmentally-friendly campuses in the world. The initial academic building, if completed today, would be the largest net-zero energy building in the eastern United States – meaning it will harvest as much energy from solar power and geothermal wells as it consumes on an annual basis.

Cornell will pay for construction and have ultimate control of the site, but Technion and Cornell will collaborate in designing curriculum, selecting students, and hiring and supplying faculty. The academic program will be built around three interdisciplinary "hubs" – connective media technologies that can apply to everything from finance to social media; health care industries; and sustainable urban development. A key attribute of the partnership between Cornell and Technion is its specific focus on strategies to spur innovation and commercialization. An integral

*NYC Tech campus (artist's view): Cornell and Technion collaborate*

part of the campus will be the Technion-Cornell Innovation Institute (TCII), a 50-50 collaboration between the two universities to form a graduate program that will focus on technology transfer of immediate relevance to the city's economic growth.

The Cornell/Technion team was up against high-powered competitors including Stanford, New York University, Carnegie Mellon and Columbia

*From left to right: Technion President Peretz Lavie, Cornell President David Skorton, and New York City Mayor Michael Bloomberg*

University. But city officials said they were won over by the combination of Cornell's familiarity with New York and Technion's track record in educating entrepreneurial engineers, generating successful technology startups and retaining its graduates in a high-tech ecosystem close to the campus – as well as by both institutions' academic excellence.

"Of all the applications we received, Cornell and Technion was far and away the boldest and most ambitious," Mayor Bloomberg said. "In a word, this project will be transformative."

For New York, the potential benefits of the the Technion-Cornell campus are sweeping. City officials estimate that the campus will spin off 600 new businesses over the next generation, creating 30,000 permanent jobs and as much as $1.4 billion in tax revenue. The project will include a $150 million venture capital fund for startup companies that agree to remain in New York for three years, as well as math and science education support for 10,000 city children.

"When people look back a hundred years from now, I believe that they will remember today as a signal moment in the transformation of the city's economy," said Robert K. Steel, Deputy Mayor for Economic Development. "This is an inflection point in an economic renaissance that will position New York City for outsized success in the decades and centuries to come."

For Technion, the benefits include increased opportunities to collaborate with American academics and business leaders; broadening public knowledge and appreciation for the university; and deepening the university's ties with the American Jewish community. "Technion can become a focal point for the Diaspora, particularly for Jews involved with technology or for young Jewish men and women who want to study engineering," President Lavie said.

For the State of Israel, too, the project creates unprecedented opportunities for deepening ties and goodwill. Recent years have seen a rush of American universities setting up campuses overseas to share their expertise with the world.[35] But Technion-Cornell campus is one of the

few instances of a foreign university being invited to bring *its* knowledge and resources to America.

"Israel is always in the news about problems with Iran or the Palestinians, but now the story is about how knowledge from Israel is coming to help the U.S. – in a city that is at the center of the world," Lavie said.

## An Island of Beauty

Long before the Technion-Cornell collaboration on NYC Tech, Cornell University inspired what became a spot of immense beauty and utility at Technion.

Smack in the center of Technion's campus is a major surprise: A serene, somewhat secluded island of beauty, a stark contrast to the chrome, aluminum and glass that comprise Technion's research labs. The island is Technion's Ecological Garden, established in 1982 by the late Professor Zev Naveh, a world pioneer in landscape architecture. The garden covers five acres and has more than 900 types of plants with special biological, ecological or ornamental value, that require little water or care. The pools in the garden recycle water from the Amado building on campus.

*The late Prof. Zev Naveh, landscape architecture pioneer*

The garden reminds us that Technion graduates produce works of beauty as well as new technology. Zev Naveh, who co-authored the first English-language textbook on landscape architecture, had a fascinating life story. He was born in Amsterdam in 1919, grew up in Germany, and in 1935 emigrated to Israel (then Palestine) with Youth Aliyah, an organization that rescued thousands of youngsters from the Holocaust. He and friends founded a kibbutz, Matsuba, in the hills of the Western Galilee. There Naveh helped reclaim rocky slopes for cultivation and herded goats and sheep. This was the start of his intense visceral connection to the Mediterranean hill and mountain landscapes.

After completing agronomy studies at the Hebrew University, Naveh became a Technion faculty member. His focus was on a total human ecosystem approach to landscaping, integrating people and their environment, long before this notion was common or popular. Naveh collaborated for years with Cornell Professor Arthur Lieberman, also a leader in landscape ecology, and co-author of Naveh's pioneering textbook.

