רשות החדשנות
Israel Innovation Authority

2017

Innovation in Israel 2017 overview

innovationisrael.org.il

CONTENTS

Minister of Economy and Industry
MK Eli Cohen

Photo: Yosi Aloni

Israeli innovation is a role model for the entire world. Delegations from around the globe frequent Israel on a regular basis to learn about the wonderful local innovation eco-system and to understand how a small country of only 8.5 million people has succeeded in becoming a world leader in this field. Pioneering Israeli technological innovation, the dimensions of which in relation to the total economy are exceptional, has justifiably earned us the name 'Start-up Nation'. Indeed, this is the very nature of Israeli society – innovative, entrepreneurial, and confident in its ability to lead and change the reality in which we live.

Israel was also a pioneer in realizing the importance of R&D and innovation to the country's prosperity. Already 45 years ago, with the establishment of the Chief Scientist's Bureau in the Ministry of Economy, we strove to promote cooperation between the government and the private sector with the objective of advancing R&D and innovation processes. This was undertaken out of an understanding that investment in innovation is the key to sustainable economic prosperity and to the creation of tremendous economic productivity and value. However, the value of innovation is not solely economic, but also exercises valuable diplomatic influence: for many other countries, Israel represents a primary target for potential collaborations in fields of science and technology.

The Innovation Report published each year by the Israel Innovation Authority has already become an honored tradition. It encompasses the range of achievements and challenges of innovation in Israel and signals the direction towards which we aspire. In so doing, the Authority is fulfilling its role as the body responsible both for advising on the formulation of innovation policy and for the efficient and high-quality implementation of this policy. This report details the Start-up Nation's achievements during the last year and the challenges we face in the future.

The Innovation Authority constitutes and important and central part of my Department's operations. I am convinced, that with the leadership of the Innovation Authority, the Ministry of Economy and Industry as a whole will meet the central challenges of the coming years as detailed in the report. Specifically, it is our intention that Israel maintains its position as a leader of technological innovation while simultaneously harnessing its resources for the benefit of Israeli industry in general and in the periphery in particular.

Best Wishes,

MK Eli Cohen,
Minister of Economy and Industry

Director of the Innovation Authority
and (Acting) Chief Scientist in the Ministry of Economy and Industry
Nachum Itzkowitz

We are honored to present the "Innovation in Israel – Situation Report 2017".

The Israel Innovation Authority was established in order to advance innovation and R&D in Israeli industry in general, and knowledge-based industries in particular, while constantly adapting its operations and availability to the changing needs of the economy. The executives and staff of the Innovation Authority, led by the CEO Aharon Aharon, are active via a wide range of channels within the Authority's spheres of operation in order to achieve these objectives. This report gives fitting expression to this diverse and worthy endeavor.

The Authority's management and employees, together with the board of directors, are currently engaged in the formulation of its operational strategy for the coming years. We are presently contending with the challenges involved in the next quantum leap of Israeli innovation, this alongside the many assets at our disposal and the important opportunities that can be leveraged for the benefit of the industry as a whole. The State of Israel has hitherto succeeded in making significant decisions resulting in impressive achievements and pronounced advancements for the high-tech industry. The consequent branding of the State of Israel as the 'Startup Nation', flourishing as a result of these decisions, constitutes a role model for the rest of the world.

We must strive to preserve this standing and to provide the industry with all the necessary resources for doing so including aspects of finance, taxation, human capital, connections with academic institutions and research institutes in Israel and around the world, and others. To this end, the government offices responsible for advancing Israeli innovation, specifically the Ministry of Finance and the Ministry of Economy and Industry (in charge of the Innovation Authority), must play their role in this mission. Within this framework, collaborations between the various units of the Ministry of Economy and Industry, led by the Minister himself and the department management, are of vital importance. The Innovation Authority must act in conjunction with the Authority for Promotion of Investments in R&D towards advanced production; assist, together with the Foreign Trade Administration, in advancing export opportunities for Israeli industry; and promote a comprehensive policy that encourages Israeli innovation and R&D, together with the Bureau of the Chief Scientist who also serves as the Chairman of the Innovation Authority.

I believe, as written in our bible, that: "those who sow in tears, will reap in joy." (Psalms 126:5)

I am proud to take this celebratory opportunity to congratulate the incoming Chief Scientist and Chairman of the Innovation Authority, Dr. Ami Appelbaum. Since being "called to duty" several months ago, it has been my privilege to lead this fascinating organization while still serving as Director of the Investment Authority. I gladly agreed to the Minister's request to devote myself to this mission and have had the opportunity to contribute significantly from my extensive experience acquired over the years. I wish my friend Ami every success in his important capacity and am sure that the many roles he has fulfilled throughout his career will prove a true asset to the Israeli high-tech industry.

I wish you all a blessed and sweet New Year,

Nachum Itzkowitz
(Acting) Chief Scientist in the Ministry of Economy and Industry and Director of the Innovation Authority

CEO, Israel Innovation Authority
Aharon Aharon

Photo: Shlomi Amsalem

When I decided a year ago to join the Israel Innovation Authority as its first CEO and leave one of the most sought-after jobs in the Israeli economy (CEO of Apple), I was uncertain as to what the future held. After a little over six months during which I have devoted all my time and efforts to my new job at the Authority, the feeling of mystery has been replaced with a sense of a mission. There is nothing to compare to the weight of responsibility that accompanies me each and every day as I come to work in order to fulfill the Authority's mission – the preservation and strengthening of the Israeli high-tech system while simultaneously harnessing it to the other industrial and social spheres.

Indeed, the mission we have been entrusted with is especially challenging. Not just to assist hundreds of companies every year to develop advanced technologies, some of which feature frequently in the amazing success stories of Israeli high-tech, but also to strive for integration of wider circles of the Israeli economy in the worlds of technological innovation. These circles touch sectors of the population under-represented in Israeli high-tech, primarily women, Arabs, Haredim and older workers, but also traditional industries that have yet to adopt innovation as a business strategy.

In order to successfully meet these challenges, the Innovation Authority had been structured into Innovation Divisions alongside administrative units, responsible for designated missions and clientele. This has been done with the objective of adapting the supportive tools to the challenges and needs of the companies and entrepreneurs, as well as improving the service provided to our clients. The Authority's Innovation Divisions reflect the full life-cycle of the entrepreneurs and their companies – the academic researcher searching for the business partner to turn his pioneering study into a practical application, the lone entrepreneur with the idea and daring to take risks and succeed, start-up company employees investing their efforts and talents to develop innovative technologies that will change our lives, the company that has already burst on to the market and is in the midst of its growth and expansion, and leading global corporations seeking to invest and generate the most from Israel's unique and robust innovation eco-system. It is our role to lend the optimal support to all these bodies in the range of different technology fields: software, electronics, life sciences, energy, manufacturing technology and others.

The Innovation Authority is a public body, investing Israeli tax payers' money in order to strengthen the Israeli economy. I regard the wise and efficient use of every tax-payer's shekel we invest to be of the upmost importance. I was therefore happy to find at the Authority a professional and dedicated group of public servants, investing great effort and performing their jobs at the highest level out of a deep sense of duty. With such a high-quality team at the Authority, I am convinced that we will succeed in fulfilling our mission over the coming years.

During the past year, we said goodbye to several employees and this is an opportunity to mention three of them who retired: Lydia Lazanes who served in her last job as Deputy Chief Scientist for budgeting and retired following 40 years in the Chief Scientist's Bureau; Ya'akov Fisher who for the last decade directed the Tnufa Program; and Ilan Peled who retired after 20 years during which he led the MAGNET Administration (today the Technology Infrastructure Division). All three were public servants of the highest degree and we owe them our thanks. In addition, Avi Hasson, the outgoing Chief Scientist, this year completed a six-year tenure. Avi has a founder's share in the establishment of the Authority and I wish to extend him our thanks.

In conclusion, I wish to thank the Authority's Strategy Division and Marketing Department for leading the process of composing, editing and publishing this report. We have made every effort to present a report that is accessible, clear, and comprehensive while detailing the challenges and opportunities facing the Israeli innovation system. I hope that we have succeeded.

Aharon Aharon
CEO, Israel Innovation Authority

רשות החדשנות
Israel Innovation Authority

Chapter 1

Innovation in Israel

Developments in Industry and Government 2016-2017

The Israeli high-tech industry is dynamic and constantly changing. What happened to the High-Tech Index, what are the prominent financing trends, and which regulatory changes were introduced? Developments in high-tech 2016-2017

INNOVATION IN ISRAEL - DEVELOPMENTS IN INDUSTRY AND GOVERNMENT

2017-2016

A Continued Surge in the Startup Companies; Several Achievements for the Mature Companies

A 20% increase in the scope of the average financing round and growth in later rounds — $7.2 M

Total capital raised by startup companies in 2016. The Israeli industry **breaks the record again** — 4.8B

The ratio of **service exports** out of the total high-tech exports **continues to climb** — 20%

Total high-tech exports in 2016 - the growth trend continues — $43 B

The ratio of acquisitions by local companies out of the total acquisitions of Israeli high-tech companies is **on the rise** — 25%

Total acquisitions by Israeli high-tech companies in 2016 — $8.5 B

Total acquisitions by Israeli high-tech companies in 2016

PLARIUM	NeuroDerm	MOBILEYE
$0.5 B	$1.1 B	$15.3 B

Government activity: regulatory easing measures and a solution for the human capital shortage

- **National program for increasing the number of skilled personnel in the industry**
- **Removing obstacles to mergers and acquisitions**
- **Tax benefits for high-tech companies**

The Process of Foundation is Complete – The Innovation Authority is Stepping up a Gear

The Innovation Authority was established in 2016 and began full operation in 2017

NIS 1.4 million
the average grant awarded during 2016

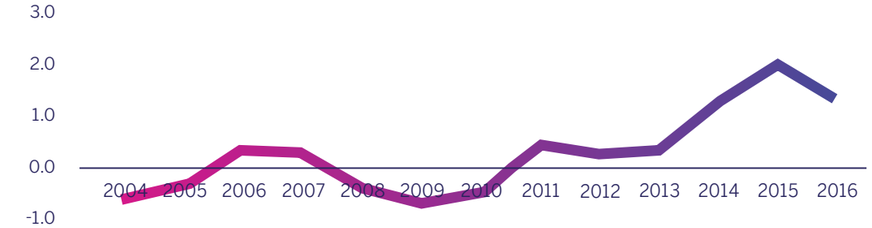
1115 projects of **650 companies** - supported by the Authority in 2016

NIS 1.6 billion
The Innovation Authority's annual budget

The High-Tech Industry in Israel – The Surge Continues

In 2015, we were witness to the peak of the Israeli high-tech industry's performance, as was reflected by the **Innovation Authority's High-Tech Index** (see below). In 2016, the high level of performance has been maintained, although a slight decline has been recorded in several indicators, expressed in both the Start-Up Companies Sub-Index and in the Mature Companies Sub-Index. This raises a question – **does this level reflect the glass ceiling of high-tech performance given its present limitations (mainly the shortage of skilled labor)**? Alongside a discussion of the industry's performance during the years 2015-2016 as reflected by the various weighted indicators in the High-Tech Index, in this section we will also present initial indicators of high-tech performance in 2017.

DIAGRAM 1: **HIGH-TECH INDICES 2004-2016**



What is the High-Tech Index?

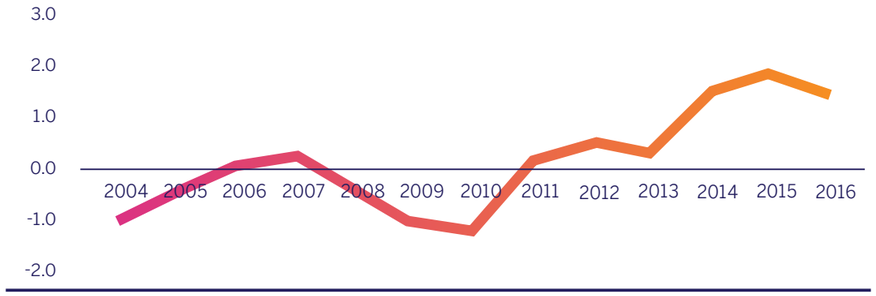
The High-Tech Index is a synthetic index created by the Innovation Authority's Strategy and Economy Division. The index is intended to reflect the different levels of activity in the Israeli high-tech industry. The index is divided into two sub-indices: **The Startup Companies Sub-Index and the Mature Companies Sub-Index**, out of an understanding of the fundamental differences between the large mature companies and the startup companies operating in the local market (for more details on the indicators comprising the index and their values throughout the period of their use, see the appendix to this chapter). The cumulative result of the index itself incorporates a weighted calculation of these two sub-indices.

This year, with the cooperation of Prof. Camil Fuchs, the methodology used for calculating the index was revised. The main adjustments are surveyed in depth in the methodology appendix that can be found on the Authority's website under Strategy and Economy Division Publications.

http://economy.gov.il/RnD/Documents/HiTechIndex.pdf

As we did in previous years, in discussing the high-tech industry, we are continuing to distinguish between two groups: the startup companies group and the group of mature companies. **In the group of startup companies, we saw a continuation of the positive and consistent trend that began with the end of the global financial crisis, even if at a slightly lower level than the peak of last year** (See Diagram 2).

DIAGRAM 2: **THE HIGH-TECH INDEX – STARTUP COMPANIES SUB-INDEX, 2004-2016**



The large scope of funds raised by high-tech companies had a significant influence on this result. According to the IVC Research Center, approximately USD 4.8 billion flowed into the companies' cash reserves, a figure that constitutes a new Israeli yearly record. This is while in the United States, venture capital investment actually declined for the first time after five consecutive years of growth. Furthermore, the financing rounds themselves were larger than normal: **the average round stood at approximately USD 7.2 million, some 20 percent more than the average during the previous five years**. Specifically, the average round in advanced stages[1] grew from approximately USD 20 million in 2015 to USD 25 million in 2016[2].

2017 commenced at a similar pace with USD 2.3 billion being raised during the first half of the year, 75 percent of which was in mid-stage and late-stage deals (all with a scope of at least USD 10 million per transaction)[3]. These results apparently testify both to the maturity and readiness of the Israeli companies and also to higher investor willingness than in the past to become involved in follow-up investments at later stages.

A slight decline in relation to 2015 was registered in the net addition of new startup companies (companies opened less those closed), but it should be mentioned that a net increase of more than 600 companies to the total number of start-up companies is a significant addition of which many countries would be proud.

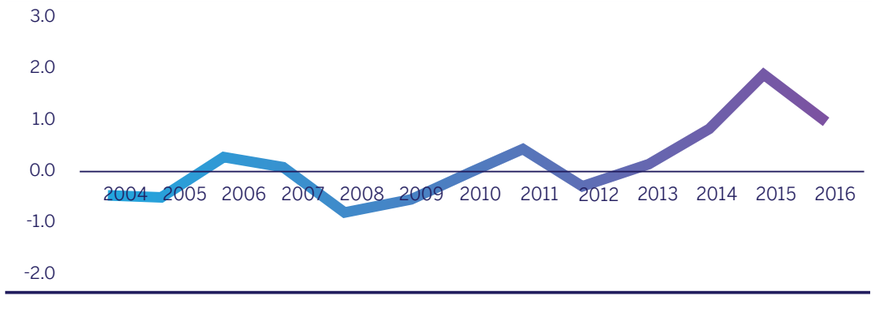
The scope of 'exits' during 2016 was slightly lower than in previous years, however it is important to mention that consensus regarding this figure is not universal, specifically concerning the definition of an "Israeli exit"[4]. Nevertheless, the scope of exits may yet reach a new record in 2017, this in light of several huge deals that have been completed this year: the closing of the Mobileye sale to Intel for the sum of USD 15.3 billion[5]; the sale of NeuroDerm, that had enjoyed the support of the Innovation Authority since inception, to the Mitsubishi Corporation for USD 1.1 billion, and the sale of Plarium to the Australian company Aristocrat for USD 500 million. This figure testifies again to the attractiveness and high technological level of the Israeli startup companies but also presents a policy challenge – how to retain more of the fruits of Israeli high-tech in Israel when the technology giants are eager to acquire Israeli technology in its early stages. This issue is discussed in the chapter on the Innovation Authority's strategy in this report.

1 Series B and onwards.
2 Geektime (January 2017). Annual Report 2016: Startups and Venture Capital in Israel
3 IVC figures
4 IVC reported on a total of USD 10 billion in 2016 while PWC reported only USD 3.5 billion. The difference stems from disagreement regarding the inclusion of the Playtika acquisition by a Chinese consortium and with the participation of the gaming corporation Giant Interactive, from the previous owners Caesars Interactive Entertainment who were also not Israeli. For the purpose of calculating the index, use was made of the IVC figures without the Playtika transaction.
5 Mobileye had already evolved from the startup to developed company stage prior to the acquisition. Accordingly, it can be said that this deal should be considered a merger and not an 'exit'.

One huge 'exit' that stood out during 2017 expresses the unrealized potential within the Israeli pharmaceutical industry. The Kite Pharma Corporation, with products based on technology developed at the Weizmann Institute, was recently sold for USD 12 billion to the American corporation Gilead. Although Kite Pharma was initiated at the Weizmann Institute and is headed by an Israeli, its entire operations are conducted in the United States where it is registered. Furthermore, the majority of its investors and employees are American. The State of Israel will therefore benefit from only a tiny portion of the economic profit of Israeli-developed technology.

The mature companies group displayed a similar picture i.e., positive performance but lower than that of 2015[6], a fact expressed in the decline of the relevant sub-index (see Diagram 3)

DIAGRAM 3: **THE HIGH-TECH INDEX – MATURE COMPANIES SUB-INDEX, 2004-2016**



In 2015, almost all the indicators comprising the Mature Companies Sub-Index rose with noticeable increases in the total value of acquisitions made by Israeli high-tech companies[7] and the total of secondary issues of Israeli companies[8]. These issues served, among others, to finance these same acquisitions. During 2016, most of the sub-index's indicators showed a decline as could be expected following a record year and yet, a number of indicators reflect important achievements. Specifically, the total acquisitions made by Israeli companies continued to climb and reached USD 8.5 billion[9]; the ratio of high-tech employees out of the total employees in all sectors returned to the previous record level – 8.3 percent – at which it stood on the eve of the 2008 crisis[10]; and total high-tech exports reached a record level of approximately USD 43 billion, reflecting an increase of approximately 5 percent (see Diagram 4)[11].

6 The 2016 Innovation Report presented only a partial picture regarding 2015 for the Mature Companies Sub-Index.
7 USD 7.7 billion, after disregarding the Teva-Allergan deal.
8 USD 9.4 billion, compared with the previous high of USD 3.5 billion.
9 According to Start-up Nation Central figures, 24 percent of all acquisitions of Israeli high-tech companies in 2016 were made by local companies.
10 Calculated after adaptation of NBS data by the Strategy and Economic Division of the Innovation Authority. The adaptation included revaluation and historic adjustment of all salaried employees by retroactively adding the number of salaried employees in the I.D.F. (regular and permanent service) including before 2012 (the year in which the NBS began publishing the total figure).
11 According to a combination of data from the Export Institute (for service exports) and the NBS (for industrial exports).

DIAGRAM 4: **RECORD HIGH-TECH EXPORTS; THE RATE OF SERVICE EXPORTS CONTINUES TO RISE**

Total High-Tech Exports (in billions of dollars) and the rate of services out of total high-tech exports (in percentage), 2005-2016

Source: NBS and the Export Institute

The increase in high-tech exports stems entirely from a growth of approximately 20 percent in service exports (that includes mainly computer and software services, R&D services, communications and others). Industrial exports, on the other hand, dropped by approximately 6 percent. The trend of change in the composition of high-tech exports and the diversion of focus from manufacture to services, is expected to continue in coming years, as is already reflected by the results for the first half of 2017[12]. A cause for concern is the recent weakness of the TEVA Corporation that may negatively affect the total Israeli exports as well as the Tel Aviv Stock Exchange.

Global Trends: Are 'Exit' Possibilities Diminishing?

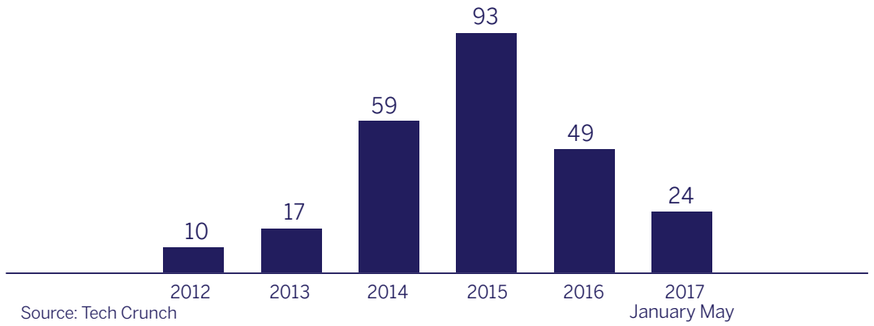
The global innovation system is witness in recent years to two prominent financing trends that could also influence the Israeli high-tech industry.

