

Israel in Space

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The Harold Hartog School of Government and Policy



Tel Aviv Workshop for Science Technology and Security

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Notes by the head of the Harold Hartog School of Government and Policy and the head of the Tel Aviv Workshop for Science Technology and Security

In recent years the Harold Hartog School of Government and Policy at Tel Aviv University has been hosting a broad-based project on how science and technology affect security. The subject of space occupied a central position in this project, and for good reason. Space is one of the four basic components of modern warfare in the information age.

Israel is one of the few countries in the world that builds and launches communications and imaging satellites. Despite Israel's being a small country with limited resources, it has no choice but to be active in the space arena. This is because the advantages of space allow Israel to make the most of the only resources that are available in abundance - quality personnel and the ambition to excel, especially in the defense establishment and the security industries. In addition, being in space enables the State of Israel to increase its deterrent ability via demonstrating technological capability in an era when the traditional method for increasing deterrent ability - the use of military might - is becoming harder and harder.

Space also has a welcome effect on the economy: the growth of a modern economy is largely dependent on human capital and on the extent to which a society and its economy are based on science. Space technology contributes directly to these factors and helps Israel retain the best scientists and engineers.

The policy paper "Israel in Space" is based on a master's degree thesis written by Deganit Paikowsky. Her thesis deals with the effect of space technologies on warfare patterns in modern times. The policy paper that was presented at the evening seminar analyzes how Israel's military and civilian sectors have benefited from the development of an independent space program, leading to the conclusion that the space program should be treated as a national asset.

This field has received hardly any in-depth academic or public attention, so the Harold Hartog School of Government and Policy and the Tel Aviv Workshop for Science Technology and Security felt it was appropriate to grant the policy paper a stage. The policy paper and the evening seminar held on April 14 2005 were very well received and aroused great interest in both the political and defense establishments. We hope that this will contribute to the improvement of the public discourse of this field and therefore also to Israel's national security.

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Israel is a member of the exclusive club of fewer than ten countries that develop and launch satellites into space. Since gaining independence, Israel has focused its efforts on strengthening her national security vis a vis her neighbors by maintaining a qualitative edge over their quantitative edge. Israel has had an independent space program for over 20 years and it is an expression of that concept.

The establishment of an independent space program in a small country is no small thing and requires vision and substantial investments. Over 20 years ago there were visionaries who pushed for Israeli involvement in space, but there were also many objectors. Even today, with Israeli satellites orbiting overhead, the future of the Israeli space program is neither clear nor certain.

We are pleased that this evening's topic for discussion is the result of a policy paper written by one of our brilliant students, Deganit Paikowsky, whose paper addressed the civilian and military advantages for Israel's national security inherent in Israel's involvement in space. This is the issue that we and Deganit, along with the large audience here this evening, feel deserves significant attention.

The policy paper is part of a broader study conducted by Deganit as part of the research for her master's degree in international relations in the Faculty of Political Science, under the guidance of Prof. Isaac Ben Israel, head of the Security Studies Program. We thank Prof. Isaac Ben Israel.

It is a wonderful feeling for the School of Government when we publish our students' papers and seeing such a large audience is heartwarming. I would therefore like to thank all of you for coming. Prof. Ben Israel will present this evening's workshop.

Prof. Isaac Ben-Israel

The story of Israel in space is not something that can be taken for granted. We must remember that Israel is a very small country with very limited resources and for Israel to start being involved in space is not an automatic assumption. I have already told this story on previous occasions, and might tell it again: The decision to develop a satellite in Israel, made by a series of Israeli defense ministers and approved by prime ministers, was carried out largely in spite of objections from the IDF, as strange as this sounds, as the IDF is the space program's main consumer.

Ehud Barak, who once served as chief of staff, strenuously objected and we had to appeal several times to the defense minister, Yitzhak Rabin, who was also the prime minister at that time, and twist the IDF's arm in one way or another, so that the program could continue. After we had begun to launch satellites we came to report one of the launches to the prime minister, by that time Ehud Barak. He toasted the satellite and said he had to congratulate the team of people who had developed the satellite, because they had overcome unbelievable difficulties in developing it, and he winked at me - because he was referring to himself.