During a visit to Cornell, Naveh was impressed by the thousands of trees on its beautiful campus, "Cornell Plantation", used both for beauty and for research. He decided to initiate a similar garden at Technion. "Not a botanical garden!" Naveh insisted, "This garden must combine beauty and functionality, to become a center for instruction, research and testing, a center for conservation, restoration and landscape enhancement, with plants that can withstand harsh conditions." The result was the Ecological Garden.

## Tomorrow's Einsteins

Could Chaim Weizmann and Martin Buber have imagined any of this – 67,000 graduates, a $60 billion impact on the Israeli economy, three Nobel Prize winners, and a New York campus – when in 1901 they called for a Jewish "Technikum" in Palestine? Could Albert Einstein have imagined it in 1924 when he became chairman of the first Technion Society?

The benefits that Technion has brought to Israel and the world over the past century are the result not of one or two famous leaders, but of tens of thousands of people working together – faculty, staff, donors, friends, alumni.

And students – who will be the ones fueling Technion's next century of dogged research, ground-breaking discoveries, technological spin-offs and international impact.

Today, though, those students are preoccupied with more immediate things. Homework. Midterms. Friends. More homework.

Compared to American college students, Technion undergrads seem remarkably focused and serious. But then, most have been through at least three years of military service already. They arrive with clear goals and an appreciation of the opportunity they've been given.

On one typical autumn day in the student food court, a group of four urban planning students chat and arrange their evening carpool home to Tel Aviv. They find the commute worthwhile, both for Technion's strong academic program and its diversity. "In Tel Aviv, you find one type of student – Jewish, young, mostly from families with a good financial background that enables them to live in Tel Aviv," one says. "Here it's different. There are a lot more Arab students, a lot more Russians."

Nearby, 24-year-old Saar Zehavi mulls over a math problem while eating a sandwich. Zehavi has a busy schedule: as a first-year student, he is taking calculus, linear algebra, physics, computer programming and digital systems, as well as volunteering with a group that educates high school students about driver safety.

" … Technion is the place that inspires excellence," says Zehavi, who is from Petach Tikvah. "I want to do something new, make this world a little better, maybe start a company. Technion is probably a better place to find people to do that with."

A few tables away, Irit Shwartz and Kinneret Lipovski trade ideas from their third-year aerospace engineering classes. They both wear rubber bracelets from NASA that say "Failure is not an option."

Lipovski became interested in aerospace engineering when her army

*Technion students: Creativity, excellence, startups*

service brought her into contact with satellites. Shwartz was inspired by the death of Israeli astronaut Ilan Ramon in the Columbia space shuttle disaster. "I was 14 when the Columbia disaster happened, and I wanted to continue in Ilan Ramon's path," she says. "I would like to be an astronaut, but my mother says no."

Shwartz and Lipovski are among a relatively small number of women in aerospace engineering. But they don't mind their minority status – or Technion workload.

"It's kind of a known fact that you come here and you lose your social life," Lipovski says. "Usually you can go out a bit when the semester starts. But then come midterms, and you don't leave the house much. But it's worth it… Plus it's very nice to see everyone's response. When you say you go to Technion, they say 'Wow!' Even more so when you're a girl. And even more when you're in aerospace engineering! It makes me proud to be among such a small number."

And then there is Aharon D., the fourth-year civil engineering student from the ultra-Orthodox family whom we met in that quiet nook of the Civil and Environmental Engineering building.

Aharon was among the 30 students in Technion's first preparatory program targeted at the ultra-Orthodox. When he signed up for the program at age 25, he did not tell his father or mother or anyone other than his wife.

It was a brutal transition. Aharon had spent his entire life in yeshiva studies. He knew no English, had never studied science, and his math skills stopped after addition and subtraction. The first time that a professor wrote an algebraic equation on the board, Aharon had no idea what the symbols meant. He had never taken a written test of any sort in his life.

"At the beginning it was very hard, until I got into the way of thinking," he recalls. "But I never gave up. And Technion helped me out. Normally you need passing grades in English, but because I was good in math and physics, they let me skip the English. They were very positive in helping me, and in realizing I was not an ordinary student – I had three kids who would start jumping on me at 6 a.m."