Firstly, **the "unicorn"' phenomenon (companies valued at more than USD 1 billion), that began to spread throughout the global innovation industry in 2014, sometimes hinders capital raising during advanced stages or 'exits' for start-up companies**. During the phenomenon's early stages, unicorns raised capital on a massive scale, at valuations of billions of dollars. Today, many investors who participated in these capital-raising transactions, are now waiting, sometimes in vain, to see whether these companies will succeed in increasing their value even more, thereby making an exit worthwhile. A current example, recently becoming public knowledge, is the collapse of the American Jawbone Corporation, that developed wearables technology and that at its peak had an estimated value of USD 3.3 billion. The company received an acquisition offer prior to its collapse, that it was however forced to reject as it reflected a value significantly lower than the previous capital recruitment – only USD 1.5 billion.

12 The Trends and Developments in Exports Report – First Half 2017, The Economic Division of the Export institute

DIAGRAM 5: **THE "UNICORN" PHENOMENON BEGAN DECLINING IN 2016**

Total High-Tech Exports (in billions of dollars) and the rate of services out of total high-tech exports (in percentage), 2005-2016



Source: Tech Crunch

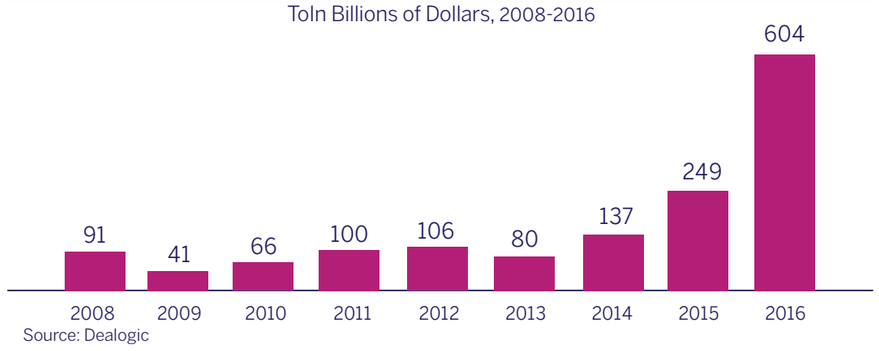
There are those who claim that the deceleration in venture capital investments in the United States during 2016 stemmed, among others, from this phenomenon. Venture capital funds preferred follow-up investments in later-stage companies in their portfolio rather than investment in new and young companies, however the high valuations according to which companies recruited capital between 2014-2016 hindered implementation of successful follow-up investments. Nevertheless, the first half of 2017 has witnessed a trend of recovery in the global venture capital industry. Specifically, during the second quarter, the trend of stagnation in valuations for later cycles ceased and 16 companies became new unicorns[13], suggesting that it is still too early to eulogize this phenomenon.

In any case, it seems that the difficulties created by the unicorn phenomenon have thus far passed over Israeli industry. We are witness in Israel, and indeed worldwide, to an increased emphasis on follow-up investments at later stages and to a parallel consistent increase in the value according to which companies recruit capital. It appears therefore that the valuations assigned to Israeli companies at the market height in 2015 reflected their real value.

An additional global trend is the **consolidation process occurring among the large technology companies**. In 2016, a record number of merger and acquisition transactions was recorded in the international high-tech industry (see Diagram 6), including huge deals such as the acquisition of NXP by Qualcomm for USD 47 billion and the purchase of LinkedIn by Microsoft for USD 28 billion. There are those who claim that this trend may reduce the feasibility of strategic acquisition for young technology companies. This is because the abundance of giant mergers means a reduction in the number of potential buyers, and among those that remain – a depletion of cash reserves and the shifting of managerial attention to the application of integrational processes that accompany mergers.

13 KPMG. (July 2017). Venture Pulse Q2 2017.

DIAGRAM 6: **A SURGE IN THE SCOPE OF MERGERS AND ACQUISITIONS IN THE GLOBAL HIGH-TECH INDUSTRY**



Source: Dealogic

While the possibility of acquisition by larger technology companies is diminishing, the giant corporations, active in other areas, are beginning to express interest in purchasing and assimilating innovative technologies. This phenomenon is part of a broader process of blurring borders between the high-tech industry and "traditional" sectors in which the latter are becoming increasingly technology based. For example, in 2016, the American retail giant Walmart purchased technologies for a total sum of USD 3.3 billion and both Unilever and GM acquired technologies for approximately 1 billion dollars each. Walmart even launched a business incubator for startup companies during 2017 with the objective of investing in pioneering technologies for the retail world. The flip side of the phenomenon is that technology companies are becoming interested in acquiring businesses from "traditional" sectors. One such example is the acquisition of the food retail chain Wholefoods by Amazon. The scope of this trend is still limited however its development should be monitored.

Government Activity – Easing the Conditions for Business and Advancing the Industry's Human Capital

Several steps have been taken by the government in 2016 and 2017 that are expected to prove beneficial to Israeli high-tech. Among these steps are regulatory easing measures and actions to strengthen the infrastructures necessary for the industry.

Firstly, the government has updated the taxation environment of high-tech companies in Israel. This has been done in reaction to publication of the BEPS Regulations that are aimed at preventing the shifting of high-tech companies' profits to countries with more attractive tax regimens and tax shelters around the world. Accordingly, at the end of 2016, **an amendment was passed to the Law for Encouragement of Capital Investments which reduced corporate tax for high-tech companies from 25 percent to 6-12 percent**, depending on the nature of the company. The Amendment also instituted additional tax benefits on dividends and capital gains tax. This development is presented in detail in the chapter dealing with multinational corporations' R&D centers later in this report.

Secondly, in August 2017, **the Knesset passed a bill aimed at removing bureaucratic obstacles and easing the completion of high-tech mergers and acquisitions in Israel.** The objective of the proposed law is to adapt the regulation on companies' structural changes to the needs of the high-tech industry which is characterized by frequent corporate changes and rapid growth. In this light, the law expands the application of tax benefits in cases of various structural changes such as company merger and acquisition and asset transfer. In addition, it removes bureaucratic obstacles such as the need for the Tax Authority's authorization to execute a merger by means of exchange of shares, and in order to implement a vertical split. The proposed law is consequently expected to increase the attractiveness of merger and acquisition transactions for both investors and companies. Thirdly, at the beginning of 2016, the Knesset passed an amendment to the 'Angels Law' that expanded application of a tax benefit granted to individual investors (angels) on an investment in high-tech companies at initial stages of their operation.

Finally, at the beginning of 2017, in light of the shortage of engineers and programmers in the high-tech industry (as presented in detail in the 2016 Innovation Report), **a government resolution was passed to implement a national program for increasing the number of skilled personnel in the high-tech industry.** The program enlists all the relevant government bodies towards this objective and comprises several steps aimed at increasing the industry's supply of human capital. Among others, it was decided that the Planning and Budgeting Committee at the Higher Education Council will act to increase the number of first degree students in high-tech professions by 40 percent. In addition, the Director of Employment will implement steps to integrate sectors of the population currently under-represented in the high-tech industry, primarily women, Charedim, and ethnic minorities. Likewise, the Innovation Authority will act to promote extra-academic training programs relevant to the high-tech industry (see about the 'coding bootcamps' below). Furthermore, a decision was made to implement different steps to increase the potential human capital for the high-tech industry by means of integrating personnel from overseas: returning Israelis, new immigrants and foreign citizens.

The Innovation Authority - The Process of Foundation is Complete

The law on the basis of which the Innovation Authority was established was authorized by the Knesset in August 2015[1], however the Authority itself only commenced operation at the beginning of 2017

As is known, the Authority was set up on the basis of the Office of the Chief Scientist in the Ministry of Economy and Industry. The objective was to optimally fulfill the missions assigned to it by the R&D Law and to provide efficient and high-quality service to the Israeli innovation system. In order to do so, the Authority operates with a structure of Innovation Divisions (see Diagram 1) that allocate a cumulative budget of approximately NIS 1.6 billion each year. The Authority supports companies at all stages of their life and in all innovation sectors via a range of programs (see Diagram 2)

DIAGRAM 1: **THE INNOVATION AUTHORITY OPERATES WITH A STRUCTURE OF INNOVATION DIVISIONS**

Technological Infrastructures	Research infrastructures, pioneering technologies and bridges between academia and industry
Startup	Assistance in creating a sufficient dealflow of technological startup companies and in achieving fundable milestones
Growth	Assisting companies in growing in Israel by means of innovation
Advanced Manufacturing	Propelling the manufacturing industry towards a sustainable competitive path via innovation
Societal Challenges	Propelling the mSupporting technological solutions for social and public causes, increasing and diversifying the supply of high-tech personnel in the Israeli innovation system anufacturing industry towards a sustainable competitive path via innovation
International Collaboration	Aiding Israeli companies' accessibility to global markets, strengthening and financing R&D collaborations with foreign companies

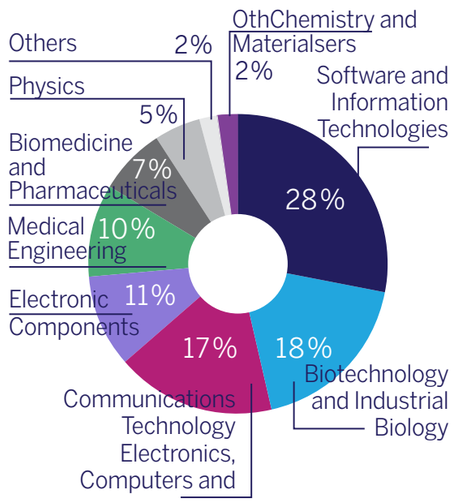
DIAGRAM 2: **AUTHORITY GRANTS IN 2016 - THE NUMBERS**

- 1,115 projects of 650 companies received grants
- 179 entrepreneurs received support as part of the TNUFA Program
- 135 companies received support as part of the Beginner Companies Program
- The percentage of grants awarded out of the approved budget stoodat 53 percent
- The average grant stood at NIS 1.4 million

1 The Encouragement of Industrial Research and Development Law (Amendment 7), 2015

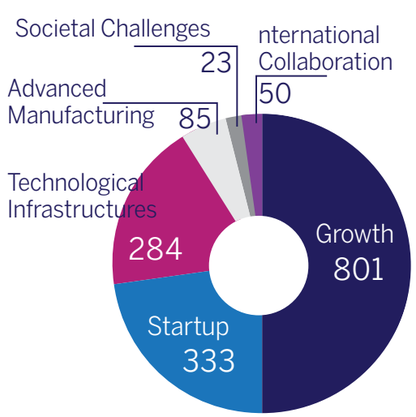
Distribution of Grants in the Growth Division in 2016

According to Technological Classification



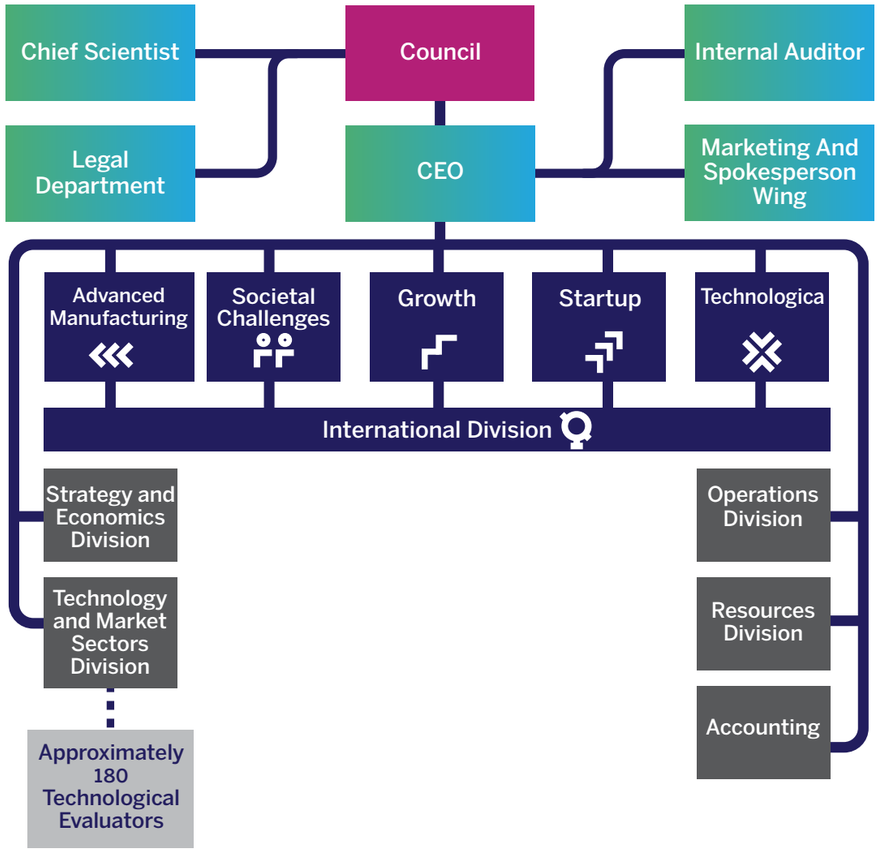
Distribution of Innovation Authority Grants in 2016

(In Millions of Shekels)



Innovation Authority Structure

The Authority's workforce grew this year to approximately 120 employees, and approximately 10 more are expected to join us in the various units in coming months (see Diagram 3). In addition, senior positions in the authority were filled during this last year including the Authority CEO Aharon Aharon. Furthermore, the Authority operates a team of approximately 180 technological evaluators responsible for evaluating the requests submitted to the Authority and for presenting a professional assessment to the different research committees.



Main Activities During the Past Year

The Authority Council, the body responsible for supervision of the Authority's operations and for outlining its direction, has thus far authorized 4 new support programs in addition to those that were transferred from the Chief Scientist's Bureau to the Innovation Authority: Innovation Laboratories and a Biotechnology Incubator within the framework of the Startup Division, 'Coding Bootcamps' under the Societal Challenges Division, and a Multinational Corporations' R&D Centers Program under the auspices of the Growth Division.

The objective of the **Innovation Laboratories** Program is to encourage industrial corporations, with an emphasis on those engaged in advanced manufacturing, to cooperate with technology entrepreneurs as leverage for growth and for the formation of a strategy for the future. This is done via participation in financing the establishment of a unique technological infrastructure and the laboratory's ongoing operation. The laboratories will operate according to a model of open innovation that constitutes a necessary tool for companies' development in the digital era and for their adaptation to sophisticated and constantly developing markets. The initial competitive procedure concluded in July, during which five franchisees were selected: in fields of smart infrastructures (Shikun&Binui and ENEL), a smart factory (Ham-Let), food (Frutarom), urban transport (Renault-Nissan) and smart materials (Merck Performance Materials and Flex).

The **Coding Bootcamps** program, that was initiated as part of the national program for increasing the supply of skilled personnel to the high-tech industry, is intended for players seeking to establish or expand extra-academic training programs for coding studies. Details of this program can be found in the chapter dealing with human capital challenges in this report.

The **Multinational Corporations' R&D Centers** program is a trial program aimed at enabling multinational corporations in the biotechnology and medicine fields to establish or expand R&D, innovation or manufacturing activities in the State of Israel. The program utilizes the changes being made in the tax regimen of high-tech companies in order to expand their economic activity in Israel. Details of this program can be found in the chapter dealing with multinational corporations' R&D centers in this report.

In addition, the Authority recently presented its **strategy for the coming years** before the Authority Council. A summary of the strategy can be found as a separate chapter in this report. The steps detailed all express the transition made by the Innovation Authority this year, from inception to execution.

Innovation Authority Activity: In Practice

Via the different programs it operates, the Innovation Authority supports many technology companies at different stages of their development and in a variety of fields. The following examples represent the fruits of the Authority's investment in Israeli industry:

Yotpo's Accelerated Growth: Yotpo was founded in 2011 and began in the Innovation Authority's Technological Incubators Program. The company develops marketing platforms for online businesses that make use of user content. Following a trend of accelerated growth, Yotpo currently serves 140 million clients each month, and is proud to collaborate with Google, Instagram, Facebook and Pinterest. In 2016, the company raised USD 22 million in a Round C cycle and declared its intention to use this sum in order to expand its operations to several branches worldwide and to examine possibilities for acquiring other companies.

Valtech's Large Exit: The medical device company Valtech was founded in 2005 and also initially began operation in the Authority's Incubators Program. The company develops advanced technologies that enable the repair and replacement of heart valves via catheterization without the need for open heart surgery. In 2016, Valtech was purchased by the American medical device giant Edwards Lifesciences for the sum of USD 1 billion, after total investment in the company until that stage of only USD 70 million.

Allium Medical's International Collaboration: The Allium Medical Company develops, manufactures and markets minimally invasive medical devices for a range of applications. The company, that was founded in 2001 and registered on the Tel Aviv Stock Exchange in 2007, has enjoyed the support of the Innovation Authority since its inception via several programs. In 2014, Allium Medical signed an agreement with the National University of Singapore (NUS) and its leading researchers to develop and commercialize a unique minimally invasive product for treating Stage 2 Diabetes and obesity. The development and commercialization project was supported to the extent of approximately 50 percent of its cost by the bi-national Singapore-Israel Fund (SIIRD), operating under the auspices of the Innovation Authority for the advancement of R&D cooperation between the two countries. The project is currently in its final stages of development and is expected to progress to the human clinical trials stage at the end of 2017.

רשות החדשנות
Israel Innovation Authority

Chapter 2

Innovation Policy in Israel: Promoting Innovation as Leverage for Inclusive and Sustainable Economic Growth

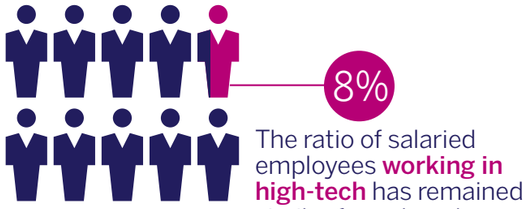
Israel has become a global focus of innovation over recent decades, however, the prospering high-tech sector has largely remained insulated and the majority of the economy has yet to gain from its benefits. This presents the Innovation Authority with an important mission: to preserve and strengthen world leadership of innovation while increasing the resultant economic-social yield

Innovation Authority Strategy

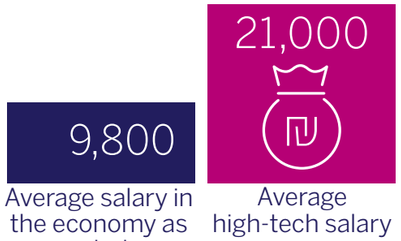
Advancing Innovation as Leverage for Inclusive and Sustainable Economic Growth

Israel is a Technological Innovation Power, especially in the Field of ICT

Technological innovation is the key to economic prosperity, however the financial potential of Israeli innovation has yet to be fully realized



The ratio of salaried employees **working in high-tech** has remained similar for a decade



Average salary in the economy as a whole

Average high-tech salary

The Innovation Authority has formulated a strategy for preserving international competitive positioning and for increasing the economic-social yield from Israel's prospering technological innovation

1 Expanding the field of operation: developing and strengthening complete innovation systems

2 Formulating a Policy Based on a Distinction Between Innovation Systems

In the ICT innovation system: emphasis on increasing the **economic value** of advanced technology and on expanding the **supply of human capital**, alongside preservation of the strengths in the system's other components.

In **export industries**: emphasis on **encouraging R&D and the fostering of the necessary infrastructures**.

Development of further leading innovation systems in Israeli locations with seeds of quality innovation, **and examination of Israel's ability to build a competitive advantage around the worlds that overlap the ICT arenas**

Since the industrial revolution, innovation has been the key to sustainable economic growth. Innovation is a significant component in the two central routes to creating a competitive advantage in a free market: the development of better goods and services or the production of existing goods and services at a lower cost. Furthermore, innovation can change existing markets and create new markets in their place, a phenomenon occurring with increasing frequency in recent decades. It is enough to remember that the I-Phone, the prototype of modern smart phones that have changed our lives unrecognizably, is only ten years old.

Technological innovation is also a key to high-quality and well compensated employment. The large technology companies, that succeeded in leveraging their competitive advantage, employ tens of thousands of workers in an innovative and rewarding environment. Productivity (measured as product per hour of labor) and accordingly, average salary, is higher in technology-oriented sectors than in others. For example, the average salary in high-tech sectors in Israel in 2016 stood at approximately NIS 21000, while the average salary in the economy as a whole was approximately NIS 9800 – less than half[1]. Moreover, the Head Economist's Division in the Ministry of Finance pointed out that social mobility, in other words the ability to climb the earnings ladder, frequently passes through relevant studies and subsequent integration in high-tech sectors2.

In light of the above, it is not surprising that we are witnessing an increased emphasis on innovation during recent years, both among companies competing on the free markets and among economies interested in joining the route to sustainable growth. Our 2016 Innovation Report cited the innovation revolution in China as one such example, one that receives official expression in the Chinese government's relevant five-year plans. In this report, we discuss South Korea that has been transformed from an agrarian, war-stricken country into a leading developed economy via massive investment in technology.

The Israeli Innovation System is Ready to Make the Next Step

Israel burst on to the world scene as a leading center of innovation during the 1990's, after a prudent government investment in the building of a technological infrastructure during the preceding two decades. The leap that Israel made from an economy with an average level of innovation to that a global center of technology, justifiably branded the 'Start-Up Nation', is a role model for both developed and developing countries, and an achievement that we should not relate to lightly.