This evening we will hear Degani's lecture, on a policy paper that is part of her research toward her master's degree in the contribution of space to the process of changing the concept of warfare in the West, in the United States and in Israel. After Degani's lecture we will hear two responses. The first, from Reserve Brigadier General, Prof. Chaim Eshed, who has headed the satellite development program since its inception about 25 years ago. As everyone knows, he is also a professor at the Technion's Space Research Center, and holds the record for winning the Israel Defense Award three times. He has also been awarded several military citations, including from the chief of staff. Chaim will be followed by Dr. Reuven Pedatzur, familiar to everyone for his articles in Haaretz newspaper and as a lecturer in the defense studies program at Tel Aviv University and at Netanya College.

Ms. Deganit Paikowsky

It is a pleasure to see so many people as interested in space and as fascinated as I have been these past three years during which I have been preoccupied with it on an almost daily basis. I would like to begin this lecture with a personal anecdote from about six years ago, when I was involved in a totally different field. At that time I was an editor and producer for Army Radio, where my work included the preparation of the call-in program "Listeners in the Morning." One Friday morning a listener phoned and asked to share with us a solution he had found to the country's problems with our neighbors. He suggested putting the land of Israel, the "Holy Land," up for sale - as real estate the Holy Land is quite valuable. He said that the money obtained from the sale could be used to transfer the whole State of Israel to the moon and set up the first Jewish settlement in space. We would have no hostile neighbors there and Israel's existential problems would be solved. Israel's space program in its current format does not presume to establish a Jewish settlement on the moon, but certainly does contribute to Israel's national security. It is those contributions that I would like to discuss this evening.

First, I would like to define the military and civilian space applications, and what national security is. For the past few decades we have been in the throes of the information revolution, or the information age. Human society in the West has switched from being a society in which industry and the economy are based on industrial mass production to a society in which information technology is the main resource of the economy, industry and the foundation of society. Space technology is mainly information technology. It therefore plays an important and central role in the discussion of national security and the empowerment of countries in our times. Technological support from space via satellites now touches various aspects of our lives - both military and civilian: meteorology, communication, mass media, navigation, land measurement, surveillance intelligence, early warning, agriculture, water, etc.

What is national security? This term has many interpretations, but they all have one goal - existence or survival. It is common to think of national security in terms of military might, but also fitting to give it a broader interpretation and look at Israel's power to survive in terms of civilian and social strength. Throughout the world, all of a society's components affect its national security, for better or for worse. According to this approach, national security includes state's economy, social fabric, the quality of the education system, human capital and more. The basic assumption is that all these factors determine the national strength and society's endurance in the face of difficulties and threats.

The space program is an expression of the balance between these two perceptions. In this context the Israeli program was at first intended for military needs, but its civilian contribution (economic and social) is no less than its military one. In an era in which advanced technological ability is the main resource fuelling society and the economy - an independent space program is clearly a big advantage.

Such a program improves and maintains the quality of human capital, encourages scientific research, strengthens the economy and boosts civilian and military industries.

Space became a part of our lives in October 1957 when the Soviet Union launched "Sputnik 1". Throughout the Cold War the space race was a main component in the conflict between the superpowers. The trends in American activity in space are quite evident from an analysis of the investments allocated to military activity and civilian activity (NASA). The graph presented here (see Figure 1) clearly shows three periods of change in the emphasis on the nature of American activity in space.

In the 1960s the emphasis was on the civilian program, with the aim of making achievements in space specifically in science and technology - with the main focus being the "Apollo space program" and the goal - landing man on the moon. President John Kennedy declared this in a speech in 1961 and in July 1969 "Apollo 11" landed on the moon. During that period the scientific race to space was the main expression of the direct struggle between the two superpowers.

In the 1980s this trend switched, with the emphasis on military activity in space, both in investments and in the strategic importance of space. In the late 1970s Americans first declared their right to self-defense in space and thus opened the door for massive investments in military activity. In 1983 President Ronald Reagan announced the "Strategic Defense Initiative" that we know as "Star Wars". Tremendous sums were invested in military activity aimed, among other things, at prompting the Soviet Union to make investments too, that would gradually lead to its economic collapse. At the end of that decade the Soviet Union did collapse, although for other reasons, and the Cold War ended. This signaled a significant decline in the investments in space and in military activity in general.