Because of his lack of experience with testing, Aharon scored 30 percent on his first exam. But his second garnered a 97 percent. He was one of 12 students from the initial 30 who finished the preparatory course and enrolled in regular Technion undergraduate studies.

Today, he balances coursework with raising his three kids and with paid work at a local cemetery. About a year ago, he told his parents about his new life and they accepted it. He remains ultra-Orthodox and is educating his own son in a yeshiva – but with the addition of a private tutor to make sure his son learns English.

And when he finishes?

Aharon hopes to continue for a master's degree – and eventually, a job as a professor of civil engineering. That may sound like an impossible dream, but so did Aharon's application to Technion five years ago.

So did Technion itself a hundred years ago.

Already, he is serving as a teaching assistant.

# Epilogue

In this book, we've tried to show how powerfully Technion has placed its stamp on Israel and on the world. Now this has become true, literally. In January 2012 an official stamp was issued, with face value of NIS 2.60, known as the Technion Cornerstone Centennial Stamp. Designed by Naama Tumarkin, the stamp shows the original Technion building created by architect Alexander Baerwald. And on the stamp, emerging from the building, is a "nano-parachute" developed by Technion Distinguished Professor Daniel Weihs, Professor Alexander Yarin and Professor Eyal Zussman.

The nano-parachute serves as a highly sophisticated detector of airborne toxins and could help defend Israel from a biological or chemical attack. It is made of nano-fibers with diameters of less than 1,000 nanometers, about 1/100 of the width of a human hair. These tiny parachutes change color in the presence of toxic gases, providing rapid and valuable information about the type of toxins present. This in turn enables quick response by military and civilian workers charged with treating and preventing injuries. The stamp's first day cover, a ceremonial document created for its initial release, also features icosahedrons – the 20-sided quasicrystals discovered by Nobelist Dan Shechtman and later found as icosahedrite in nature.

Technion Nation has placed its indelible stamp on Israel and on the world. And Israel, in return, has placed Technion on its stamp. For both nations, Technion and Israel, the future remains bright.

# APPENDIX

## NASDAQ-listed Companies with Technion Leadership (Founder and/or Senior Management)

| | | | | **Mkt Value $ million** | **Revenue $ '000** |
|---|---|---|---|---|---|
| 1 | ALLT | Allot Communications Ltd. | Computer Communications Equipment | **484.76** | **56972** |
| 2 | ALVR | Alvarion Ltd. | Telecommunications Equipment | **76.63** | **205815** |
| 3 | AUDC | AudioCodes Ltd. | Telecommunications Equipment | **165.22** | **150040** |
| 4 | BPHX | BluePhoenix Solutions, Ltd. | Information Technology | **16.28** | **57120** |
| 5 | CAMT | Camtek Ltd. | Electronic Components | **71.44** | **87780** |
| 6 | CRNT | Ceragon Networks Ltd. | Radio and Television Broadcasting and Communications Equipment | **306.48** | **249852** |
| 7 | CEVA | CEVA | Semiconductors | **671.55** | **44911** |
| 8 | CIMT | Cimatron, Ltd. | EDP Services | **32.07** | **36074** |
| 9 | CKSW | ClickSoftware Technologies Ltd. | Computer Software: Prepackaged Software | **328.09** | **71019** |
| 10 | CTCH | Commtouch Software Ltd. | Telecommunications Equipment | **81.25** | **18161** |
| 11 | CMVT | Comverse Technology Inc. | Telecommunications Equipment | **1290.00** | **1623427** |
| 12 | DMED | D. Medical Industries Ltd. | Medical/Dental Instruments | **7.16** | **357** |
| 13 | DSPG | DSP Group Inc. | Semiconductors | **150.58** | **225482** |
| 14 | ESLT | Elbit Systems Ltd. | Military/Government/ Technical | **1800.00** | **2670133** |
| 15 | EFII | Electronics for Imaging, Inc. | Computer Communications Equipment | **797.84** | **504007** |