Today, Israel ranks extremely high in most innovation indices (See Diagram 1), and particularly excels in the intensity of civilian R&D, 4.3 percent of GDP – first in the world in almost every year during the last ten years – and in its entrepreneurial activity. These achievements are the result of decades of intelligent innovation policy at the center of which lies a productive partnership between the private and government sectors

DIAGRAM 1: ISRAEL LEADS IN INNOVATION INDICES

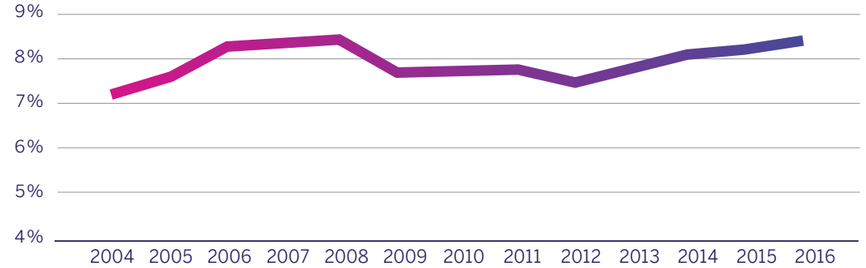
1 National Bureau of Statistics, Statistic Yearbook 2017, Panel 12.33 (2016 data).
2 Chief Economist's Wing, Ministry of Finance (16.6.2017). For more on the connection between academic studies and ascending the socio-economic ladder, see: The Weekly Survey.

A wider view of the Israeli economy however, **reveals that the high-tech sector has largely remained insulated and the majority of the economy's other sectors have yet to benefit from its prosperity**. An important figure testifying to this is the rate of high-tech employees out of the total number of the economy's salaried employees. For more than a decade this figure stood at approximately 8 percent[3] (see Diagram 2), following a rapid rise during the 1990's. Moreover, despite its high technological innovation intensity, the high-tech industry does not contribute enough to narrowing productivity disparity with the developed economies (see Diagram 3).

In addition, in the 2016 Innovation Report we indicated that the Israeli innovation system, after long years as a world leader, is currently positioned at a crossroads. The increasing investment by other countries in technological innovation, combined with the fierce global competition between technology companies and the swift pace of change in these worlds, requires action to renew the rapid growth of the local high-tech sector and to strengthen its connection to the rest of the economy. Standing still, even for just a few years, may cost us the leading position achieved with so much effort over the previous decades, and widen the gap with the developed economies. We must learn from modern history about the pace at which leading economies in science and technology lose their competitive status, mainly against the background of the erosion of the socio-political agreement regarding the importance of innovation, and the decline in required investment of resources

DIAGRAM 2: **HIGH-TECH'S PROPORTION OF EMPLOYMENT HAS REMAINED SIMILAR FOR A DECADE**

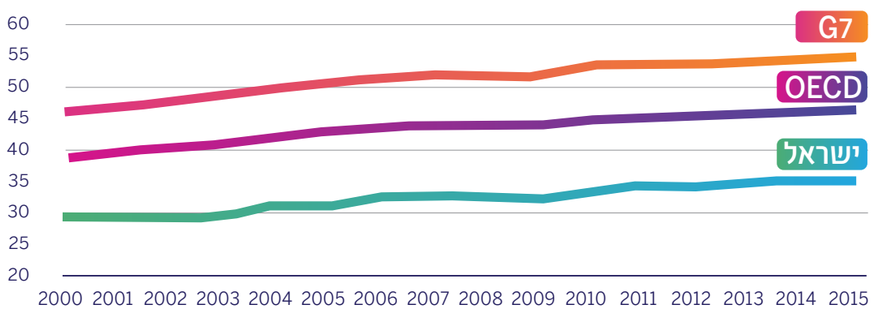
The proportion of high-tech salaried employees out of the economy's total number of salaried employees, 2004-2016



Source: OECD

DIAGRAM 3: **ISRAEL IS FAILING TO CLOSE THE PRODUCTIVITY GAP FROM THE DEVELOPED COUNTRIES**

Product per hour of labor, 2000-2015, Fixed prices 2010, USD PPP



Source: Innovation Authority Adaptation of NBS Data

3 Calculated after processing by the Strategy and Economy Division of the Innovation Authority, based on NBS data. The processing included valuation and historic adaptation of the total number of salaried employees by retroactively adding the number of salaried employees in the I.D.F. before 2012 (the year in which the NBS began publishing the total figure).

Despite all this, it is the Innovation Authority's view that the technological and economic potential embodied in the Israeli innovation system is far from full utilization. We believe that we have the capability to perform another quantum leap similar in intensity and influence to that of the high-tech burst in the 1990's. **We also believe that the Israeli innovation system has the ability to maintain and strengthen its leading technological and entrepreneurial position while simultaneously increasing the socio-economic yield from innovation in a manner that benefits wider circles of the economy**. In order to do so, we must understand the factors preventing Israeli high-tech from breaking the glass ceiling it has encountered in recent years, while distinguishing between several innovation ecosystems, at different stages of development.

ICT – Expanding the Economic Influence

The ICT innovation system (Information and Communication Technology), the most advanced and developed in Israel, has for many years benefitted from a broad and advanced infrastructure that includes: skilled workers, a military system that produces advanced technologies and trains high-quality and experienced personnel, an entrepreneurial culture that yields hundreds of innovative start-up ventures each year, multinational corporations possessing experience, knowledge and a connection to the markets, and a designated and developed government and private finance system (mainly venture capital).

Nevertheless, Israeli ICT has suffered in recent years from two central weaknesses that have prevented it from surging forward. The first is the significant shortage of skilled personnel that serves as the central element fueling the innovation engine. This shortage constitutes an obstacle in the face of future growth and may even harm this field's competitiveness versus parallel systems around the world. One indication of this is the high employment cost of engineers in Israel, reflecting a low level of supply in relation to demand. As an illustration, between the years 2005-2015, the average salary in high-tech rose by 38 percent, the significance of which is even starker for the companies in this sector in light of the 13 percent appreciation in the value of the shekel against the USD during this period.

The system's second weakness is the gulf between the significant technological value it produces and the relatively limited economic impact on the Israeli economy. The Israeli innovation model is largely based on the creation of technological value, mainly in start-up companies and multinational corporations' R&D centers. However, the Israeli innovation system is still in the initial stages of developing efficient mechanisms to capture the economic value resulting from the technological value it produces. The result is that today, much R&D activity performed within the Israeli economy – mainly that in multinational corporations' R&D centers and start-up ventures – is the base for the creation of significant technological value in Israel, while the economic value is captured outside the country.

As will be detailed below, it is our view that this is a changeable reality. The ICT sector's economic influence can be expanded via three central steps. The first step is focused on expanding the supply of skilled workers to the sector (mainly in software) while fully utilizing the pools of potential labor in the Israeli market. These pools of human capital exist chiefly in sectors of the population in which the rate of participation in high-tech is relatively low – women, Arabs, Charedim, and older workers.

The second step is to assist further innovation-oriented companies to grow and expand in Israel as "complete companies". Alongside R&D, a complete company includes manufacture of advanced components, global technological support, product engineering and manufacture, design, global operation, accountancy, finance, logistics and others. The high economic influence of these companies is expressed mainly by their ability to employ large numbers of highly paid workers in different professions the fostering of whom is one of the innovation Authority's central strategic objectives. The welcome trend of growth

companies' development, to which we referred in the 2016 report, testifies to the fact that the aspiration to increase the economic impact of Israeli innovation is not a mere dream.

The third step is the **increase of economic value generated by the multinational corporations' R&D centers in this field**. As will be detailed later in this report, multinational corporations possess a significant positive influence on the Israeli innovation system, with emphasis on the knowledge and expertise that they bring with them, and which trickle down to the remaining components of the innovation system. However, here too, the economic potential of the multinational corporations' activity in Israel has yet to be optimized. These corporations, responsible for approximately half of the corporate R&D investment in Israel, largely operate in Israel in the format of R&D centers with only limited financial influence within other circles of the Israeli economy. The more we succeed in creating appropriate incentives for these corporations to expand their Israeli activity to sections of the value change beyond just R&D, so their impact on the Israeli economy will grow.

The Manufacturing Industries – Jump Starting Innovation and Productivity

If, in the ICT's innovation system, the challenge is in the improved utilization of high-level innovation's economic potential, in the other sectors of the economy the task is even more complex. While the high-tech sectors in Israel present workforce productivity higher than the average among OECD countries, the majority of the economy's other sectors suffer from low productivity compared to their counterparts in these countries[4]. Despite Israel's small territory and its characteristically dense social and professional networks, the innovation and technology created in the high-tech sectors do not sufficiently reach the other industrial sectors.

We place special emphasis on the manufacturing industries which have difficulty competing with the low production costs in developing countries (mainly in the East) but on the other hand, sometimes fail to meet the high-quality threshold of western manufacturing companies. As we elaborated in detail in the 2016 Innovation Report, the main reasons for this are low technological intensity and lack of a sufficient level of innovation, particularly problematic characteristics in an industry that does not benefit from proximity to the main markets or advantages of economies of scale.

It is our belief that the manufacturing industries are also at a crossroads. Without determined and effective action, we will continue to witness the current trends of erosion and the widening of gaps relative to parallel sectors in developed economies. In the face of the wide-scale scope of employment in these industries today, realization of this scenario contains severe ramifications on a socio-economic level: the level of inequality will rise and the separation between the "traditional economy" and "the high-tech economy" will continue to worsen. This polarization also has a geographical aspect, as while high-tech companies are focused in the central region and the other large metropolises, the majority of the manufacturing industry is located in the periphery.

4 'Basic Financeability of the Workers in Israel and Productivity in the Market's Sectors', from the Periodical Fiscal Survey and Assorted Research Issues, Research Division, Bank of Israel, July 2016

On the other hand, harnessing the engine of innovation and entrepreneurship to the manufacturing industry may cause a halt in its erosion and develop for it a sustainable competitive advantage. **Special importance should be given to the integration of the industry in Israel with current technological trends, primarily the 'Industry 4.0' revolution that is leveraging developments in the fields of robotics, Internet of Things, Machine Learning and Big Data, in order to streamline production processes and increase productivity**. Israel's leading position in these technologies, together with the developed local entrepreneurial culture, create the conditions for a significant leap in the level of the manufacture industry's innovation and productivity.

Life Sciences, Agriculture and Food: Enhancement of Innovation Systems

Another innovation system we should consider is that engaged in life sciences, agriculture and food. **In these fields, Israel possesses a range of advantages and even boasts several success stories; however, they have yet to sprout a surrounding sophisticated innovation system**. Specifically, key elements that contribute to the success of the ICT system in Israel, such as a widespread financing infrastructure and multinational corporate activity, are as yet not sufficiently developed in these fields. By developing the lacking elements, it may be possible to leverage these fields' existing comparative advantages to a complete system. **In particular, consideration should be given to Israel's ability to create a comparative advantage based on interface with technological strengths in the ICT field**. This is especially so in those areas which already present growth potential such as medical equipment, digital medicine, personally tailored healthcare and precision agriculture.

The field of medical devices is one of wide-spread activity with approximately 570 Israeli companies[5] that have already yielded several success stories, especially in the medical aesthetics sub-sector in which Israeli companies lead the world market. A further field evolving in Israel in recent years, and one in which Israel possesses valuable assets that can be leveraged is that of digital health. These include firstly, Israel's technological leadership in the field of data processing and secondly, the information, unique in its scope, stored in Israeli medical files. Government action such as the national program for digital medicine and the Mosaic Initiative seek, among others, to enable Israeli industry and academia to maximize the advantages these assets have to offer.

Israeli scientific excellence contains significant potential for the pharmaceutical field. Although necessary for success in this field, such excellence is by itself not sufficient for success. Several research institutions of world acclaim operate in Israel, most prominent among them the Weizmann Institute that was ranked sixth in the world among life science research institutes by the respected 'Nature' magazine[6]. However, research excellence has yet to crystallize into a complete industrial eco-system and commercial successes are few. Nonetheless, recent years have produced the first signs of maturation of the Israeli pharma industry. In particular, we have witnessed a considerable number of companies reaching the clinical trials stages and it is to be hoped that this trend will continue and grow.

5 Israel's Life Sciences Industry IATI Report 2017
6 https://wis-wander.weizmann.ac.il/weizmann-institute-science-ranked-6th-nature-innovation-index-2017-and-1st-outside-us

Plan of Action: Complete Innovation Systems – Infrastructure Development, Investment in R&D, and Creation of Economic Value

The establishment of the Innovation Authority at this time, signals an understanding that an innovation-based quantum leap necessitates a policy change. This change is expressed by the designation of the Innovation Authority's mission – **promotion of innovation as leverage towards inclusive sustainable economic growth.** As such, we have a double task: to preserve and strengthen innovation assets and to leverage these assets better towards the widening of the financial influence on the economy at large.

It is our belief that expansion of economic influence must be ultimately expressed in the increase of the level of employment in innovative companies. In order to attain this goal, we must promote and develop all industrial sectors, whether in high-tech or traditional industries. We believe that a significant breakout of the high-techs bounds will occur only if we succeed in developing leading innovation systems alongside the systems that exist today. Our vision is that large numbers of companies, in all sectors of the economy, will therefore adopt a strategy of technological innovation, use it to develop competitive advantages, and employ workers at high levels of pay and productivity.

The Innovation Authority is striving to fulfill this vision. The Authority's strategy, in accordance with the analysis presented in this chapter, is based on three levels: infrastructure, technology and economic value – while distinguishing between different innovation systems. It should be mentioned that this strategy constitutes a change in innovation policy in Israel, that hitherto concentrated mainly on the second level, i.e., encouraging R&D processes and the creation of technological value

First Level of Action: Innovation Infrastructures

The first level turns to **the development and strengthening of the infrastructures necessary for creating technology and a leading innovation system**, and is expected to occupy a more significant function in government innovation policy than in the past. This level, in which the Innovation Authority acts in conjunction with other government bodies, is built on three central pillars. The first focuses on the **fostering of skilled human capital** – the heart of the Israeli economy's advantage and the basis for all R&D and innovation activity. Here too, the distinction between different innovation systems is beneficial: in the ICT field, there is upmost importance to solving the shortage of skilled human capital for R&D positions, while expanding the participation of sectors of the population underrepresented in the high-tech worlds. In the field of life sciences, there is a sufficient supply of skilled R&D workers. It seems clear however that this industry will benefit greatly from the cultivation of the knowledge and skills necessary to translate scientific research into leading commercial development, such as managing regulatory processes and advancing from prototype to manufacture. Another aspiration should be to enable mobility of skilled workers and knowledge between innovation systems, that would be especially beneficial for sectors not characterized by high technological intensity.

The second pillar focuses on the **investment in research infrastructures**. These infrastructures are essential in many cases in order to enable efficiency and collaborations for creating advanced technologies. In the manufacturing industries, for example, investment in research infrastructures such as innovation laboratories or designated research institutes is critical for the cultivation of an innovation system based on advanced technologies. Occasionally, the public system itself maintains infrastructures that can be made accessible to industry such as valuable medical information in the field of digital medicine.

The Innovation Authority – In Practice: Human Capital, Research and Financing Infrastructures

The Innovation Authority is active in developing and strengthening three important aspects of innovation infrastructure - human capital, research and financing – and will continue expanding its activity in the near future in accordance with the strategy detailed in this chapter.

In the aspect of **human capital**, the Authority has begun operating the 'coding bootcamps', aimed at promoting the establishment of extra-academic coding training programs. These programs are intended to increase the supply of skilled workers for the high-tech industry (for a detailed description, see the Human Capital Challenge chapter in this report). **In the research infrastructure** aspect, the Innovation Authority conducts a variety of programs within the framework of the Technological Infrastructure Division, including programs for supporting industrial research institutes that provide the research infrastructure for the manufacturing industries. In the **financing infrastructures aspect**, the Innovation Authority is active in increasing the scope of credit to growing high-tech companies via a program providing guarantees to banks, currently being formulated.

Second Level of Action: R&D Investment

The second level includes **addressing market failures in R&D investment**, and particularly, bridging the "death valleys" that prevent good companies from reaching the markets, and participating in risk in order to encourage companies to take larger technological risks. Until recently, this activity was the core of government support for innovation in Israel. It continues to constitute a central level in the Innovation Authority's strategy, however if in the past its main objective was to increase the scope of R&D in Israeli industry, today greater importance is attributed to reinforcing the quality of R&D, its market influence and its ability to leverage the company towards significant economic activity.

Addressing market failures in R&D investment is required to an even greater extent in manufacturing industries and other innovation systems in growth stages, in order to establish a global competitive advantage. This activity will also continue to exist in the ICT innovation system whilst focusing on projects of the highest R&D risk, and in additional technological arenas that generate pioneering innovation.

The Innovation Authority – In Practice: Addressing Market Failures in R&D Investment

The Innovation Authority invests in research and development at all stages of technological development and in all branches of innovation. In 2016, the Authority's budget stood at approximately NIS 1.6 billion. The Authority operates via designated innovation arenas that conduct a range of support programs. These programs provide a response for challenges that arise during the various life-cycle stages of companies investing in R&D. The Technological Infrastructure Division is responsible for research infrastructures, groundbreaking technologies, and bridges between academia and industry; the Startup Division assists young and innovative companies in reaching financing milestones; the Growth Division encourages growth of technology companies via R&D investment and the creation of designates supplies of finance; the International Division acts to strengthen and finance R&D collaborations with multinational corporations; the Advanced Manufacturing Division strives to encourage R&D investment in manufacturing infrastructures and to assist in transforming them into innovative and advanced industries; and the Societal Challenges Division supports investment in technology for social and public purposes.

The Third Level of Action: Economic Value Capture

The third level, especially relevant today for the ICT sector, focuses on **the capture of economic value, i.e., encouraging companies to increase the economic value resulting from their core of innovation**. Two central directions of operation in this level are encouraging the cultivation of complete companies in Israel via development of a suitable finance and regulatory infrastructure, and the creation of incentives for multinational corporations to expand the scope and range of their operations in Israel. In this case too, a window of opportunity has evolved around preparations for the implementation of the OECD's BEPS Regulations[7], as will be explained in detail later in the report. A further direction of operation at this level relates to the leveraging of the operations of innovative Israeli companies in global markets. Special emphasis has been placed in recent years on building a bridge to emerging markets and to the strengthening of cooperation with leading countries in Europe, America and the East.

The Innovation Authority – In Practice: Encouraging Technology Companies to Increase the Economic Value of their Activity in Israel

The Innovation Authority has recently begun acting in order to encourage technological companies to increase the economic value of their activity in Israel, and will continue expanding this activity in the near future in accordance with the strategy detailed in this chapter. Accordingly, in 2017, the Authority launched a program for encouraging the establishment and expansion of multinational corporations' R&D centers in the biotechnology and medicine fields. The program emphasizes the expected economic contribution to the economy as the result of the centers' expanded activity. For further details, see the chapter on multinational corporations' R&D centers in this report. In addition, the Authority is striving to expand the supply of credit to high-tech companies in Israel. This activity is directed at supporting the companies' growth and the maximization of economic value from their technological innovation.

If so, the State of Israel can no longer be content with the wonderful achievements of the high-tech industry as an insular system. The Innovation Authority has therefore taken upon itself an ambitious and challenging mission: a quantum leap for Israel's innovation system. We are striving to preserve and strengthen Israel's standing as a global focus of innovation; to spread the high-tech flame – of technological innovation and entrepreneurship – to additional sectors of the economy; and to increase the economic value generated by the bustling technological activity in the field of ICT. Action on all these fronts demands strict strategic planning, broad agreement of all relevant national parties and determined and continued action.

7 The regulations determine that only the country in which intellectual property has been developed may grant tax benefits on the derived income, thereby providing an opportunity for countries that hitherto hosted multinational corporations R&D activity to create a competitive tax regime.

רשות החדשנות
Israel Innovation Authority

Chapter 3

Expanding the Circle: Multinational Corporations' R&D Centers

Alongside the flow of knowledge into the Israeli economy and the high productivity of multinational corporations' R&D centers, incentives must be created for expanding their scope of operation and employment. Adoption of the BEPS Regulations by the developed countries presents Israel with an excellent opportunity for doing so.