| | | | | **Mkt Value $ million** | **Revenue $ '000** |
|---|---|---|---|---|---|
| 16 | ELTK | Eltek Ltd. | Electrical Products | **9.85** | **37514** |
| 17 | EZCH | EZchip Semiconductor Ltd. | Computer Communications Equipment | **925.19** | **61998** |
| 18 | GILT | Gilat Satellite Networks Ltd. | Radio and Television Broadcasting and Communications Equipment | **172.46** | **232985** |
| 19 | GIVN | Given Imaging Ltd. | Medical/Dental Instruments | **560.63** | **157809** |
| 20 | HLIT | Harmonic | Radio and Television Broadcasting and Communications Equipment | **735.55** | **423344** |
| 21 | JCDA | Jacada Ltd. | Computer Software: Prepackaged Software | **7.90** | **17155** |
| 22 | MAGS | Magal Security Systems Ltd. | Telecommunications Equipment | **44.84** | **49699** |
| 23 | MLNX | Mellanox Technologies, Ltd. | Semiconductors | **1480.00** | **154640** |
| 24 | MTSL | MER Telemanagement Solutions Ltd. | Telecommunications Equipment | **8.03** | **11639** |
| 25 | MTLK | Metalink, Ltd. | Telecommunications Equipment | | **813** |
| 26 | MNDO | MIND C.T.I. Ltd. | EDP Services | **45.31** | **19473** |
| 27 | NICE | NICE-Systems Ltd. | Computer Manufacturing | **2360.00** | **689451** |
| 28 | NVMI | Nova Measuring Instruments Ltd. | Electronic Components | **234.64** | **86620** |
| 29 | OTIV | On Track Innovations Ltd. | Semiconductors | **40.80** | **53627** |
| 30 | OBAS | Optibase Ltd. | Real Estate | **20.96** | **1650** |
| 31 | ORBK | Orbotech Ltd. | Industrial Machinery/ Components | **386.94** | **529355** |
| 32 | ORCT | Orckit Communications, Ltd. | Telecommunications Equipment | **17.97** | **17256** |
| 33 | PTNR | Partner Communications Company Ltd. | Telecommunications Equipment | **1370.00** | **1885000** |

| | | | | **Mkt Value $ million** | **Revenue $ '000** |
|---|---|---|---|---|---|
| 34 | PSTI | Pluristem Therapeutics, Inc. | Biotechnology: Biological Products (No Diagnostic Substances) | **112.07** | **8,311*** ** |
| 35 | PBTH | PROLOR Biotech, Inc. | Major Pharmaceuticals | **343.60** | **5220** |
| 36 | RADA | Rada Electronics Industries Ltd. | Electronic Components | **18.66** | **27523** |
| 37 | RDCM | Radcom Ltd. | Computer peripheral equipment | **28.07** | **19173** |
| 38 | RVSN | RADVision Ltd. | Computer Software: Prepackaged Software | **146.98** | **95239** |
| 39 | RDWR | Radware Ltd. | Business Services | **701.84** | **144119** |
| 40 | RTLX | Retalix Ltd. | Computer Software: Prepackaged Software | **446.55** | **207374** |
| 41 | RITT | RIT Technologies Ltd. | Telecommunications Equipment | **20.74** | **11400** |
| 42 | RRST | RRSat Global Communications Network Ltd. | Telecommunications Equipment | **77.19** | **102027** |
| 43 | SPNS | Sapiens International Corporation N.V. | Computer Software: Prepackaged Software | **154.46** | **52235** |
| 44 | SILC | Silicom Ltd. | Computer Communications Equipment | **117.06** | **30399** |
| 45 | ELOS | Syneron Medical Ltd. | Biotechnology: Electromedical & Electrotherapeutic Apparatus | **385.52** | **189528** |
| 46 | TATT | TAT Technologies Ltd. | Aerospace | **39.09** | **79755** |
| 47 | TISA | Top Image Systems, Ltd. | Computer peripheral equipment | **29.28** | **21762** |
| 48 | TSEM | Tower Semiconductor Ltd. | Semiconductors | **250.63** | **509262** |
| 49 | VRNT | Verint Systems Inc. | EDP Services | **1090.00** | **726799** |
| | | | **Total** | **18662.16** | **12652993** |

# Notes

1 Edward Roberts & Charles Eesley. *Entrepreneurial Impact: The Role of MIT.* (MIT Sloan School of Management: Cambridge, MA, Feb. 2009).
2 Dan Senor and Saul Singer. *Startup Nation: The Story of Israel's Miracle.* Twelve: 2009.
3 As of November 2010, 72 NASDAQ companies had their headquarters or main offices in Israel. Forty-nine of those were founded by Technion graduates or had Technion graduates in their senior management. The 49 Technion-led NASDAQ companies are listed in the Appendix.
4 A full report on our survey of Technion graduates, completed by some 4,000 of them, is available as: A. Frenkel, Samuel Maital, *Technion's Contribution to the Israeli Economy Through Its Graduates,* Samuel Neaman Institute report (downloadable at www.neaman.org.il).
5 Zoran was acquired in mid-2011 by CSR, a British wireless communications company.
6 Our alumni survey indicated that 95.6 percent of alumni live in Israel – 47 percent in Haifa and the north, 43.4 percent in Tel Aviv and central Israel, 2.7 percent in Jerusalem, and 2.5 percent in Beersheva and the south.
7 "Nathan Answers Haifa Criticism," *New York Times*, February 1, 1914.
8 "Zionist Outbreaks Due to Language," *New York Times*, January 19, 1914.
9 Carl Alpert, *Technion: The Story of Israel's Institute of Technology*. 2 vols. (New York & Haifa: American Technion Society & Technion, 1982-2001), 1:44.
10 Svetlana Reingold, "War of the Languages: Founding of Technion/Technikum." (Haifa: Haifa City Museum, 2011.) http://haifa.academia.edu/SvetaReingold/Papers/893625/War_of_the_Languages_Founding_of_the_Technion_Technikum
11 Alpert, *Technion*. 1:112.
12 Dan Senor and Saul Singer, *Startup Nation* (New York: Hachette Book Group, 2009), p. 143.
13 Ibid., p. 227.
14 As of February 2012, NASDAQ's web site listed 57 Israeli companies, compared with 10 French, 10 German and 31 from the U.K. (NASDAQ's tally of Israeli firms is less than our list in the Appendix since NASDAQ does not count Israeli-run firms that choose a U.S. office as their listing address.)
15 Senor and Singer, *Startup Nation*, p. 11.
16 Dan Yachin and Oren Raviv, *IHTIA Annual Review Israel ICT Industry, 2010* (IDC: February 2011), p. 5. http://www.iva.co.il/attachments/272_HTIA%20Annual%20Review%20Israel%20IDC%20Industry,%202010.pdf
17 Senor and Singer, *Startup Nation*, p. 18.
18 Clive Thompson, "Batteries Not Included," *New York Times Magazine*, April 16,

2009. http://www.nytimes.com/2009/04/19/magazine/19car-t.html?_r=2&ref=magazine&pagewanted=all

19 A book of these lectures was produced. See S. Maital & D. Shechtman, *Technological Entrepreneurship*, Ateret Publishing Co., Herzliya: Feb. 1996, 248 pages.

20 Based on Dun & Bradstreet (Israel) list of top Israeli executives for 2009 and records of Technion Alumni Association. The most recent D&B list of top Israeli executives can be found at http://duns100.dundb.co.il/indexeng.asp.

21 The net profit figure is an estimate since some of the public companies did not disclose their annual profits.

22 ORL has since that time merged with Carmel Olefins.

23 Barbara Opall-Rome, Yair Shamir interview, *Defense News* (March 2, 2008). http://www.defensenews.com/story.php?i=3382470

24 Author's disclosure: Shlomo Maital, one of the co-authors of this book, is a partner with Ruttenberg in the e-book venture.

25 U.S. Department of Labor – Bureau of Labor Statistics, Weekly Earnings Summary, Oct. 20, 2011. http://www.bls.gov/news.release/wkyeng.nr0.htm

26 Michael Greenstone and Adam Looney, "Where is the Best Place to Invest $102,000 – In Stocks, Bonds, or a College Degree?" (Washington D.C.: The Brookings Institution, June 25, 2011). http://www.brookings.edu/papers/2011/0625_education_greenstone_looney.aspx

27 The average Israeli wage in January 2010 was NIS 8,120, according to National Insurance data, while the average wage for Israelis with 16 years of education was NIS 11,602, according to Central Bureau of Statistics manpower survey data. To convert shekels to dollars we assumed an exchange rate of NIS 1 = $0.26.

28 G.S. Becker, *Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education* (New York: National Bureau of Economic Research, 1964). Also see Becker, "Nobel Lecture: The Economic Way of Looking at Behavior," *Journal of Political Economy*, 101(3): 385-409.

29 For more on this calculation and our methodology, please see our paper "Technion's Contribution to the Israeli Economy through its Graduates," on the Samuel Neaman Institute web site, http://www.neaman.org.il/Neaman/.