MULTINATIONAL CORPORATIONS' R&D CENTERS - EXPANDING THE CIRCLE

The R&D Centers Generate Approx.
50% of the Total Investment in R&D

90% of this Investment in R&D is Assigned to ICT

20% of the R&D Centers Engage in Manufacturing Activity

More than **300** Active R&D Centers

An Average of **20** New R&D Centers are Established Every Year

R&D Centers Acquired more than **100** Israeli Companies

The R&D Centers Create Quality Employment, but in Limited Circles

Approx. **70%** of all Jobs at R&D Centers are in R&D Positions › Compared with Approx. **20%** of all Jobs in Local Companies Engaged in R&D

As Long as the Pool of Engineers Doesn't Grow, the R&D Centers' Demand for Skilled Engineers and Programmers is Expressed Mainly by the Recruitment of the Best Workers

Multinational Corporations' R&D Centers

Fierce Competition Over Too Few R&D Workers

- Startup Companies
- SME's
- Growth Companies
- Large Corporations

Action must be Taken to Expand the R&D Centers' Activity to other Spheres of the Value Chain

R&D › Design › Manufacturing › Marketing › Service and Support

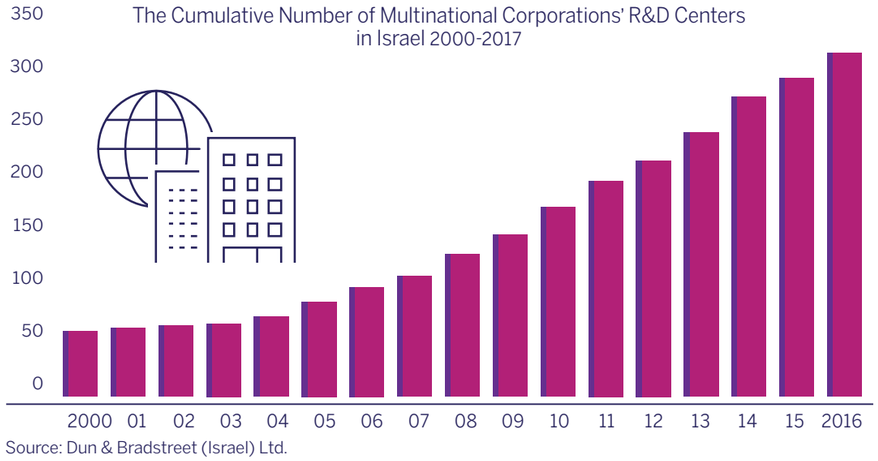
The Government is Striving to Strengthen and Expand the R&D Centers' Activity in Israel

- Adapting the taxation on high-tech companies' to the international environment: Corporate tax on high-tech companies was reduced from 25% to 6-12%; Other benefits on dividend and capital gains tax
- The Innovation Authority is opening a program to encourage the establishment and expansion of R&D centers in biotechnology and medicine
- The Foreign Investment and Industrial Cooperation Authority is acting to attract investment of multinational corporations engaged in advanced manufacturing

The Israeli innovation system constitutes a focus of attraction for the most advanced technology companies in the world. Over recent decades, more than 300 multinational corporations, active at the forefront of technology, chose to establish a research and development center in Israel, and some even operate a number of centers in different fields of development. During the previous ten years, multinational corporations have been thronging to Israel in increasing numbers: between 2007-2016, an average of twenty new R&D centers were established every year[1].

DIAGRAM 1: **MULTINATIONAL CORPORATIONS FLOCKING TO ISRAEL OVER THE LAST DECADE**

The Cumulative Number of Multinational Corporations' R&D Centers in Israel 2000-2017



Source: Dun & Bradstreet (Israel) Ltd.

The establishment of a center, or its expansion, frequently takes place following the purchase of Israeli companies. Over time, multinational corporations operating R&D centers in Israel have acquired more than 100 Israeli companies. A number of multinational corporations – Intel, Microsoft, Broadcom, Cisco, IBM, and EMC – have even acquired more than 10 local companies each during their operations in Israel[2]. This phenomenon reached its peak earlier this year with the purchase of Mobileye by Intel for the sum of USD 15.3 billion, a huge transaction expected to lead to the expansion of both companies' operations in Israel.

This lively activity is sustained by the many assets of the Israeli innovation scene: leading research, skilled personnel, a culture of innovation, pioneering technologies, and flourishing innovation, especially in the fields of computing, communications, and software (ICT). The question naturally arises regarding the degree to which these centers contribute to the local innovation system and the Israeli economy.

1 According to Dun and Bradstreet (Israel) Ltd.
2 According to Start UP Nation Central

R&D Centers Create Significant Technological Value

The multinational corporations' R&D centers (hereinafter: R&D centers) claim a place of respect in the development of Israeli high-tech. The pioneers - IBM, National Semiconductors and Intel – began operating in Israel already in the 1970's and paved the way for the hundreds of companies that followed in their footsteps. Today, **R&D centers comprise an essential element in the Israeli innovation system and create significant technological value**. One illustration of this is the fact that the increase in their activity constituted the primary source of growth of corporate R&D in Israel over the last decade. Since 2005, the R&D centers' share of the business sector's total expenditure on R&D increased from 29 percent to 47 percent[3]. The number of those working in these centers (mainly R&D employees, as will be seen below) increased during this period at an average annual rate of 14 percent, this compared with 5 percent a year in other companies engaging in R&D.

Furthermore, the R&D centers pos**itively influence salary and productivity related aspects of the economy**. A study conducted by the Chief Economist's Division of the Finance Ministry reveals that the salaries of workers employed in multinational corporations are expected to be significantly higher later in their careers than that of workers employed only in local companies[4]. An empiric estimate calculated as part of the study reveals a positive and clear salary differential of 8.4 percent paid by the multinational corporation to any given employee[5]. Another study conducted by the Applied Economics Corporation found that start-up companies established by former employees of multinational corporations grow at a faster rate in human resources and salaries than start-up companies founded by entrepreneurs employed solely in local companies[6]. The R&D center graduates who move throughout their careers between the different players in the high-tech industry, thereby distribute their accumulated technological and management skills – a phenomenon the professional literature terms spillover.

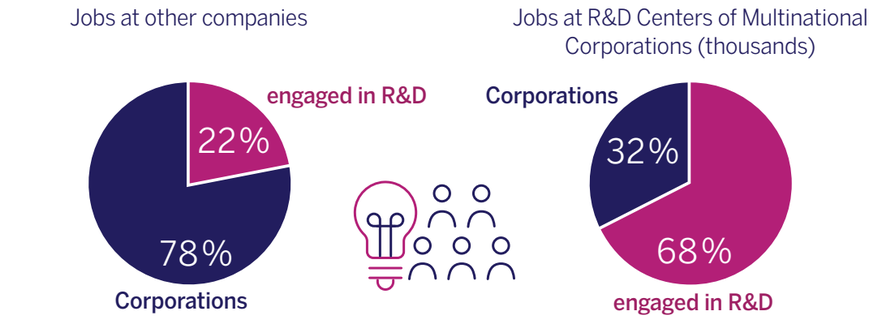
Increasing the R&D Center' Economic Influence

Despite the figures cited above, and as stated in the Innovation Authority's Strategy chapter, the economic impact described here does not adequately summarize the underlying potential in the technological value created by the R&D centers. Specifically, **the overwhelming majority of the centers engage exclusively in R&D activity, while other links in the corporate value chain are active in other countries**. This phenomenon is even more marked when examining the employment aspect of their activity. Although the R&D centers create approximately 40 percent of all R&D jobs in the business sector, the total of all the jobs they provide, including peripheral jobs, constitutes only 18 percent of all positions in companies engaging in R&D. The reason for this is that approximately 68 per cent of jobs in R&D centers are those at the core of the R&D process itself, and most are intended for engineers and programmers[7]. In other words: **these centers create high-quality employment, however only within limited spheres of employment**.

3 National Bureau of Statistics, Corporate Sector R&D Survey, 2014 and annual statistical journal 2016.
4 In a sample of workers employed by multinational companies between 2005-2010, the average salary of workers also employed at the end of the period was higher by 43 percent than the salary of those working in local companies during the same period. The gap grows to 64 percent when examined versus a general sample of workers in local companies (without the requirement of previous employment in multinational corporations).
5 Slobodnitsky, Drucker and Geva; The Contribution of Multinational Companies to Productivity in Israel, September 2016, Chief Economist's Division in the Ministry of Finance.
6 The study was conducted for the National Council for Civilian Research and Development by the Applied Economics Corporation Ltd. together with a steering committee headed by Prof. Zvi Ekstein.
7 National Bureau of Statistics 2015. It should be mentioned that the NBS definition for multinational corporations' centers is slightly more limited than that of other information sources.

This focus on R&D and the resultant engineer-biased employment mix restrict the potential influence of the R&D centers. This is especially so since the players in the innovation arena – multinational corporations, start-up ventures, small and medium sized businesses, growth companies and senior and established corporations – are all competing for the same limited pool of skilled engineers. The shortage in supply of high-tech engineers and programmers coupled with the ever-growing demand for these professionals leads primarily to an increase in their salary and an indirect impingement of the competitiveness of Israeli high-tech. Furthermore, in this competition, the R&D centers possess significant advantages that their competitors are having difficulty overcoming. They can offer employees an attractive remuneration package, the building of a reputation, knowledge, experience, and access to other international centers of the multinational corporation. Therefore, as long as there is no significant increase in the supply of engineers, the R&D centers' demand for skilled workers is expressed mainly by their ability to recruit the best engineers available. Their influence on the scope of high-quality employment in Israel is therefore limited, and more specifically, they contribute only modestly to increasing the economy's quota of high added-value jobs.

DIAGRAM 2: **THE MAJORITY OF JOBS AT MULTINATIONAL CORPORATIONS' R&D CENTERS ARE R&D POSITIONS**



Source: National Bureau of Statistics

The Israeli economy will also yield great benefit from the expansion of the R&D centers' existing activity to other spheres of the corporate value chain: manufacturing, marketing, support, design, and others. For example, expanded manufacturing activity of high-tech multinational corporations will have a far-reaching influence on the cultivation of skilled technological personnel for the manufacturing industries, for strengthening a culture of technological innovation and toward the accumulation of relevant knowledge. Further activities in the chain of value will widen the circle of high-salaried employment that the R&D centers create around them, thus enabling workers in non-technological professions to be able to also benefit from the many advantages of multinational corporations. **Expansion of the Israeli R&D centers' scope of operation to becoming more complete companies is, therefore, a strategic objective of innovation policy in Israel.**

It should be mentioned in this context that already today, approximately 20 percent of the R&D centers also engage, to varying extents, in manufacturing of high technological intensity, usually in locations in the geographical periphery[8]. Among the multinational corporations conducting manufacturing operations in Israel in addition to their R&D activity are KLA-Tenkor, HP Indigo, Applied Materials and of course, Intel.

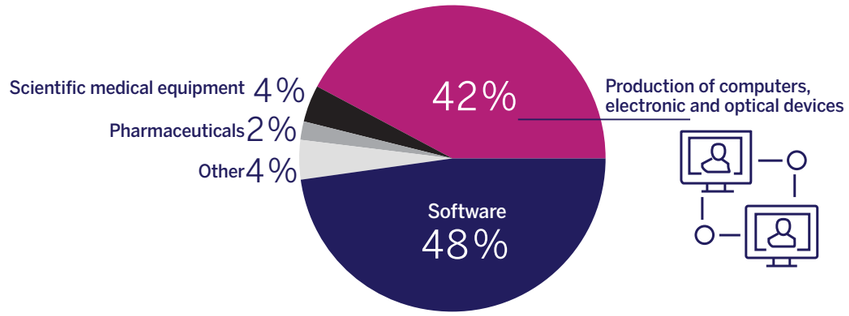
8 According to figures of the Authority for Industrial Cooperation and the Advancement of Foreign Investments

Encouraging R&D Centers' Activity in Additional Technological Fields

Although the multinational corporations' activity in the ICT field is already widespread, in other spheres, the scope of their R&D activity in Israel is relatively low. For example, while the ICT fields are responsible for 90 percent of R&D expenditure in the multinational corporations' R&D centers, medical equipment is responsible for 4 percent, and pharmaceuticals for merely 2 percent (see Diagram 3). Non-ICT manufacturing sectors such as chemicals, plastic, and others – occupy only a tiny proportion of these corporations' R&D expenditure.

DIAGRAM 3: **THE OVERWHELMING MAJORITY OF MULTINATIONAL CORPORATIONS' R&D EXPENDITURE IS FOCUSED ON COMMUNICATIONS, SOFTWARE, AND COMPUTING (ICT)**

Ongoing R&D Expenditure in Multinational Corporations' R&D Centers, According to Field of Development (2015)



Source: National Bureau of Statistics, Survey of R&D in the Corporate Sector, 2014

Technological sectors suffering from under-representation in the multinational corporations' R&D activity do not currently benefit from the technological advantages that they bring to the fields of ICT. These sectors will, therefore, profit greatly from the attraction of multinational corporations' R&D centers in Israel. **The cultivation of additional thriving innovation systems in areas in which the Israeli economy possesses a leverageable advantage is a central component in the Innovation Authority's strategy**. Accordingly, the granting of appropriate incentives to multinational corporations choosing to conduct R&D and other activity in the value chain, in fields other than ICT, is a clear strategic objective both for the Innovation Authority and for the government in general.

Indeed, the government has already begun acting in this direction: this year, the Innovation Authority launched a program to encourage the establishment or expansion of R&D centers' activity in the fields of biotechnology and medicine. Also, the Ministry of Economy and Industry's Foreign Investment and Industrial Cooperation Authority is active in attracting investments to Israel in the field of advanced manufacturing (for more details on these two programs, see the table below).

Steps to Expand the R&D Centers' Activity in Israel

The Innovation Authority is launching a trial program to encourage the establishment or expansion of the R&D centers' activity in the fields of medicine and biotechnology.

The Innovation Authority is currently launching a pilot program with the objective of enabling multinational corporations, active in the fields of medicine and biotechnology, to establish or expand their Israeli R&D activity, technological innovation or production. The program leverages the changes in the tax regime of high-tech companies to expand their economic activity in Israel. The program has two central elements:

1. **Selection of R&D Centers Operating in the Fields of Biotechnology and Medicine:** The selection entitles the centers to submit requests for grants from the Innovation Authority. The criteria for selection emphasize technological innovation alongside the expected contribution to the economy. Particular emphasis will be placed on the possibilities for the expansion of employment circles beyond the R&D employees and the contribution to the Israeli eco-system through activity in new technological fields or in areas in which the R&D activity in Israel is relatively low but possesses high potential.

2. **Awarding of R&D Grants to Companies Selected as R&D Centers in the following fields:** The centers selected as eligible in this track will be able to submit a request for grants for R&D programs, including perennial programs, for a total of up to NIS 50 million for a six-year period. Centers receiving a grant will be exempt from paying royalties to the Innovation Authority. In addition to the degree of technological innovation and risk, the criteria for authorization of support for an R&D project in this track also include the expected contribution to the economy, from taxation and employment aspects, to innovation activities in which the Israeli economy lacks experience, and R&D supporting activities.

The Foreign Investment and Industrial Cooperation Authority strives to encourage investments by multinational corporations in advanced production in Israel.

The Foreign Investment and Industrial Cooperation Authority, under the auspice of the Ministry of Economy and Industry, was established in its present format approximately two years ago out of a desire to increase quality foreign investment in Israel. Investment in advanced manufacturing by innovative multinational corporations is central in this regard, the objective being the expansion of Israel's share in the innovative multinational corporations' value chain from R&D alone to the manufacturing of higher technological intensity.

Within this framework, the Authority is operating on three central axes: Firstly, **the Authority is focusing its marketing and development efforts towards promoting this model** by means of designated conferences, global campaigns via different forms of media, delegations, and activity with target companies while utilizing the Department's global array of attaches, and while relying on business intelligence capabilities developed by the Authority. Secondly, the Authority offers investors a **One-Stop-Shop** model including accompaniment throughout all stages of the investment with designated sector managers. Because investment in manufacturing occasionally results in increased "friction" between the company and government regulators, the Authority has also established an **Investors Service Center** with the goal of reducing this friction.

Thirdly, the establishment of the Authority in its current format merged the encouragement of foreign investments and activity associated with the foreign companies' offset obligation in Israel. Because the majority of the obligated companies are also the world's largest industrial corporations, the consolidation of these two spheres enables the leverage of the local activity from one of the foreign company's obligation to that of opportunity for investment and growth in Israel, including manufacturing.

Further information can be seen on The Foreign Investment and Industrial Cooperation Authority

The BEPS Regulations: An Opportunity to Maximize Economic Value

As mentioned above, the consistent growth in the R&D centers' activity is powered by Israel's comparative advantages. Efficient tax planning constitutes another incentive for dispersing operations in the multinational corporations' value chain between different countries. In this way, while their activity in Israel yields large-scale R&D output, the intellectual property developed within the framework of this activity has, until now, been listed in other countries in which taxation of income from intellectual property is considered more convenient.

Accordingly, the R&D centers' operations in Israel is, in most cases, taxed by the 'cost-plus' method[9] that fails to gross up the actual business profit from the company's R&D activity. This means that tax revenue from the R&D centers in Israel does not reflect the added value of their research and development activity, i.e., the high income from the sale of products worldwide.

This status quo of dispersal of global activity based on tax planning was interrupted during 2016 with the publication by the OECD of the BEPS Regulations[10]. **The objective of the regulations is to prevent the relocation of high-tech companies' profits to countries with favorable tax regulations and to tax havens worldwide**. The regulations mean, among other things, that intellectual property must be registered in its country of development. The full adoption of the BEPS Regulations by the developed countries, therefore, presents multinational corporations with two alternatives: the first, to transfer their R&D operations to a country in which both the tax and business conditions are optimal for them. The second option is to leave the R&D activity in those countries possessing the comparative technological and systemic advantages for innovation, despite the change in tax payments expected with the ascription of sales income to these countries.

At the same time, countries of the second category, including Israel, will be required to conform their tax system to prevent corporations from transferring their R&D activity to countries enjoying a comparative tax advantage. **The regulations determine that only the country in which intellectual property has been developed may bestow tax benefits on income derived from it, and they therefore provide an opportunity for countries that have hitherto hosted multinational corporations' R&D activity, to create an attractive tax regime**.

If so, the BEPS Regulations constitute a challenge for preserving the attractiveness of the Israeli innovation system in the eyes of multinational corporations. Primarily, the State of Israel must maintain those comparative advantages due to which multinational corporations have come here in such large numbers – skilled personnel mainly in ICT, groundbreaking high-tech companies, world-leading technology, and others. Also, the restriction on granting tax benefits on income from intellectual property creates an opportunity to incentivize multinational corporations to register here the intellectual property developed in Israel. Experience proves that the establishment of intellectual property in a particular country frequently leads to the expansion of that company's management activity there. Such a dynamic is also expected to bring about an increase in high-salaried employment of workers in supportive functions, including management. The registration of intellectual property in Israel may therefore lead in the long-term, to an expansion of the multinational high-tech corporations' economic activity in Israel.

And indeed, **the government is currently engaged in adapting the tax system that applies to high-tech companies to the international tax environment in accordance with the recent changes.** Following preparatory work led by the Ministry of Finance, the Knesset authorized in late 2016, Amendment No. 73 to the Encouragement of Capital Investments Law and the Finances Committee recently authorized the ordinances for its implementation. The Amendment creates a special track for high-tech companies and grants them significant tax benefits on income from technological developments. The benefits include the lowering of corporate tax from 25 percent to 6-12 percent[11] and significant benefits in the tax rates on dividends and capital gains.

Within the framework of the Amendment, the Innovation Authority received several consulting and arbitral powers the objective of which is to make the Amendment's implementation easier for technology companies, this based on its proximity to the industry and its in-depth familiarity with research and development processes. Firstly, it was determined that companies failing to conform to the special track's conditions as determined by the law, may submit a request to the Innovation Authority asking to be included in the definition of an "innovation advancing plant." This definition will allow them to receive the benefit granted in the Amendment. Secondly, the Innovation Authority has the power to adjudge whether technological knowledge developed in Israel or transferred to Israel conforms to the application of tax benefits[12].

The described changes will allow multinational corporations to continue expanding their R&D activity while registering the resultant intellectual property in Israel, and will even make the transfer of intellectual property from other countries to Israel worthwhile. These changes are not, of course, only relevant to Israel: with the publication of the BEPS Regulations, a kind of 'arms race' of tax regime adaptation developed in the international arena. Will the changes that Israel is implementing be effective in preserving and expanding the R&D activity of multinational corporations? How will their tax revenues change? In light of the central role played by the multinational corporations in the local economy, these are indeed critical questions for the future of Israeli innovation.

The Innovation Authority – In Practice: Supporting Strategic Cooperation between Israeli Companies and Multinational Corporations

Multinational high-tech corporations can benefit the Israeli high-tech system not only by means of the activity of the R&D centers located here but also, via strategic collaborations with Israeli start-up companies. These collaborations pave Israeli companies' way to markets and avenues of operation both in Israel and around the world, and infuse Israeli industry with knowledge, experience and skills at all stages of the technological development's value chain.

A successful example of such cooperation is the connection between the Israeli company Qlight and the global chemical and pharmaceutical corporation Merck. Qlight was founded in 2009 and develops applications for LED lighting and television screens, based on a nano-technology originally developed at the Hebrew University, that enables precision color control. Merck expressed interest in Qlight's technology already at its inception, joined forces with it in joint development and invested in the start-up company at an increasing rate. **The Innovation Authority's support of Qlight, within the framework of the Global Enterprise Collaboration Program, assisted in strengthening the strategic collaboration between the two companies**. Merck's vast knowledge aided Qlight in understanding market needs and focusing on new directions.

In 2015, following years of joint endeavor, Merck completed acquisition of Qlight. Following the acquisition, Qlight's R&D infrastructures were significantly expanded. The company is continuing its operation in Jerusalem as a R&D center of the global Merck Corporation in the field of advanced materials.

We wish to thank The Foreign Investment and Industrial Cooperation Authority in the Ministry of Economy and Industry for its contribution to this chapter.