30 To calculate the rate of return for the Class of 2010, we attributed Technion's entire undergraduate operating cost to that class. Although in fact the staff and facilities are shared by four classes each year, many of those costs would be incurred whether there were one class or four. So we took a conservative approach of allocating the entire annual undergraduate budget of about $265 million to the class we were studying. Over four years, then, the estimated cost of educating that class would be about about $1 billion.

31 Planning and Budgeting Committee Report in *Technological and Scientific Personnel in Israel,* by D. Getz et al. (Haifa: Samuel Neaman Institute, Technion, 2007).

32 Based on the equivalent of a monthly average of full-time jobs. Source is Israel Central Bureau of Statistics, 2010.
33 A. Bar, *Analysis of the Higher Education Budgetary Proposal for the Fiscal Year 2011-2012* (Jerusalem: Knesset Research and Information Center, Budget Control Department, 2011).
34 Amnon Frenkel and E. Leck, "Investments in Higher Education and the Economic Performance of OECD Member Countries." Paper presented to the 46th Congress of the European Regional Science Association, Volos, Greece, August 30th – September 3rd, 2006.
35 Tamar Lewin, "U.S. Universities Rush to Set Up Outposts Abroad," *New York Times*, Feb. 10, 2008. http://www.nytimes.com/2008/02/10/education/10global.html

# About the Authors

Ilana DeBare is a former reporter for the *San Francisco Chronicle* and *Sacramento Bee*. She is author of *Where Girls Come First: The Rise, Fall and Surprising Revival of Girls' Schools* (Tarcher/Penguin, 2004), which grew out of her experience helping start an all-girl middle school. Ilana currently works as Communications Director for Golden Gate Audubon Society and serves on the board of J, the Jewish newsweekly for northern California. She lives in Oakland, California, with her husband and daughter, and blogs at http://midlifebatmitzvah.wordpress.com.

Amnon Frenkel is a senior research fellow at the Samuel Neaman Institute for Advanced Studies in Science and Technology, Technion. He is chair of the Graduate Program for Urban and Regional Planning at the Faculty of Architecture and Town Planning at the Technion, and member of the board of directors of the Center for Urban and Regional Studies. He is the representative of the Technion at the Israeli National High Committee for Planning and Building, and is the chair of the Israeli Section of the Regional Science Association International. His publications includes books, chapters in books, and many articles with an emphasis on technology policy, and diffusion of innovation in space.

Shlomo Maital is a senior research fellow at the Samuel Neaman Institute for Advanced Studies in Science and Technology, Technion, and a Technion emeritus professor. He served as Academic Director of TIM-Technion Institute of Management for a decade, working with over a thousand Israeli managers and 200 high-tech companies. He has written or edited more than a dozen books, including the latest, *Innovation Management* (SAGE India, 2nd edition, 2012). He writes a regular column for the *Jerusalem Report* and blogs at timnovate.wordpress.com. He and his wife Sharona have four children and a dozen grandchildren.

# Index

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*Technion Nation* tells the story of how Technion's graduates drove Israel's transformation from an economy of Jaffa oranges to semiconductors. It tells how Technion scientists have given the world new forms of matter, discoveries leading to treatments for cancer and Alzheimer's and countless innovations that enrich the lives of people everywhere – winning Nobel Prizes along the way.

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For me, being an engineer is a personality, a character and an aspiration. Aspiration to envision, create and build something new that will make a difference to other people, to society, to the world. For me, as a proud graduate of the Technion, there is nothing that better represents this spirit of creation than the Technion, which itself is founded on an aspiration to build a new nation.

**- David (Dadi) Perlmutter,** *Executive VP, General Manager of Intel Architecture Group and Chief Product Officer, Intel*

*Technion Nation* offers a candid look at the fascinating development and impressive achievements of Technion-Israel Institute of Technology during its first century and its prospects for the future. Frenkel and Maital have done an extraordinary job in documenting the Technion's myriad contributions in education, discovery, innovation and entrepreneurship. Written in a clear, engaging style, the book documents Technion's transformative influences on Israel and far beyond. I highly recommend this book.

**- David J. Skorton,** *President, Cornell University*

There are few institutions like the Technion that can demonstrate so clearly their profound influence on the development of a country. After reading *Technion Nation*, one has to ask "what would the State of Israel be without the Technion Nation?"

**- Prof. Daniel Zajfman,** *President, Weizmann Institute of Science*

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For Advanced Studies In Science And Technology

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