9 Pricing of the added value according to the operation's cost price plus a profit constant accepted in the sector, and determined by the tax authorities. The accepted rate in multinational corporations' R&D centers is 5-12 percent.
11 Base Erosion and Profit Shifting

11 Twelve per cent for preferred technological factories, 7.5 per cent for preferred technological factories in Development Areas 'A', and 6 per cent for special preferred technological factories (giant corporations).
12 The full details are updated on the innovation Authority's website.

רשות החדשנות
Israel Innovation
Authority

Chapter 4

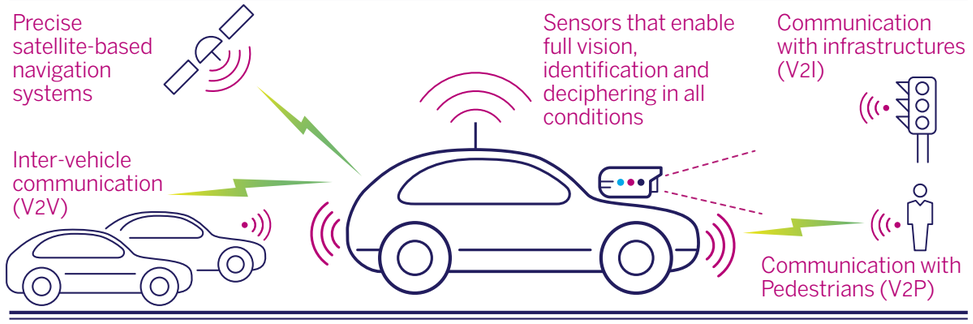
Steering the Wheel to **Artificial Intelligence of Autonomous Vehicles**

Autonomous vehicles are revolutionizing driving. Future drivers will be machines, and vehicles will become smart platforms based on sensors, computers and communication technologies. The automotive industry is transforming to a high-tech industry, and a range of markets and human activities are expected to change. This revolution creates a great opportunity for Israeli technology companies

THE AUTONOMOUS VEHICLE REVOLUTION

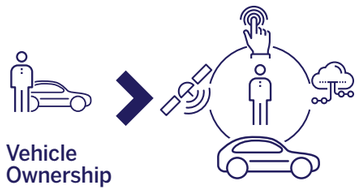
The Technological Goal: An Autonomous Vehicle on the Road within 5 Years

Technological challenges in the fields of sensors, artificial intelligence, navigation and communications lie at the heart of the race to develop the autonomous vehicle



Future Mobility Services: The Sky is the Limit

The autonomous vehicle's entry into the markets will alter the existing mobility model and our lives will be changed beyond recognition



Transport Safety is expected to improve

Travel costs will decrease dramatically

Travel Time is expected to significantly decrease

The traveller's time will become available for leisure and work

Accessibility will increase for sectors of the population with independent mobility difficulties

The Autonomous Vehicle Revolution - A Range of Technological and Economic Opportunities for the Israeli High-Tech Industry

The Vehicle Revolution is becoming a High-Tech Industry - Technology giants and startup companies are leading the revolution alongside traditional car manufacturers

3X The expected increase in investments in high-tech companies in the Auto Tech field from 2016-2017

New Technological Markets are being Born - A rapid growth opportunity for innovative and young companies

450 Israeli companies currently active in smart transportation

$ 15.3 B Israeli companies currently active in smart transportation

The Changes in the World of Transport will Influence many Markets - An opportunity to create innovative business models that will yield their developers significant economic value

60% The car insurance market will shrink

33% The digital media market will grow

In 1903 the Ford Corporation began marketing their famous Model T. This car signaled the beginning of the mass manufacturing of motor vehicles for private use and fundamentally changed the economy and human culture. Since then, many technological developments have enhanced the safety, speed and comfort aspects of the traveling experience and the vehicles themselves have become more reliable and easier to operate. Nevertheless, no significant disruption has occurred in the field of transportation since the beginning of the twentieth century. Now, for the first time in approximately one hundred years, we are witnessing two significant changes.

The first change is the replacement of the internal combustion engine, the workhorse that has powered cars since the early twentieth century, with an electric engine. Advanced technology already enables us today to overcome the main limitation of electric vehicles – the limited duration of the journey until the battery is recharged. As an illustration, the Tesla Corporation's "Model 3" that was recently released on the market, displays a travel range of 350 kilometers between battery charging and other models even reach a range of approximately 500 kilometers. In light of this, a continuous increase in the production and purchase of electric vehicles is to be expected over coming years.

The second change, that of the autonomous vehicle revolution, is expected to propel the world towards the dawn of a new transportation age. This revolution includes different stages and many technological challenges but the final destination is clear: the transfer of driving from human to machine. Already today, the motor vehicles on the road combine sensors for driver tracking and control, and many electronic systems. In the near future, an autonomous vehicle will itself perform all the actions necessary for driving, and will coordinate them with other vehicles, infrastructure, pedestrians and other transportation factors. **The vehicle is becoming a smart system brimming with sensors, cameras computerized devices and communications systems.**

This revolution is expected to have far-reaching ramifications in a range of fields: in the field of transportation and the global culture of mobility; in overlapping spheres such as insurance, maintenance, refueling and traffic policing; in transportation-based fields such as freight transport and delivery, and even in seemingly remote fields such as hotels, restaurants, retail and real estate[1]. The transition from a model of vehicle ownership to that of transport subscription and a personally tailored service including many information technologies and connectivity, will completely change the range of human actions, and create both economic and social opportunities and challenges that cannot yet be foreseen.

The Objective: An Autonomous Vehicle to take the Road Within Five Years

Motor vehicles possessing partial autonomous capabilities are already being sold today and travelling the roads. Vehicles with much more highly developed autonomous capabilities are currently conducting road trials but still require driver supervision and can contend with only limited challenges. The forecasts of most of the car manufacturers set the early 2020's as the target for entering the market with cars that will drive autonomously in 90-95 percent of the scenarios.

Naturally, in order to enable the mass marketing of autonomous vehicles, an appropriate regulatory environment must be developed. Today there are several countries that have created supportive regulation for the experimental stages, most noticeably California. However, there is still no legal framework for the commercial operation of autonomous vehicles. The legislators (including those in Israel) will need to plot guidelines relating to aspects of safety, manufacturing standards, licensing, insurance, traffic laws and others.

1 CB Insights (July 31, 2017). 24 Industries Other Than Auto That Driverless Cars Could Turn Upside Down.

From the technological aspect too, the effort required to develop a motor vehicle that will drive autonomously in almost all scenarios is significantly larger than the total resources invested thus far. Concentrated effort is being invested today in the development of sensors and more varied and better identification capabilities, however significant technological gaps in the field of artificial intelligence loom in the background.

The Sensory Challenge: Fusion of Sensor Data

An autonomous vehicle requires "eyes", in other words sensors, that will enable it to identify and decipher its environment. They will simulate peripheral vision from all necessary directions and ranges and will allow a rapid identification of objects in the area – obstacles, other vehicles, road markings and traffic signs – in all weather and light conditions and every road situation.

Sensory systems, called ADAS, are already available today and include a single sensor – one video camera at the front of the vehicle. The data from the camera is analyzed by an algorithm-based processing unit that warns of different dangers and obstacles. In the near future, each sensor will be based on a different technology and will be specially adapted for different purposes and conditions. Camera, laser (LiDAR) and radar sensors will operate alongside sensors that will use 3D imaging for improved identification of risks, a more accurate modelling of objects in the area, and an estimation of the distance between them. In addition, different types of sensors will enable night vision. In order to prevent errors that may occur as the result of road conditions or a system failure, data required for the journey will be received via a number of technologies simultaneously.

The vast data that will be produced by the various sensors will necessitate **advanced solutions for the fusion of information from different sources, and algorithms for visual and data processing**. All these are required to operate at an extremely high reaction speed. In addition, **challenges exist in reducing the high costs involved and in increasing the operational range of a complete sensory system**, especially in laser-based devices (LiDAR).

The Navigational Challenge: High-Precision Location Identification

The navigation system in an autonomous vehicle is based on identification of the vehicle's location – both absolute location and relative to surrounding objects – within an accuracy of centimeters. It is required to operate continuously, even in a complex urban environment, including in tunnels, shopping malls and parking lots. Therefore, an additional group of sensors and devices planned for integration in autonomous vehicles is intended to enable its independent navigation. These sensors include GNSS sensors (Global Navigation Satellite System) that receive satellites' navigation signals; Optic sensors that identify more accurate location and changes along the route, Vehicle cameras and radar systems that can compare their data to absolute coordinates; And speed and acceleration sensors.

No GNSS system exists today that enables satisfactory location accuracy in a motor vehicle dynamic, and this field therefore possesses potential for pioneering innovation. Several Israeli companies are currently operating, together with the Innovation Authority, to achieve accuracy of approximately 10-20 centimeters, with the ultimate aspiration of reducing this to only a few centimeters.

The many channels in a connected car create a communication challenge

Until recently, most of development efforts in the field of autonomous vehicles focused on the autonomous control system while wireless connectivity was not considered vital. However, experiments conducted proved the need for developing an infrastructure that will enable the vehicle to communicate with its surroundings – an approach known as V2X (Vehicle to Everything). This approach encompasses communication between the vehicles themselves, between the vehicle and the pedestrians, and between the vehicle and infrastructures. The communication between the vehicle and its surrounding infrastructure (V2I) seeks to provide a solution for complex driving situations, such as impaired vision that affects the sensing abilities of the car's cameras, or lack of communication with the navigation satellites. Inter-vehicle communication (V2V) enables the transfer of information regarding speed, direction and the route of other vehicles. Communication between vehicles and pedestrians (V2P) can, for example, warn pedestrians of approaching vehicles and assist them safely cross the road.

The central technological challenge today in the V2X field is the extremely low-latency transmission of large scopes of data between millions of vehicles and surrounding objects. The realm of wireless communication for autonomous motor vehicles is developing in several parallel directions. Firstly, efforts are being made to develop V2X applications that meet the DSRC standard[2] and the 802.11p Wi-Fi standard that operate on the same frequency range, and specifically communications applications for interaction with traffic signs. These efforts have encountered difficulties, both because of the lack of uniformity in allocating these frequencies in different places around the world, and also due to the lack of enough traffic signs adapted for V2I communication.

Parallel efforts are based on cellular communication. The Qualcomm Corporation for example, recently declared that it is harnessing 4G technology in order to develop better V2X technology. The breadth of the cellular network's band will enable to communicate with a larger number of vehicles and to receive swift and precise alerts about happenings such as sudden braking. 5G communication networks that will be set up in the future will support faster and larger than ever scopes of communications.

The Cyber Security Challenge

The continued increase in the autonomous vehicle's information and connectivity equipment also leads to a rise in their vulnerability to cyber-attacks. The risks include information theft, implantation of ransom software, vehicle hijacking, vehicle surveillance, injection of false information to disrupt operation, the deliberate creation of large-scale accidents and others. Past demonstrations have proven the possibility of penetrations to a vehicle via its communications system by implanting malicious software in the vehicle's control and diagnostics devices and by misleading the sensors.

The potential damage from a cyber-attack is especially large when it involves damage to a system at the foundation of many vehicles' operation such as navigations systems: the GNSS system and the GPS signal are extremely sensitive to jamming and spoofing. Significant effort is therefore currently being invested in anti-jamming technologies, both in the antenna, the system as a whole and in the algorithms. In general, contending with cyber risks in the field of autonomous vehicles is based on adapting accepted technologies in the cyber world, such as the separation of networks critical to safety from non-critical networks, identification, treatment and prevention of penetration into the system, data encryption, cross-checking of information to establish verification, and the assembly of communication with the outside world under a single channel.

2 Dedicated Short-Range Communication – a standard that was hitherto used for communication in collecting payments on toll roads.

The Innovation Authority – In Practice: Support for General Motors R&D Center in Israel

In 2008, the international motor vehicle manufacturer, General Motors, established an R&D center in Israel. The center was opened with the support of the Innovation Authority's program encouraging the establishment of multinational project centers in Israel. Today, the center is home to almost 200 researchers and engineers engaged in the technological challenges at the heart of the race to develop an autonomous vehicle. These challenges include: advanced sensing technology, connectivity, vehicle cyber protection, user interface (for the driver and passenger), acoustics, voice identification, algorithms and artificial intelligence for autonomous vehicles, models for collaborative driving and others.

The R&D center also serves as a **knowledge for the developing startup industry** in the field of autonomous vehicles and smart transportation in Israel. The center scouts for startup companies and works with them in different avenues: mentoring, help in familiarization with the market, research and commercial collaborations, and investments from General Motors' corporate venture capital fund. In addition, over the years, the R&D center has developed a **base of suppliers from the Israeli manufacturing industry** that have become, under the guidance of experts, licensed suppliers to General Motors and other companies in the field. Today, the corporation acquires an average of approximately USD 100 million per year from Israeli companies.

Future Mobility Services: The Sky is the Limit

The nature of pioneering innovation makes predictions of future impact difficult. One illustration of this is that most of the internet's dramatic multi-faceted influence on our lives could not have been foreseen in the mid 1990's when the network was opened up for mass use. Similarly, the autonomous vehicle revolution is expected to influence such a wide range of areas that any attempt to forecast the full extent of its consequences may be revealed as absurd. Nonetheless, several developments can be predicted with a relatively high degree of certainty, even if their intensity and timing are unclear. Some will directly influence consumers, in other words existing and potential users of motor vehicles, while others will influence them indirectly via a change in the infrastructures and mechanisms that lie at the foundation of the transportation and mobility world today.

Primarily, autonomous cars **are expected to be safer.** Studies indicate that approximately 90 percent of accidents are caused by human error. Naturally, autonomous cars will also sometimes "make mistakes" and cause accidents, however computerized learning processes will bring about a reduction in these errors, rendering them negligible. Secondly, **travel time is expected to be dramatically shortened**. The autonomous vehicles' swift reaction capabilities and the communication between them will enable the shortening of safety intervals and quicker travel. In addition, as soon as all vehicles are connected to the same communication data network, it will be possible to optimize the travel routes in a manner that will significantly reduce traffic congestion. All these may lead to a streamlining and increase of up to 5 times the mileage traveled on the same road infrastructure[3].

3 KPMG (2012). Self-driving cars – the next revolution

Naturally, **the travel experience will be significantly enhanced** once the vehicle becomes autonomous, thereby allowing the passengers to transfer their attention to work or leisure. The passenger's spare time will be utilized via entertainment systems and passenger information and communications systems. The future 'Infotainment' systems will be based on connectivity and will provide integrated services such as media players, augmented reality, and adaptation of the entertainment experience from aspects of acoustics, lighting and others. Car manufacturers and large technology companies are already working on these systems today.

Travel costs will also decrease dramatically, mainly as the result of the transition from the vehicle as a consumer product to 'mobility as a service' that will be provided via pools of autonomous vehicles that will compete which other in indices of efficiency and quality. Estimates are that the travel cost per kilometer will be reduced by 80 percent as the result of this transition. This saving reflects the inefficiency embodied in today's limited utilization of private vehicles, that for most of the day are parked in a static state without serving their owner. This contrasts with autonomous vehicles that will operate at almost full utilization while serving multiple users. A further parameter in which a significant change is expected is that of **accessibility**. People with disabilities, the elderly, children and other sectors of the population who have difficulty with independent mobility will be able to benefit from readily available, safe and affordable mobility. It is also reasonable to assume that this development will have additional ramifications on our daily lives. For example, the need for parents to drive their children to and from their educational institutions will become unnecessary, the children being able to safely and independently use the autonomous car themselves.

Influence will not be limited to driving however. Many mechanisms supporting motor vehicles today will be dramatically influenced by the transition to autonomous vehicles. Cities, for example, are presently planned to provide parking for a tremendous number of motor vehicles. In some cities, the accumulated parking areas even constitutes a quarter of the total city area. We can only speculate about the ramification of utilizing these areas for other purposes after we cease owning private cars and when the cars that provide service will be able to park densely and efficiently in designated areas far from the city centers.

In addition, the **operative mechanisms of transportation law enforcement bodies and the insurance companies** will also change. The insurance companies will change the insurance model such that payment will be based on usage and on manufacture characteristics such as vehicle quality grade, the algorithms upon which it is based, its safety systems and the average number of faults. Investigation of an accident between autonomous vehicles will be based on data gathered and transmitted from the vehicle to the control centers and insurance companies, and computerized automatic claims procedures will be developed between the insurance companies. Lessons learned from accidents will need to be implemented by the autonomous vehicle manufacturers for the future prevention of accidents. The regulation in this field is only in the initial stages of development, and binding principles will evolve over time in order to ensure service and safety quality.

The dramatic developments mentioned above also include aspects of concern. More than 100,000 people in Israel work as drivers, whether in public transport or in truck pools and in the delivery business[4]. What will happen to these people when vehicles become autonomous? Of relevance is the question as to whether the market will catch up with the pace of disappearance of these professions and create new ones.

These are all conceivable developments, however, the horizon of technological and socio-economic changes that the autonomous vehicle revolution creates is substantially wider than we can currently estimate.

4 National Bureau of Statistics Data 2016, Employees according to selected occupation groups

Autonomous Vehicles are a Big Opportunity for the Israeli High-Tech Industry

The dramatic changes in the global motor vehicle industry and in the world of mobility offer many opportunities for new players from additional fields to join the transportation industry and shape the revolution. Large technology companies such as Intel, Google and Apple have been working for some time on developing a prototype of autonomous vehicles, alongside car manufacturers such as Toyota, General Motors and Tesla and, on occasion, in cooperation with them. In 2016, 1.1 billion USD were invested in 'Auto tech' startup companies and in 2017, investment is expected to total three times that sum[5].

Moreover, large-scale technological revolutions frequently create entirely new markets that are characterized by extremely rapid growth. New and innovative companies at the forefront of the revolution are therefore presented with a golden opportunity to rapidly become very large and profitable. This phenomenon was demonstrated well by the internet giants during the previous decade. In addition, the changes in the structure of the markets that are expected to be influenced by the autonomous vehicle revolution, coupled with the economic and social changes it embodies, will create many opportunities for the growth of completely new business models, generating high economic value for their developers.

The technological challenges together with the economic and social changes detailed above, create a great opportunity for Israeli industry to take part in the technology race and to capture key positions in completely new markets. Already today, approximately 450 companies in Israel are engaged in smart transportation fields such as travel sharing, communication, sensors and control systems. The acquisition of Mobileye by Intel this past March for 15.3 billion USD, one of the largest transactions in the field of Auto Tech in 2017, has focused the attention of global corporations and investors on the tremendous potential of combining Israeli technological excellence with the autonomous vehicle revolution.

In order to accelerate the development of Israeli industry in the field of autonomous vehicles and smart transportation, there is profound importance in developing local infrastructure to serve Israeli companies in the development and commercialization of technologies and enable them to implement innovative business models. Also needed are the organization of a regulatory and physical trial infrastructure that will meet the relevant needs, and the opening of local transportation systems to innovation so that Israel may serve as a primary market for local initiatives in their global growth programs. This year, the government in Israel launched a **national program for the advancement of smart transportation with the objective of encouraging the integration of advanced Auto Tech technologies into Israeli transportation systems, thereby accelerating the development of Israeli technology industry in this field**. Among others, this will be achieved through the establishment of a designated trials center and adaptation of the regulatory environment. The Innovation Authority is playing an active role within the framework of this program (see below).

5 CB Insights (May 2017). The State of Auto Tech

The Government is acting to develop Israeli industry in the field of autonomous vehicles and smart transportation

In January 2017, the government authorized a 5-year program to promote smart transportation in Israel. The program was allocated a designated budget of approximately 240 million NIS, and was led by an inter-departmental team headed by the General Director of the Prime Minister's Office and the Director General of the Ministry of Transport. The Innovation Authority, together with the Fuel Choices and Smart Mobility Initiative in the Prime Minister's Office and other bodies, will take an active part in implementing this program.

The program will encourage the integration of advanced technologies in Israeli transportation systems and the development of Israeli industry in a range of avenues: creating vital infrastructures for development and trials, promoting collaborations between academia and industry, revising regulation to enable the assimilation of innovative transportation technologies and new models of mobility, promoting a supportive business environment in the entrepreneurial community and others. **Specifically, as part of the program, a center for trials of smart transportation and autonomous vehicles will be established and field tests will be promoted along with pioneering 'auto tech' initiatives**. The entrepreneur community 'Ecomotion' is another framework for State activity in developing the smart transportation technological industry. 'Ecomotion' was founded in 2012 following a joint initiative of the Fuel Choices Initiative, the Ministry of Economy and Industry, the Israel Innovation Institute, and Israeli industry, with the objective of supporting the smart transportation sector and positioning Israel as the center of global innovation in the field. The community conducts workshops and various events that bring together young and experienced entrepreneurs, market leaders, international and local industrial companies, technology professionals, policy makers, academic scholars and investors.

We wish to thank the smart transportation and autonomous vehicles Knowledge Center in the Innovation Authority for their contribution to this chapter.

רשות החדשנות
Israel Innovation Authority

Chapter 5

The Human Capital Challenge - how to integrate and preserve skilled employees in the High-Tech industry

Increasing the number of skilled and experienced personnel in the high-tech industry is a national objective, and the State of Israel is acting to achieve it. To this end, the Innovation Authority is supporting the cultivation of ”coding bootcamps” as an additional avenue for joining the industry and is examining the problem of high-tech employment among older age groups

THE HUMAN CAPITAL CHALLENGE - ROUTES TO INTEGRATION AND PRESERVATION IN HIGH-TECH

Opportunities for a Career Change are Very Important in the Modern Labor Market

Change in Priorities during a Longer Career

Academics in Different Fields are Seeking to Change Track
After a trial period, but are daunted by further academic studies

Frequent Changes in Demand for Professions

Shortage of High-Tech Programmers
High-tech companies are recruiting workers based on talent and ability even without formal education

Extra-Academic Programing Training Frameworks are Flourishing: **Coding Bootcamps**

The Means:
Intensive training in programing and career skills for academic graduates, chosen after scrupulous selection process

The Objective:
Successful Placement in the Workforce

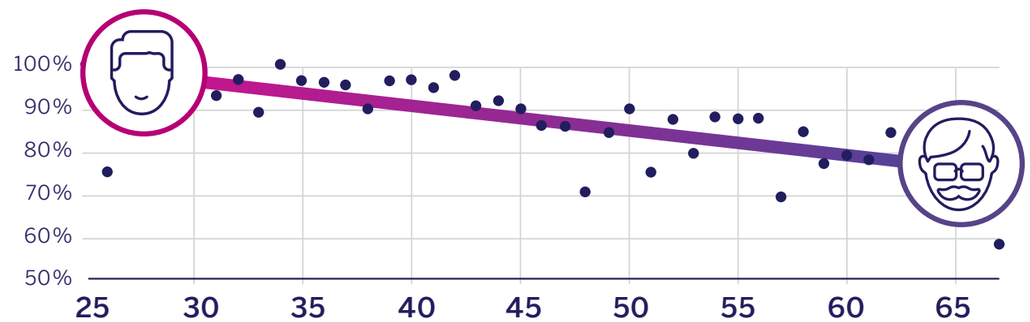
Extra-Academic Training Programs may Become a Significant Route for Joining High-Tech

In the U.S - approx. 25% of computer personnel completing their studies in 2016, were Coding Bootcamps graduates. In Israel this tool has only begun developing in the last 2 years

The Innovation Authority launched the "Coding Boot Camps" Program to encourage the growth of quality extra-academic training programs in Israel

Does the High-Tech Industry Properly Preserve its Skilled Workers?

A survey conducted by the Innovation Authority and the Engineers Association on employment of older workers in the high-tech industry reveals indicators of a decline in the rate of employment as age rises:



The Innovation Authority's annual reports from 2015 and 2016 warned of an expected shortage of skilled workers in the Israeli high-tech industry. The realization of the ramifications of this shortage led the government to initiate, at the beginning of 2017, a national program to increase the number of skilled high-tech personnel[1]. The program presents this goal as a national objective and is, therefore, enlisting all the relevant governmental bodies, including the National Economic Council, the Innovation Authority, the Director of Employment in the Ministry of Labor, Social Affairs and Social Services and others. The program includes both long-term efforts to increase the potential number of skilled personnel – primarily by increasing the number of under-graduate students in high-tech professions by 40 percent - and short-term actions intended to fully utilize the existing potential.

The Innovation Authority has a crucial role in these efforts, because of its close relationship with the high-tech industry, and as the body responsible for maintaining the industry's position as a growth engine for the Israeli economy. The Authority's "Societal Challenges Division", that began operations a year ago , will lead the development of solutions for the human capital needs and challenges of the high-tech sector and will act together with it towards their implementation.

In this context, we wish to highlight the available reserves of human capital which can be integrated (or preserved) in the high-tech industry. The first such reserve is of **highly skilled academics looking for a career change, and particularly graduates of scientific professions**. This population is the target audience for extra-academic 'coding bootcamps' – fast-track quality programs aimed at enabling high-tech integration for non-high-tech professional graduates.

The second reserve of **personnel is senior employees (from approximately age 45 and upwards) in the high-tech industry who, have difficulty maintaining their positions in the high-tech labor market**. This issue will be discussed below based on the results of a unique survey examining the employment of senior high-tech workers, conducted by the Innovation Authority in conjunction with the Association of Engineers.

Studying Computer Science or Engineering is Not the Only Way to obtain High-Tech Employment

One of the central questions surrounding the discussion about the shortage of skilled high-tech employees is **why it is that the high salary, that reflects the high demand for these workers, is not enough to attract more workers to choose this career path**. The significance of the disparity between the average wage in the high-tech industry – NIS 21,000 per month – and the average wage in the economy at large – approximately NIS 9,800[2]. This large difference becomes even more significant taking into account the complex high cost of living in Israel. Nonetheless, the figures indicate a more than decade-long stability in the ratio of salaried employees working in high-tech (see Diagram 1)[3], compared to a thriving corporate demand for labor expressed by a constant increase in salaries.

1 The Government Resolution can be seen at: http://www.pmo.gov.il/Secretary/GovDecisions/2017/Pages/des2292.aspx
2 National Bureau of Statistics, Annual Statistics Journal 2017, Panel 12.33 (2016 data)
3 Calculated after adaptation of NBS data by the Strategy and Economic Division of the Innovation Authority. The adaptation included revaluation and historic adjustment of all salaried employees by retroactively adding the number of salaried employees in the I.D.F. (regular and permanent service) including before 2012 (the year in which the NBS began publishing the total figure).

DIAGRAM 1: **THE RATIO OF SALARIED HIGH-TECH EMPLOYEES HAS REMAINED ALMOST UNCHANGED FOR A DECADE**

Source: Innovation Authority's adaptation of NBS data

There are a number of explanations for this phenomenon. Firstly, **high-tech career paths traditionally pass through a relatively limited number of entrance gates**, the central ones being academic studies of engineering or computer science or service in the I.D.F. technological units. The entrance thresholds for these tracks are relatively high and filter out many young people interested in joining them including those young people who are endowed with the basic talents necessary for succeeding in high-tech professions. In this context, it should be mentioned that the national program for increasing skilled personnel to the high-tech industry set a target increase of 40 percent in the number of higher education students in high-tech professions. The main thrust of effort in this direction will be undertaken by the universities. In order to achieve the goal, the Planning and Budgeting Committee in the Council for Higher Education is operating in several avenues: expanding the academic staff in high-tech professions, developing the necessary physical infrastructure, reducing the drop-out rate from high-tech professions, increasing the rate of special populations in these fields, especially women, the computerization of courses and others.

Secondly, **there is a significant group of young people capable of meeting the academic entrance criteria for engineering or computer science professions but who choose a different route.** This is explained by the fact that the striking advantages of the high-tech industry are not at the top of their list of priorities when making a career choice. The choice of study field, which to a large degree shapes their future career path, is generally made in the early 20's and is based on perceptions and priorities reflected at that point in time. According to an OECD study, young people choose a field of study according to (in descending order) interest, self-fulfillment, future salary and convenience[4]. This order of priorities may change during their professional lives, as may their perceptions regarding interest and self-fulfillment at work.

The modern labor market is characterized by frequent changes in demand for different professions. On the other hand, the increase in life expectancy results in careers that may last many long years. The option to change track during one's career therefore assumes great importance. **Today, many young people who previously chose a particular study field are now changing their career preferences after a period of familiarization with the labor market, but the perception according to which a professional change involves a return to academic studies reduces their motivation to embark upon such a move.**

4 OECD (2008). Encouraging Students Interest in Science and Technology Studies

The high demand in the high-tech industry for recent graduates of I.D.F technology units illustrates however that academic studies, with all their obvious advantages, are not the only way to become a part of the industry. Indeed, some of the high-tech companies in Israel – especially dynamic software companies that recruit a large number of programmers – adopt selection processes based on talents and abilities, without reference to the candidate's formal education. This phenomenon is also linked to the increasing demand for programmers throughout the entire market. **The existing shortage drives the employers to recruit talented workers via alternative means, thereby creating opportunities for wider circles of the population to join the high-tech industry.**

Coding Boot Camps: An Alternative Route to Integration in the High-Tech Industry

It was in light of these circumstances that extra-academic training programs for computer studies began to rise. Of all such active programs, we will focus on those known as "coding bootcamps". These frameworks –involve intensive, concentrated and demanding training that combines theoretical study with practical application. Programs such as these began to develop in the United States in 2012, due to disappointment from the universities' inability to meet the increasing demand for workers in technological fields. Among the prominent programs in the U.S. are for example Le Wagon, Ironhack and General Assembly. **The demand for studies at these programs is, to a large extent, concentrated among academics who have worked in the profession they studied and are now interested in making a career change to another profession with higher earning potential.**

The majority of the programs teach common programing languages and update the syllabus according to market demand. Alongside these, new programs are being developed to offer training in fields such as data science, cyber security, UX/UI, design and marketing[5]. In addition to knowledge in programming languages, these programs strive to provide their graduates with soft skills vital for the modern labor market including independent learning, teamwork, inter-team work and tools for long-term career development.

The high-quality training programs, and especially those with a business model that is built on rewarding successful placement in the workforce, maintain a scrupulous selection policy and high demands throughout the training. As a result, the typical participant profile is of academic graduates with degrees in science or technology professions and who possess a background that lessens the difficulty of the intensive programming studies.

In order for these programs to succeed in creating a significant flow of skilled workers for the Israeli high-tech industry, they must be attractive both for talented candidates and for the employers searching for skilled workers. Specifically, in order for these programs to expand, an increase in demand for them is required on the part of outstanding academics interested in professional retraining as well as an increase in employers' demand for graduates. This tool needs to be developed in Israel and is still relatively unknown. Alongside a limited number of veteran programs, new extra-academic training programs have begun to appear in the last two years. As a result, potential candidates still feel uncertain as to the success of these programs because of the investment required from them – in terms of cost, time and intellectual effort[6]. Also, the employers' familiarity with these programs and their potential benefit, remains low. Much work needs to be done.

5 Stewart, L. (2016, December 07). 2016 Growth of the Bootcamp Model. Course Report

6 This training generally takes a number of months and is conducted in an intensive manner. The student is required to devote himself completely to the training and is unable to work during this period. Aside from the loss of alternative income during the training period, the student bears the cost of tuition that generally reaches at least NIS 20000, in other words, between 60-100 percent of the cost of an academic degree at a public institution. In frameworks at which training is free in exchange for future employment, the cost of training may be even higher and is collected in practice from the graduate's salary during the two years employment as a training graduate.

The success of these training frameworks in the United States reflects their potential: Graduates of coding bootcamps constitute approximately a quarter of all computer personnel completing their studies in 2016 in the country, and are now part of the American high-tech industry, including in leading companies. **Therefore, promoting the attractivity of extra-academic training programs, both for potential candidates and for employers, may prove to be the solution for integration into the high-tech industry.**

A higher number of quality candidates enlisting in these programs will create a positive reputation for the programs' graduates and enable their integration into high-quality and well-paid jobs. Such development will also entice additional outstanding academics interested in a career change to sign up for the programs and so on. At the same time, it is important to learn from the shut down of a number of programs in the United States in recent months. These programs either had unsuccessful business models or just some failed to adapt to the changing needs of high-tech employers. Therefore, **The Israeli Innovation Authority seeks to encourage the growth of quality extra-academic programming training in Israel. Accordingly, this year the Innovation Authority has launched a coding commando program (see below).**

Senior High-Tech Workers – an Under-Utilized Resource?

The government is investing much effort in many spheres with the aim of **increasing** the supply of skilled workers for the high-tech industry. At the same time, we must ensure that the high-tech industry makes full use of their existing human resources in the most efficient possible manner. In other words, the industry's ability to **retain** the skilled workers it recruits must be examined. In the following section, we will discuss the retention of senior high-tech employees[7].

Claims have been made by the public and the media that employment in the high-tech sector is unsustainable at later ages, however, these claims have not been proven empirically. High-tech employees are required to continue learning new technologies throughout their careers, some significantly different from those with which they are familiar, and to adapt to unexpected changes such as company closure or the diversion of the business focus from certain areas to others. There are those who believe that the industry's rapid pace of change, both from a technological and a business aspect, is inherently difficult for older workers. Others indicate that the high salary levels attained by high-tech employees throughout their careers are a millstone, raising the risk of their job termination in times of crisis, in favor of younger and "cheaper" employees hired in their place. Finally, a conjecture exists according to which the industry is characterized by a pyramidical structure, so that workers promoted to middle management roles but not to senior management positions, have difficulty in finding professional fulfillment after age 45.

These claims are not unique to the high-tech sector. A study conducted by the Employment Service on the employment of older workers found that workers aged 45 and above may experience difficulties in retaining their job or in finding a suitable job – in all sectors of the labor market. Indications of these difficulties are represented by the decrease in the level of employment in this age group, and by the increase in the time period needed to find a job[8]. **However, in light of the shortage in skilled high-tech labor, such a phenomenon in this sector would be surprising**. If the chances of employment for skilled senior high-tech employees are indeed lower than those of younger workers, this means that the industry fails to utilize all its available human capital reserves. A proven answer to this question is critical in order to formulate appropriate policy tools for resolving the shortfall and for the cultivation of a long-term supply of skilled human capital for the high-tech industry.

7 It is customary to relate to senior workers as those aged 45 and up.
8 R. HaCohen (2014). Adult Employment in Israel, Survey on Status of Workers over 45 in the Israeli Labor Market, Israel Employment Service

The Innovation Authority – In Practice:

›"Coding Boot Camps" Program – the Innovation Authority has begun supporting extra- academic training programs

In accordance with Government Resolution No. 2292 passed at the beginning of 2017 (The National Program for Increasing Skilled High-Tech Personnel), the Innovation Authority is currently formulating a number of programs aimed at increasing the number of skilled high-tech personnel in the Israeli workforce. The programs, that will attempt to address the shortage of labor in this sector in the short, medium and long terms, primarily include support for extra-academic programming training. In addition, they will strive for the engaging skilled workers from outside of the country with a special emphasis given to returning Israelis and to those eligible to immigrate.

The Innovation Authority will support extra-academic coding training courses within the framework of the **"Coding Boot Camps"** program. This program is intended for training companies, non-profit organizations, academic institutions and high-tech companies interested in establishing or expanding such a program.

The Innovation Authority's effort in this area is divided into two levels:

1. **The creation of a quality reputation among potential employers and workers** by encouraging quality players to enter the arena of training, program supervision and control, and by raising awareness of their existence and potential.

2. **Enhancement of the market and increasing the number of students in the coding commandos via grants for selected programs.** The level of the grant is determined according to the salaries of program graduates employed in high-tech upon completion of the training, that are regarded as an indication of the program's quality. A higher grant will be awarded to graduates belonging to one of the groups suffering from under-representation in the high-tech sector. The programs may use the grants, among other things, for student stipends, thereby enhancing their accessibility.

The program will operate initially in trial format and its expansion will be considered according to the results. The tender for operating the program will be published towards the end of the year (Q4, 2017).

For further details: http://economy.gov.il/RnD/Programs/Pages/coding-bootcamps.aspx

›The Israel National Braingain Program – Created to engage Israelis with international experience in the Israeli Industry

The national program for returning academic Israelis was created to deal with the increasing demand in the Israeli market for leading academics in their field. These academics have accumulated knolwge, education and international experience. The program started in 2013 as a partnership between the ministry of immigration, the mistry of economy, the ministry of finance and the budgeting committee of the high education council and the Israel Innovation Authority.

The program is open for Israeli academics who live outside of Israel and can become part of the industry, academia and medical institutions in Israel, together with the empolyers in the Israeli Market. In 2016 there were more than 4,000 academics listed and 400 employers active. In total the program has managed to bring back to Israel 900 academics since its inception.

In January 2017 it was decided to change the program so it will be led by the Israel Innovation Authority with an emphasis on the needs of the Israeli High-Tech Industry. The program will be directed towards academics who desire to work in the Israeli High-Tech industry whether they are Israelis living abroad and also potential relevant immigrantes. The Innovation Authority is developing the final details of this program.

Survey of Senior High-Tech Employment – Initial Findings

In order to answer this question, **the Innovation Authority conducted a comprehensive survey regarding the employment of senior (older) high-tech workers. The survey was conducted in conjunction with the Association of Engineers, Architects and Graduates in Technological Sciences in Israel.** The survey was widely circulated[9] and a sample of approximately 1,200 respondents was received, comprising employees or former employees in the high-tech sector or professionals from the high-tech industry who are employed or were employed in overlapping fields.

The respondents were asked about their employment situation (salaried employees, self-employed or unemployed), and about various employment characteristics such as the industry to which they work in, their salary range, the type of job/role in which they are employed, education and others. Among those who are unemployed, the survey examined different aspects of the difficulties in finding a new job. In addition, the respondents' views with regard to the employment situation of older high-tech employees were also examined, including aspects such as obstacles to their employment and advisable solutions. This report provides initial findings from an analysis of the survey results on the basis of which the Innovation Authority will subsequently conduct a thorough study..

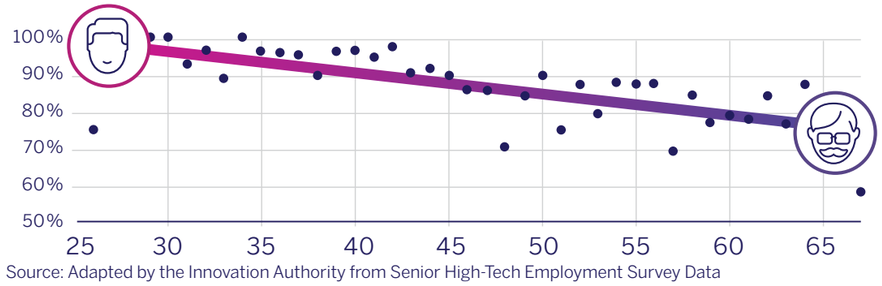
TABLE 1: **SURVEY CHARACTERISTICS – SURVEY OF SENIOR HIGH-TECH WORKER**

Demographic Characteristics	80% Male
	90% Hold an academic degree
Employment Characteristics	50% Employed (or were employed in their previous job) in professional -technological jobs. 40% employed in management roles (including professional-technological management), and the remainder – in peripheral and other jobs.
	35% earn (or earned in their previous job) in excess of NIS 30,000 per month.

The first and most striking finding of the survey is the decline in the rate of employment with the increase in age (see Diagram 2). In other words, age has a negative influence on the chances of finding employment[10]. The survey results also reveal that the phenomenon of decreasing rates of employment are more striking among managerial personnel. It should be noted that among the unemployed respondents, the overwhelming majority are actively searching for work and only a small minority had left the labor market entirely. In other words, this is not a trend of early retirement.

DIAGRAM 2: **THE RATE OF EMPLOYMENT DECLINES WITH AGE**

Rate of Employment (as salaried-employee or self-employed) calculated according to age for entire survey (n=1147)



Source: Adapted by the Innovation Authority from Senior High-Tech Employment Survey Data

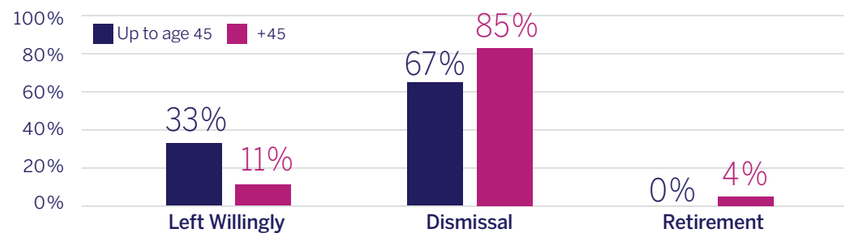
9 The survey was distributed via the internet.
10 It should be mentioned that the age influence embodies, for example, the cohort influence, in other words, the influence of demographic or statistical differences between different age groups. An example of such a difference may be the type of technological training given to different cohorts.

A further finding relates to the variation in the employment makeup with age. T**he ratio of salaried employees declines as the workers increase in age, while at the same time, the ratio of self-employed workers increases.** In other words, the picture being revealed shows that throughout their careers, some of the salaried-employees in the high-tech and associated fields, leave the workforce and some become self-employed.

Among those unemployed in the sample group, the overwhelming majority of the older workers (those aged 45 and over), left their previous jobs unwillingly while higher proportions of the younger workers left their last position of their own volition (Diagram 3)[11]. This does not mean however that the older workers were necessarily dismissed more than the younger employees. It is feasible that the rates of dismissal are similar, but that the younger workers find a new job easier and were therefore not "caught" in the unemployed category when responding to the survey.

DIAGRAM 3: **A HIGHER RATE OF UNEMPLOYED OLDER WORKERS LEFT THEIR PREVIOUS JOB UNWILLINGLY**

Among the unemployed in the sample: Reason for leaving last job



Source: Adapted by the Innovation Authority from Senior High-Tech Employment Survey Data

Additional findings relate to the widespread conjectures regarding obstacles to the employment of older workers in high-tech. The respondents were asked about the reasons that in their opinion may reduce the attractivity of employing an older worker in the high-tech field. More than half the respondents believe that high salaries constitute an obstacle[12], even though in practice, no indication was found for a negative connection between salary level and chances of employment[13]. More than half the survey's respondents are even of the opinion that the older workers' failure to keep up to date technologically may reduce the attractivity of their employment. Among the younger respondents (aged 44 and less) this rate even exceeds 60 percent. In this context, the Director of Employment in the Ministry of Social Affairs, together with JDC Israel and the Technion, has recently begun operating a technology refresher course for older software engineers (see below). More than half the respondents even mentioned a difficulty in integrating into a younger social environment, and approximately 30 percent mentioned fatigue and lack of motivation.

The survey also revealed interesting findings regarding the place of the age variable in the shaping of perceptions and feelings linked to employment stability. Firstly, o**f the total survey sample, the difficulty for older workers in finding a new job is perceived as significant**. The degree of perceived difficulty increases however with age – in other words, younger workers perceive the older workers' difficulty in finding a new job as less significant than the older workers themselves (see Diagram 4). Secondly, the survey shows that the concern regarding future employment grows with age and reaches its peak around age 50, however after this age there is actually a decline in the degree of concern (see Diagram 5). It can be suggested that this trend is connected to the proximity to the retirement age.

11 It should be mentioned that among those who retired, approximately half are also looking for work.
12 Multi-choice question – other reasons were also indicated with high percentages.
13 Within the group of unemployed, a higher salary in a previous job was not found to increase the difficulty in finding a new job. In addition, no different salary distribution was found between those employed and those unemployed, both in the total sample group and solely among the older workers.

DIAGRAM 4: **PERCEIVED DIFFICULTY FOR OLDER WORKERS IN FINDING NEW EMPLOYMENT MORE SIGNIFICANT WITH INCREASING AGE**
To what degree in your opinion, does difficulty exist for older workers in finding a new job? (1-5)

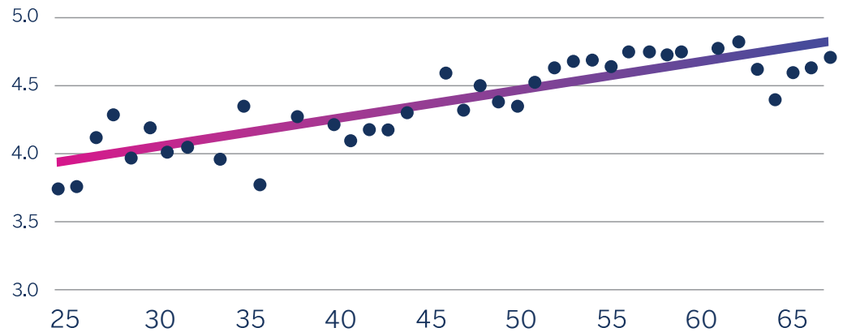
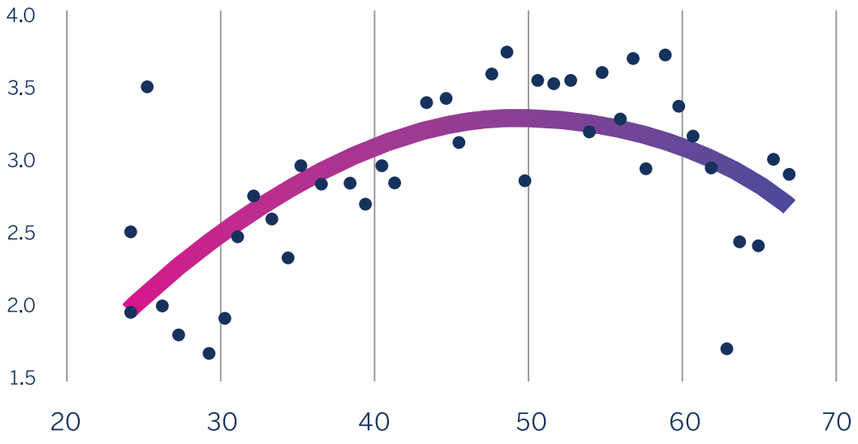


DIAGRAM 5: **DEGREE OF CONCERN FOR FUTURE EMPLOYMENT INCREASES WITH AGE BUT DECLINES TOWARD RETIREMENT AGE**
Degree of reported concern for future employment in workplace (1-5)



Source: Adapted by the Innovation Authority from Senior High-Tech Employment Survey Data

If so, an initial analysis of the survey results reveals for the first time that an empiric basis exists for the claims regarding lower chances of employment in the high-tech industry for older workers, especially among the managers. Furthermore, the survey shows that high-tech workers themselves believe that there is an employment difficulty for older workers – a feeling that intensifies with age. Further analytical work is needed however in order to delve deeper into the phenomenon and better understand its various elements. In this context, the endeavor of the Director of Employment in the Ministry of Social Affairs to reintegrate older programmers into the industry (see below) may serve as a pilot for examining some of the survey's insights, especially the aspect of remaining updated technologically. The Innovation Authority intends to examine the development of additional programs that will provide a response to this market failure and that will aid the integration of older workers.

Reintegration of Older Programmers

The Director of Employment is acting to advance the reintegration of older programmers into the high-tech industry

As part of the overall effort to address the shortage of skilled workers in the high-tech sector, the Director of Employment in the Ministry of Social Affairs recently launched a technology refresher course for older software engineers (aged 45 and over). The course is a joint initiative together with JDC Israel-Tevet, the Technion, and the "Middle of the Road" program. The refresher course aims to restore to the workforce senior software engineers who have strayed from the field of software development, through study of advanced subjects based on the participants' relevant previous education and experience.

The course, which is concentrated into four intensive days of study a week with a total scope of 320 academic hours, emphasizes the acquiring of up-to-date knowledge such as Android software, data science, the principles of agile development, and the development of practical skills. Upon completion of the course, the participants work on a product development project in which they can express the knowledge and skills acquired during the program. During the course, the participants also receive ten hours of guidance in various aspects of employment such as updating their C.V. and preparation for job interviews.

The program is offered at a subsidized cost of approximately NIS 3000 while the cost of similar private programs can reach NIS 15000 or more. The first cycle of the program commenced in July 2017 and another is expected to open in November 2017. The program's future expansion will be considered based on the rates of successful graduate placement.

For further details about the next course: RikiA@jdcnet.org

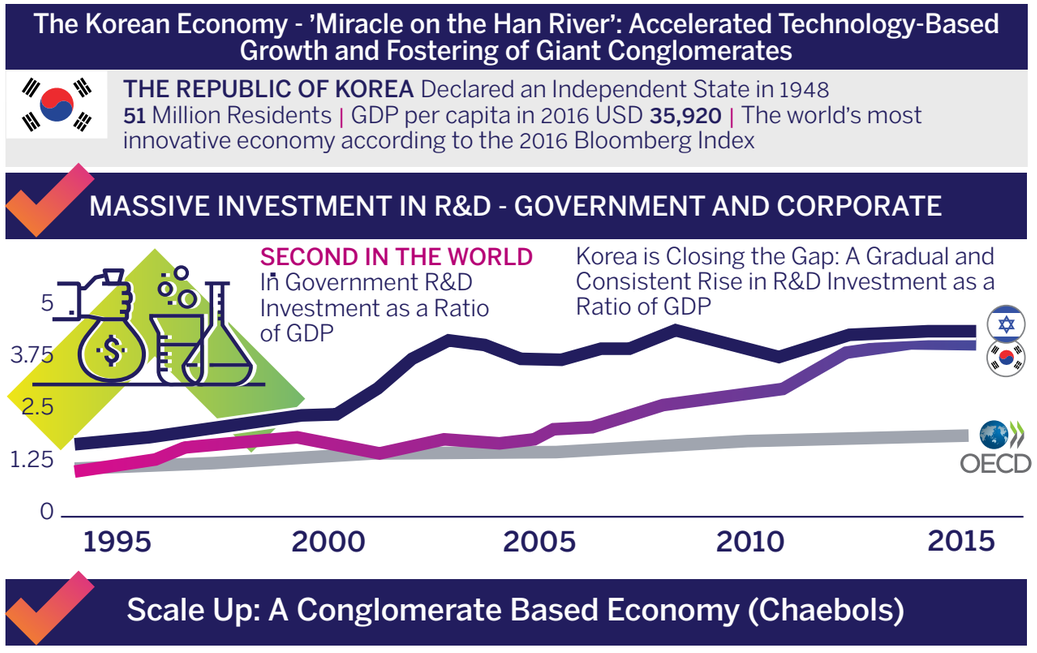
We wish to thank the office of the Director of Employment at the Ministry of Labor, Social Affairs and Social Services; The Planning and Budgeting Committee at the Council for Higher Education; and to the Association of Engineers, Architects and Graduates in Technological Sciences in Israel for their contribution to this chapter.

Chapter 6

Perfect Opposites
Innovation in Israel and In the Republic of Korea

이스라엘

Despite the two countries' cultural and commercial differences, Israeli and Korean innovation complement each other. The challenge: to bridge the gaps and advance the mutual commercial R&D relations between the two countries



A synergetic relationship, based on complementary contrasts, exists between the State of Israel and the Republic of Korea (hereafter: Korea) in the fields of innovation and commerce. In general, the two countries have much in common from historical and geo-political aspects: Similar to the State of Israel, Korea was only declared an independent state in 1948 and has since undergone accelerated economic development; it has been in the midst of a continuous state of conflict with its northern neighbor; and its natural resources are sparse. However, in contrast to Israel, the Korean population is homogeneous, numbers approximately 50 million and has a continuous 4500 years tradition in the Korean peninsula.

A spotlight on the business culture in the two countries reveals fundamental differences between Korean and Israeli innovation. The Koreans specialize in the gradual growth of small and medium sized companies to large corporations, and in the establishment of a complete production chain via advanced technology. In contrast, Israelis excel in establishing small startup companies around a ground-breaking idea.

By virtue of these complementary comparative advantages, successful Israeli-Korean ventures have developed during recent years that contribute to the economies of both countries. These mutual relations have evolved with the support and encouragement of the Korean and Israeli governments, especially via the KORIL-RDF (Korea/ Israel Industrial Research and Development Foundation), the bi-lateral Korean and Israeli R&D Fund that was formed in 2001 following the strengthening of relations between the two countries (see below). **Up to 2016, over 140 joint Israeli-Korean corporate technological innovation projects were launched with a total scope of approximately USD 54 million.**

* The characterization and comparison of cultures in different countries may be inclined towards generalization. Any error on our part regarding cultural nuances in Israel and Korea is unintentional.

The Secret of Korean Success: State Investment and Growth of Giant Conglomerates

The names of the large Korean conglomerates, such as Samsung, LG, Hyundai, SK and Kia Motors are recognized all over the western world. It sometimes seems as if Korea has always been a focus of economic and technological prosperity, but that is not so. During the first half of the twentieth century, Korea was subject to Japanese occupation that lasted for 35 years. This was the last occupation in a series of foreign conquests that began thousands of years ago. Upon conclusion of the Second World War, the world powers attempted to establish a united independent state in the Korean peninsula. The failure of these efforts led to the outbreak of the Korean War between the communists in the north and the anti-communist forces in the south. In 1953, following three years of fighting, a ceasefire was declared and the current division between the two halves of the peninsula became permanent. The Republic of Korea, an agrarian and completely devastated country in the wake of the war, began an accelerated process of rehabilitation. A momentum of construction and innovation were accompanied by a national sense of total commitment to the state and its success, and by an underlying understanding that growth was the only way forward after the low point at the conclusion of the war.

It was during these years that the infrastructures of the modern Korean economy were laid. The authoritarian regime that ruled during the post-war era established a quality education system the graduates of which comprised fertile ground for the absorption, assimilation and subsequent development of technology. The regime also established a technical university and many research institutions in a technological park that developed into a flourishing complex. **This process, termed "The miracle on the Han River", transformed Korea from a poor agricultural economy into one of the wealthiest and most developed in the world, the product per capita of which has grown from 605 dollars in 1970 to 35,920 dollars in 2016[1,2].**

1 Yim, D. S. (2004). Korea's National Innovation System and the Science and Technology Policy. Seoul: STEPI;
2 OECD figures - GDP in current prices. See:https://data.oecd.org/gdp/gross-domestic-product-gdp.htm

Over the years, the Korean government has acknowledged the significance of technological innovation for national development, and therefore invested, and is still investing, vast funds in research and development, especially in the fields of ICT[3]. The rate of R&D investment in Korea thus doubled between the years 2000-2015 and stands today at 4.23% (as of 2015)[4]. **The level of state expenditure on research and development is particularly high when compared to other developed countries, and stands at approximately 1% of GDP**[5].

To illustrate, a national R&D program launched in 1982 encouraged investment in R&D in the corporate sector by means of funding R&D, providing tax benefits and other incentives, and emphasized the companies' competitiveness in international markets. Between 1982-1993, this program resulted in 2412 projects at a total cost of approximately 2 billion dollars, of which the government financed approximately 58 percent. The program's success was reflected in the creation of 1384 patents and the development of 675 commercial products[6].

Today, the country is harvesting the fruits of its investment: **Korea was ranked as the world's most innovative economy according to the Bloomberg Index in 2016**[7]. Koreans themselves enjoy the fastest internet connection in the world, high availability of mobile telephones, and a well-deserved reputation as early adopters of technology[8,9].

A further aspect of the accelerated rehabilitation process included significant government support for several conglomerates under family control (known as "Chaebols"), considered central partners for implementation of the state program of growth and industrialization. **The Korean business approach espouses 'Scale Up': gradual growth in a comprehensive, fundamental and continuous manner.** Over the years, Koreans have specialized in the establishment of small and medium-sized companies and their scale-up into conglomerates, while relying on widespread recruitment of skilled personnel, generous government resources and large injections of funds at the beginning of each new project. Today, the conglomerates function as the country's economic backbone, while the largest, - Samsung - constitutes approximately 17% of the entire Korean economy. The Samsung Group was founded in 1969 and is today comprised of nearly 80 subsidiary companies developing, producing and marketing in a wide range of fields such as electronics, engineering, shipbuilding, construction, retail & leisure, insurance, medical services and others, in which hundreds of thousands are employed.

The conglomerates are also a major focus of technological innovation and each of their business-technology divisions includes an in-house R&D Institute. In this manner, while the private sector's share of total R&D investment stands at 75%, the 20 largest corporations in Korea's share of the total R&D investment is approximately 57%[10].

The Korean Economy: From Moderate to Pioneering Innovation

Although the total commitment to success which guided rehabilitation from the war contributed to industrial and military development and to the establishment of the conglomerates, at the same time it created a parallel business culture of fear of failure resulting in moderate innovation. **The conglomerates traditionally inclined towards low-medium risk technology projects**. They chiefly specialized in the creation of innovation-based large production lines for complex products, and less in the actual development of innovative components and pioneering technologies.

In recent years, it appears as if Korea is aspiring to prepare for a transition from moderate innovation to groundbreaking innovation. This trend is reflected in a young generation of innovators who are striving to establish innovative start-up companies, and in the parallel initial signs of proposals to finance independent innovation. Additionally, the conglomerates themselves are becoming pioneers in different sectors. For example, Samsung was a pioneer in the field of 3D NAND Flash Memory[11] and, together with LG, is at the innovation forefront in the area of OLED screens[12].

At the same time, there is a general realization that notwithstanding the significant contribution of the conglomerates to the economy, the typical size and scope of their operation creates an economic centralization and dependency which places stability at risk. This situation was clearly illustrated by the Asian financial crisis in 1997 when fourteen Korean corporations collapsed, causing heavy damage. Subsequently, the government began diverting resources towards small and medium-sized companies that until then struggled to compete with the large conglomerates, and to promote start-up ventures. Just recently, newly-elected President Moon Jae-in transformed the Korean Authority for Small and Medium-Sized Businesses from an Auxiliary Unit to an independent government ministry[13].

The Israel-Korea R&D Fund

KORIL (KORIL-DF), the Israeli-Korean binational Research and Development Foundation, was established as the result of a Memorandum of Understanding signed by the two governments in 1998 with the specific objective of advancing industrial R&D via joint technology projects. KORIL operates in conjunction with the Israel Innovation Authority and the Korean Ministry of Trade, Industry and Energy (MOTIE). Representatives of the Israeli and Korean governments comprise the Foundation's Board of Directors. The Foundation's head office is located in Seoul while an official Israeli representative is situated in Israel. The Foundation's budget was enlarged to total USD 4 million in 2013, USD 2 million from each country. Its main roles are to assist companies in locating partners for R&D initiatives from both countries; funding direct R&D expenses in collaborations between Israeli and Korean companies which develop unique commercial products based on technological innovation; and the facilitation between partners from Israeli and Korean companies, especially regarding challenges arising from differences in business culture.

Proposals for support for joint initiatives are submitted to the Foundation in three budget models: Feasibility Study, Mini Scale Project or a Full-Scale Project. The Foundation's decision whether to authorize or reject the proposal is made following parallel due diligence in Korea and Israel. Foundation website: www.koril.org

In Practice: Strategic Cooperation with BondIT

The Fintech company BondIT, founded in 2012, develops learning machine-based solutions for financial advisors, that build and optimize bond investment portfolios. In July 2016, the company signed a strategic cooperation agreement with KIS Pricing, a Korean subsidiary company of the global finance corporation Moody's. Within the framework of the cooperation, the two companies are jointly developing software for managing bond investment portfolios, with the financial support of the Israel-Korea R&D Fund (KORIL).

3 Campbell, J. (2012). Building an IT Economy: South Korean Science and Technology Policy. Issues in Technology Innovation, vol. 19, 2012.
4 Van Noorden, R. (2017, February 7). Israel edges out South Korea for top spot in research investment. Nature. http://www.nature.com/news/israel-edges-out-south-korea-for-top-spot-in-research-investment-1.21443?WT.mc_id=TWT_NatureNews
5 OECD figures for 2014
6 Lall, S. (1999). Promoting Industrial Competitiveness in Developing Countries: Lessons from Asia. London: Commonwealth Secretariat. Pp. 51-52.
7 Lu, W. and Jamrisko, M. (2017, January 7). These Are the World's Most Innovative Economies. Bloomberg. https://www.bloomberg.com/news/articles/2017-01-17/sweden-gains-south-korea-reigns-as-world-s-most-innovative-economies.
8 Son, J. (2017, March 4). South Korea has World's Fastest Internet. http://technology.inquirer.net/59866/south-korea-worlds-fastest-internet; The ICT Development Index of the ITU can be seen at: http://www.itu.int/net4/ITU-D/idi/2016/.
9 The 2016 ICT Development Index of the United Nations ITU (International Telecommunication Union). See the ITU website: http://www.itu.int/net4/ITU-D/idi/2016/
10 Chung, S. (2007). Excelsior: The Korean Innovation Story. Issues in Science and Technology, Volume XXIV Issue 1. http://issues.org/24-1/chung/
11 Team TS. Samsung continues to lead global NAND flash memory market. TechSource. March 2017. https://www.techsourceint.com/news/samsung-continues-lead-global-nand-flash-memory-market
12 Shankar B. (2017). LG to release its first-ever OLED smartphone in Q3 2017 says report. https://mobilesyrup.com/2017/05/16/lg-to-release-its-first-ever-oled-smartphone-in-q3-2017-says-report/
13 Lyan, Irina. 2017. Remapping East Asian Economies. Paper presented in Korea University Graduate Student Conference, June 23.

The Secret of Israeli Success: A Culture of Entrepreneurship Unafraid of Failure

Israel, in contrast to Korea, is a small country with a culture of entrepreneurship that relies on audacity, improvisation and experimenting. While in Korea it is expected that an entrepreneur whose venture has failed will beat his breast and express deep sorrow, business culture in Israel encourages, even admires risk taking and development of pioneering technologies, and acknowledges the benefit of spillover knowledge acquisition even from projects that fail. The serial entrepreneur Dov Moran emphasized this approach in describing his company Modu which developed a modular cellular phone and then closed in 2010. Moran stressed that as far as he is concerned, Modu was not a failure because thanks to the knowledge generated during its operation, 30 other new start-up companies were created[14].

Accordingly, the Israeli high-tech industry is characterized by a large number of innovative start-up companies that are developing pioneering components or technologies. These developments are frequently acquired by a large corporation that will then integrate them into a broader-based system or final product. The central challenge for Israeli innovation today is therefore to grow complete companies and entire value chains- that type of Scale Up in which the Koreans excel.

The Potential of the Israel-Korea Interface

By virtue of the complementary comparative advantages between Israeli and Korean innovation, great commercial potential exists at the point of interface between the two countries. Koreans are interested in investing in advanced technological developments and are constantly searching for innovative components that can be integrated into their products. Israeli entrepreneurs are also interested in technological development but additionally seek manufacturing and Scale Up opportunities that the Koreans can provide. The combination of capabilities enables the development of advanced final products and their introduction into global markets.

Two projects in which the Israeli company Sightic Visa[15] participated and that were authorized and supported by the Koril Foundation, illustrate the value in the integration of the two countries' comparative advantages. The company, specializing in the development of advanced chips for use in cameras, developed, within the framework of two separate collaborations, advanced components for the security division of Samsung of that period, Samsung Techwin, and for LGE, that were intended for integration in security and surveillance cameras produced by the Korean conglomerates.

The Korean conglomerates are even forging a presence in the Israeli innovation system via local R&D activity and direct investment in Israeli technologies. Samsung operates a R&D center in Israel that employs approximately 200 workers. The center was established in 2007 following the purchase of the Israeli company 'Transchip' that developed chips for cellular cameras. Additionally, Samsung invests in Israeli startup enterprises through its own investment channels – Samsung Venture Investment Corporation (SVIC) and Samsung Catalyst; via the innovation program Samsung NEXT Tel Aviv; and the accelerator program Samsung Runway, that invest in early stages technology companies. The LGE division of LG Corporation also operates an R&D center in Israel, the focus of which is identifying Israeli technologies capable of integrating in the company's products, and development of collaborations with the Israeli companies behind them.

The fields of academic research also possess tremendous advantages for collaboration between Korea and Israel. Korea leads the way in applied research that complements the basic Israeli research: Most Korean government ministries have several affiliated Public Research Institutes, while in Israel there is a small number of such institutes.

14 Based on a number of lectures of Dov Moran in Korea, the latest at the Hello Tomorrow Korea Conference within the framework of the Asian Leadership Conference in Seoul, July 2017.
15 Sightic Visa was acquired by Broadcom in 2010.

The Koreans bring additional important attributes to these collaborations: exemplary implementation capability, meeting deadlines, high quality service, support of minute details and an impressive reputation. Israelis, as described above, bring pioneering technologies, audacity and the appetite for risk - understanding that innovation contains no certainty of success.

The Challenges of Mutual Relations

The differences between the business approaches and accepted norms of behavior in Israel and Korea also create challenges for the realization of the potential of cooperation. The differences in the perception of innovation itself, although standing at the foundation of the synergy, may also prove to be an inhibiting factor. **While Israelis understand that innovation is by definition experimental and involves risks and frequent changes, Koreans hesitate before committing to a project the success of which is uncertain**, and might show low flexibility to changes required during the process of technological development.

Language differences might influence the quality of communication during collaborations. This challenge illustrates the significance of direct communication between the partners: a practical demonstration during the development process communicates technical knowledge between professionals even without words.

Different organizational culture between Israeli companies and their Korean counterparts also creates challenges for entrepreneurs interested in cooperating with each other. For example, Israeli companies are characterized by a relatively flat organizational structure and relatively open communication between junior staff and management. In Korea however, companies are characterized by more rigidly hierarchical structure that also leads to lengthy bureaucratic processes such as receiving the necessary authorizations to start a project.

Additionally, in Korea and in other eastern Asian countries, an alcohol-filled night outing with colleagues and clients at the company's expense (termed Hoesik) is one of the keys to conducting business. This is not practiced in Israel, where socializing – including business - is frequently done in a family setting.

Naturally, it is recommended that professionals from both countries seeking to cooperate be attentive to cultural nuances such as these different local business customs, different national holidays and other situations that may pose challenges to ongoing communication.

Routine business analyses are therefore not sufficient as preparation for the creation of collaborations with companies in both countries, and significant importance should be accorded to familiarization with both cultures, particularly common business culture. In this context, the KORIL Foundation serves as a knowledge bank and acts to bridge gaps in business culture and enable effective communication between the collaborating parties.

Upcoming Objectives: Agro-Technology and the "Civilianization" of Defense Technologies

The KORIL Foundation constantly explores new directions for cooperation between Israel and Korea. As is to be expected, KORIL invests in sectors in which both economies excel, such as ICT and electronics. In recent years considerable interest has developed in applying "smart" technologies agriculture (agro-technology), robotics, in disaster management and others. As a result of experience in contending with terror attacks and military conflicts, Israel has acquired expertise in emergency healthcare and first responders' technologies. This experience is relevant to the Koreans who in recent years have contended with civilian disasters in the construction and maritime sectors. In the robotics sectors, a large study is being conducted in both countries towards the end goal of a joint disruptive technological breakthrough.

We wish to thank Dr. Ira Lyan for her contribution to this chapter.

רשות החדשנות
Israel Innovation
Authority

Chapter 7

Articifial Intelligence
Positive Development or Existential Threat

The revolution of artificial intelligence, robotics and learning machines is threatening to remove humans from the equation as a necessary and central component of the workforce. Which professions are in danger of extinction, and why will attributes such as creativity and compassion increase demand for workers?

The Artificial Intelligence Revolution

Throughout history, technological revolutions have caused the disappearance of some jobs and the creation of others in their place.
The artificial intelligence revolution is, for the first time, undermining the place of humans in the workforce.

The Agricultural Revolution | **The Industrial Revolution** | **The Digital Revolution** | **The Artificial Intelligence Revolution**

CURRENT TECHNOLOGICAL DEVELOPMENTS: such as computerized vision, natural language processing and movement identification, enable machines to perform tasks that, in the past, were considered entirely human.

- Painting
- Writing a Journalist Report
- Medical Imaging Analysis
- Driving

There is a high chance that telemarketing, checkout and insurance agent employees will lose their jobs to software, algorithms and robots within **20** years.

Checkout Workers:	Telemarketing:	Insurance Agents:
97% chance	99% chance	92% chance

I think we should be very careful about artificial intelligence. If I were to guess like what our biggest existential threat is, it's probably that."

THE FUTURE HUMAN FACTOR:
Soft Skills, Continuous Learning and Development

- Empathy
- Creativity
- Inter-Personal Communication

The history of technology has a comforting narrative: each time a technological revolution occurs many jobs for which there is no longer a need disappear. At the same time however, new jobs are created in their place. For example, when the motorcar industry was established, the laborers who worked in caring for horses and in the manufacture of carriages found themselves out of work. On the other hand, there was a swift rise in demand for workers in car factories, and in car maintenance and repair.

This historic fact presents a seemingly balanced picture, a kind of 'Law of Technological Preservation'. Jobs disappear but new ones are created in their place. In recent years however, a series of studies and findings have hinted that something in this law has become unbalanced. People retained their importance to the workforce in the wake of the agricultural, industrial and digital revolutions, but the recent revolutions – of artificial intelligence, robotics and learning machines – are, for the first time, threatening to remove humans from the equation as a necessary and central element in the labor market.

Human Competition versus Improved Algorithm

In the past, scientists examined how humans perform various tasks and attempted to consequently teach machines to perform the same task. Today however, the programmers develop algorithms that **teach the machines how to learn**, and then present them with millions of examples with which the machines learn by themselves how to perform the job.

This breakthrough means that not only physical, routine and monotonous tasks are at risk, but also jobs in which humans have always enjoyed an advantage over machines. Now, lawyers, accountants, sales and marketing professionals, doctors, journalists and even the programmers themselves are facing competition in the workforce. Competition in of itself is not a bad thing, the opposite is the case. However, while in the past, competition was with another employee who offered his service at a lower price or did the job better, today the competition comes from a technology that performs the job not only better, but also quicker, more efficiently and cheaper.

Almost all the companies are active in this new arena alongside all nation states and the world's large organizations: IBM invests in its supercomputer 'Watson', Apple is enhancing its digital assistant 'SIRI' and Amazon is cultivating 'Alexa'. Similarly, Microsoft, Facebook, Google, the giant Chinese manufacturer Foxconn, retail chains such as Walmart, intelligence agencies and other organizations, are all investing billions of dollars in the development or purchase of new technologies, many of which are intended to replace humans.

These trends can be expressed by the term 'technological unemployment'[1]. Ninety-three percent of the world's largest investors believe that governments worldwide are unprepared for the moment, which to their perception is looming ever closer, when artificial intelligence will significantly undermine human employment[2].

Truck driving – one of the most common jobs in the world – is an excellent example. In the United States alone, there are more than 3.5 million truck drivers, however governments, giant conglomerates and different corporations are investing billions of dollars in developing technologies that will enable trucks to drive themselves. The consultation firm McKinsey estimates that approximately a third of the world's trucks will drive themselves by the year 2024, and that by 2030 this popular job may disappear completely from most countries[3].A similar situation exists with regard to other occupations in the transport sector such as bus and taxi drivers.

1 Brynjolfsson, Erik and McAfee, Andrew (2014). "The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies", W. W. Norton.
2 Koetsier, John (2016, November 10). " 93% of Investors Say AI Will Destroy Jobs, Governments Not Prepared", Forbes. http://www.forbes.com/sites/johnkoetsier/2016/11/10/93-of-investors-say-ai-will-destroy-jobs-governments-not-prepared
3 "Delivering Change: The transformation of commercial transport by 2025", McKinsey & Company, September 2016. http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/delivering-change-the-transformation-of-commercial-transport-by-2025

The Gradual Approach of the Post Human Era

It seems likely that this trend will continue and that advanced technologies are expected to keep progressing up the ladder of human proficiency. For example, until a few years ago, the trade on the world's stock markets relied on humans. Today however, companies are competing between themselves to develop the fastest trade algorithm, capable of executing transactions a micro-second faster than their competitors. Humans have been left far behind, unable as they are, to contend with the enormous speed and fantastic calculation capability of algorithms that constantly improve themselves.

Corporations, government agencies and research bodies are developing systems that are capable of analyzing pictures, video clips and natural language. These new capabilities enable them to experiment with the manufacture of products that, in the past, were considered completely human. Some such examples include media reports, medical imaging analysis, legal surveys, paintings and even jokes. IBM even claim that they have developed a system capable of locating cancer in a patient's body better than the world's best experts.

Various experts, including inventor and technologist Ray Kurzweil, have suggested that we are rapidly drawing closer to 'Singularity' – an artificial entity, the dimensions and components of which, will outstrip human capability. This entity will develop itself, progress at an exponential rate, and will launch us all into a post-human era: that in which humans no longer control the Earth, ceasing to be the planet's strongest and most intelligent entity[4].Kurzweil is convinced that this is a positive development as it will enable us to detach ourselves from the limitations of the human intellect, solve problems that we cannot solve alone (such as global warming), and live forever.

Not everyone shares the optimism. Senior scientists, including the renowned physicist Stephen Hawking, are extremely concerned by the situation. In a special column written for the British 'Guardian', Hawking estimated that the development of artificial intelligence can be expected to eradicate jobs at the heart of the middle class. He predicts that only a fraction of occupations, those that deal with care for other humans or that necessitate special creativity, will remain relevant and survive the revolution[5].

Artificial Intelligence is an Existential Threat

Hawking is not alone. The technology entrepreneur Elon Musk said with regard to artificial intelligence that "we are summoning the demon. [...] I think we should be very careful about artificial intelligence. If I were to guess what our biggest existential threat is, it's probably that."[6] Bill Gates, founder of Microsoft also expressed concern at the manner in which advanced technology may adversely affect the labor market, saying "I don't understand why some people are not concerned."[7]

These misgivings raise the important question – why is humanity developing a technology that may threaten its own existence, its own sources of employment and the livelihood of hundreds of millions of people? The answers are manifold. Firstly, each development is not in of itself perceived as a threat but rather, as an achievement in a specific field of knowledge such as the understanding of language, movement, face recognition etc. Only when all these developments are combined and unified does a terrifying picture begin to form.

Secondly, since the Age of Enlightenment, "science" and "technology" are synonyms for "progress", the latter being overwhelmingly perceived as a positive thing. Not without reason is the word "progress" associated with "progression" or "advancement" for after all, who can seriously object to progress?

Finally, scientists, technologists and people in general, do not always understand that technology may get out of control. In practice, many technologies were developed with a certain objective in mind but were ultimately used for an entirely different purpose. The technology historian Lewis Mumford, wrote in his book 'Technics and Civilization' that the mechanical clock was invented in the 13th century by Benedictine monks who prayed seven times daily at fixed times, because they sought a way to know prayer times. However, the invention of the mechanical clock "escaped" the monastery and became the central means for enabling capitalism - designated working hours, working in assembly lines, manufacturing mass consumer products. As Mumford wrote, in the struggle between God and money, the latter prevailed[8]. It was in this context that the media theorist Neil Postman wrote that, had the monks foreseen the future, they may have possibly preferred to remain with their sundial. Likewise, he conjectured, had Gutenberg known that his printing press would lead to the dismantling of the church, he may have preferred to use his machine to produce wine and not books[9].

Technology evolves faster than the framework restraining it

Moreover, if we have learned anything from the history of technology, it is that it tends to develop faster than the cultural, ethical or legal frameworks that are supposed to restrain it. Only after the invention of nuclear weapons, any consideration was given to preventing its proliferation, only after the cloning of a sheep was accomplished, people started devoting efforts to prevent human cloning, and only after development of the cellphone did cultural norms consolidate regarding its public use. The problem with the developments in the field of artificial intelligence and algorithms is, that we may ultimately discover that the moment at which we begin to contend with their ethical and economic ramifications, is one moment too late.

If that is not enough, the new technologies may have significant psychological ramifications for the identity and the sense of self of us all. The most prominent economists and sociologists, including Karl Marx, have extensively expounded on the degree to which work is central to a person's existence. For thousands of years we have been accustomed to drawing our satisfaction, self-identity and pride from the fruits of our labor, all of which are dealt a harsh blow with each successive technological revolution.

This was demonstrated by the industrial revolution when millions of laborers, who toiled in jobs that were handed down from father to son over the generations, were disinherited from their jobs and sent to work in a factory where they performed basic, exhausting and uninspiring labor. A century later, the factory workers discovered that they too could be replaced by machines and robots, and were consequently sent to work in service-based industries such as support, service and sales. **Now, according to estimates of the best experts, there is a 99% probability that most of the telemarketing jobs will be transferred to computer programs, algorithms and robots within the next twenty years. The chance that checkout workers will lose their jobs stands at 97% and the probability that insurance agents will find themselves replaced is estimated at 92%**[10].

4 Kurzweil, Ray (2012), "The Singularity is Near", Tel Aviv: Magnes (Heb.)
5 Hawking, Stephen (2016, December 2). "This is the most dangerous time for our planet", The Guardian. http://www.theguardian.com/commentisfree/2016/dec/01/stephen-hawking-dangerous-time-planet-inequality
6 McFarland, Matt (2016, October 2104). "Elon Musk: 'With artificial intelligence we are summoning the demon.'". The Washington Post. http://www.washingtonpost.com/news/innovations/wp/2014/10/24/elon-musk-with-artificial-intelligence-we-are-summoning-the-demon/
7 Holley, Peter (2015, January 29). "Bill Gates on dangers of artificial intelligence: 'I don't understand why some people are not concerned'". The Washington Post. http://www.washingtonpost.com/news/the-switch/wp/2015/01/28/bill-gates-on-dangers-of-artificial-intelligence-dont-understand-why-some-people-are-not-concerned/
8 Mumford, Lewis. (1964). Technics and Civilization. New York: Harcourt Brace & Company. P. 15.
9 Postman, Neil. (2003) Technopoly: The Surrender of Culture to Technology, Tel Aviv, Sifriat HaPoalim, P. 15. (Heb.)
10 The probability that your job will be replaced by a machine can be seen here: http://www.npr.org/sections/money/2015/05/21/408234543/will-your-job-be-done-by-a-machine

How will the labor market be influenced by technology that is progressing at dizzying speed?

Despite the gloomy forecasts, it must be honestly admitted that our ability to contain, comprehend, and predict the future is gradually diminishing. The main reason for this is the intensity and speed of modern technological changes. Processes that in the past occurred over centuries, and later over generations, occur today within merely a few years. In practice, this is one of the reasons that we find it so difficult to keep up: What was true yesterday, is only barely true today, and will certainly not hold true tomorrow.

It is for this reason that we cannot rule out the possibility that the artificial intelligence and learning machines revolution will create new jobs, fields of employment and expertise that we cannot even imagine today. Jobs such as "Data Scientist", "Search Engine Optimization expert", "Video Blogger at YouTuber" or "Online Social Network Community Manager" have been created during recent years, and are a direct result of the rapidly developing internet economy that has created a new echelon of workers and jobs that rely on companies such as Google, Facebook, Amazon and others.

Today's reality whereby someone's day at work focuses on the attempt to convince Google's grading algorithm that the site he is promoting should be at the top of the search results list, would have seemed beyond belief twenty years ago. It is hard to remember that back then, we searched for a doctor by paging through the telephone directory... Consequently, the presumption to know how the labor market will be influenced by technologies advancing at dizzying speed, is one to be approached with a good deal of modesty.

Still, those who believe that developments in the fields of software, robotics and algorithms will not affect them, are choosing to bury their heads in the sand. **In coming years, both organizations and employees will be required to locate and invest in skills and abilities that rely on clear human attributes such as creativity, sympathy, compassion, face-to-face communication - 'soft skills' - those that are difficult to program and hard for machines to imitate.**

Workers must remember that in this age, education does not stop after high school or even university. They must continue to study and develop themselves, and vary their abilities and fields of knowledge. They must develop their creative muscle, their imagination, initiative and even their sense of self-criticism. Digital literacy is an essential skill for every school pupil and certainly for students and adult workers.

Moreover, while computers (still) depend on logic, rationalism, and calculations of probability, humans also rely on, and are motivated by, emotions and intuition. They occasionally act against their own interests; they have the ability to be surprised by their own decisions. If, in the past, these attributes were regarded as "weak", in the super-rationalist era they actually become important. We wouldn't like to see judges made of code and steel passing judgment on us. We would not like robots to do the work of kindergarten or schoolteachers, social workers or of any other professionals associated with the human experience. Human beings, not robots, are aware of the meaning of death, suffering or heartache, and therefore performing their job with sensitivity, compassion and tenderness.

Personally, I hope that despite the fact the machines are expected to take control over increasingly number of tasks and jobs, we will know how to preserve the things that makes us all so special, so important, and so human.

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APPENDIX

APPENDIX

RESULTS OF INDICATORS COMPRISING THE HIGH-TECH INDEX

The Startup Companies Sub-Index:

1. **Net New Companies:** The sub-index represents the net change in the number of Israeli companies operating in the high-tech industry. In other words, subtracting the number of Israeli high-tech companies that were closed from the number of Israeli high-tech companies that were established. It should be mentioned that the figure for 2016 is not final and is based on IVC estimations.
2. **Amount and Value of Capital Raised by Companies:** The total value and number of financing transactions in which Israeli high-tech companies raised capital from all investors – venture capital funds, angels and other investors.
3. **Number and Value of Exits:** The monetary value of, and number of exits in which the Israeli high-tech companies participated. An exit is defined both as an initial offering (IPO) and a merger or acquisition (M&A).
4. **Capital raised by VC Funds:** The indicator totalizes the total capital raised by Israeli venture capital funds in a year. The figure constitutes an indication of the expected future investments of those same funds in Israel.

	Actual Value			Normalized Value		
Indicator \ Year	2014	2015	2016	2014	2015	2016
Value of Exits	7.77	8.04	5.6	0.65	0.74	-0.10
Number of Exits	119	109	103	1.31	0.6	0.17
Value of Capital Raised	3,408	4,307	4,775	2.21	3.62	4.36
Number of Financing Rounds	684	706	659	1.62	1.85	1.37
Capital Raised by VC Funds	1,396	1,497	1,355	1.54	1.79	1.44
Net New Companies	634	736	613	1.6	2.56	1.4

Mature Companies Sub-Index:

1. **Added Value:** Defined as the difference between the gross output and total input. The sub-index is calculated as the sum of the added value, both in high-tech manufacturing and in high-tech services (the computer and software sector and the R&D services sector which includes startup companies).
2. **High-Tech Exports:** The total exports of the high-tech sectors in manufacturing and services including that of the startup companies.
3. **Ratio of Salaried High-Tech Employees:** Ratio of high-tech employees, excluding employees in the communications services sector, out of the total employees in all sectors.
4. **Technology Stocks:** The Tel Aviv Blue-Tech 50 Index, that includes the 50 shares with the highest market value of all the shares included in the TA Technology Index and the TA Biomed Index. The figure is calculated as an average of the daily closing indices, for each year.
5. **Number and Value of PE Transactions:** PE financing includes bridging loans, financing via sale of shares, Buyout and mezzanine loans by Israeli high-tech companies.
6. **Number and Value of Secondary Offerings:** Number and value of the rounds of public financing undertaken by Israeli high-tech companies whose securities are already registered for trade (secondary offerings). This variable represents the continued growth of Israeli public companies.
7. **Value and Amount of High-Tech Acquisitions:** The total sum of all merger and acquisition transactions executed by Israeli high-tech companies, while the acquired company is not necessarily Israeli or technological.

	Actual Value			Normalized Value		
Indicator \ Year	2014	2015	2016	2014	2015	2016
Added Value (In Millions)	108,178	109,096	111,765	1.6	1.67	1.87
Ratio of High-Tech Employees	8.0%	8.1%	8.3%	0.54	0.81	1.46
High-Tech Exports (In Millions)	35,854	39,043	40,895	1.21	1.78	2.11
Technology Stocks (Yearly Average, in Millions)	328	352	335	0.34	0.42	0.55
	328	352	335	0.31	0.69	0.42
Number of PE Transactions	49	53	44	1.12	1.65	0.45
Value of PE Transactions (In Millions)	2,065	1,924	1,611	1.20	1.00	0.56
Number of Secondary Offerings	24	34	18	0.95	2.06	0.27
Value of Secondary Offerings (In Millions)	1,932	9,384	635	0.57	6.82	-0.52
Number of High-Tech Acquisitions	66	75	68	1.22	2.19	1.44
Value of High-Tech Acquisitions (In Millions)	3,080	7,694	8,544	-0.32	1.03	1.28


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