Lately, there has been a renewed trend toward increased investments in military activity in space, stemming mainly from American successes in the first Gulf War - which American strategists call the first space war - and its success in the war in Iraq, where the Americans initially demonstrated and applied the military thinking and warfare patterns developed in the wake of her technological abilities in space. In the first Gulf War, the Americans used about 25 satellites. In the war in Iraq in 2003 that number had been doubled and they were used during the fighting, with the military operations relying mainly on space technology.

The great importance attributed to this technology can be seen in the massive increase in the use of satellites. In recent years there have been over 400 successful launches that put some 600 satellites into orbit, with over 20 percent of these being military satellites. 60 percent of all satellites launched during these years are communication satellites, 11 percent are surveillance and remote sensor

satellites. This means that the two main uses are for communication and intelligence. These are also Israel's fields of expertise in space.

A close look at the ownership of the satellites launched in recent years shows increased interest in space, with many countries seeking their own foothold there. Thus we can find more countries developing satellites and other countries buying satellites, including countries hostile to Israel, such as Saudi Arabia, Algeria, Pakistan, Malaysia and Indonesia. Although these satellites are quite simple, they reflect an increasing recognition of the importance of being in space. This means that if Israel is interested in continuing to maintain the qualitative and technological edge on her neighbors, she must not lag behind.

The importance attributed to space technology can also be seen in the tremendous investments diverted to this field around the world, and mainly in the United States. The U.S. alone now invests about \$35 billion in space annually, for both civilian and military purposes, with \$20 billion earmarked for military activity. This is 4.5 percent of the entire defense budget. Europe invests some \$6 billion annually, with about \$4 billion of this designated for the European Space Agency's budget. Official data indicates that China invests over \$2 billion, but it probably invests far more than that. Japan also invests over \$2 billion annually. As for Russia, the official figure is \$1 billion, but the actual investment is probably less. In recent years India has invested about half a billion, and in the 2005 budget this figure was increased to \$722 million. Austria, quite a small country, invests some \$80 million annually in the European Space Agency. In that context it should be noted that according to foreign sources, Israel invests only \$50-\$60 million annually. The conclusion is that even with modest budgets small countries can achieve substantial accomplishments in this field, as Israel is one of the few nations with the ability to independently develop satellites and launchers.

This brings us to the Israeli space program. The Israeli space program was established in the 1980s, motivated mainly by military, and primarily intelligence needs. In the framework of the peace accords with Egypt, Israel lost intelligence assets in the Sinai, as well as the ability to send manned aerial photography planes to that area. Even though a peace treaty had been signed, there was a clear need for intelligence on what was happening in Egypt. The Prime Minister, Menachem Begin, approved the establishment of the space program in July 1981 and in 1988 the first satellite – "Ofeq 1" - was launched. This whole time the program had many objectors and it is thanks largely to dedicated zealots that it exists and achieved such accomplishments. This month marks 10 years since the successful launching of the first operational satellite – "Ofeq 3" - launched on April 5, 1995. This was also the year that the IDF, for the first time, defined the operational need for a photography satellite. In other words, this means that the program functioned for 15 years without such operational need for two reasons - firstly, there was insufficient faith in the ability to implement the program, and secondly, there were fears that it would drain the defense budget. After "Ofeq 3" began transmitting, the fears

evaporated and the need materialized. Even though the army did not want the satellites, various defense ministers saw fit to channel budgets to the space program. Due to its size and limited resources, Israel chose to focus on two main space technologies: intelligence and communication.

Today there are 5 Israeli satellites in orbit – "Ofeq 5", launched in May 2002 - a military photography satellite; "EROS 1", made by Israel Aircraft Industries - a civilian photography satellite; two communications satellites – "Amos 1" and "Amos 2"; and the Technion's students' satellite. To these we must add Israel's ability to launch satellites independently. Six months ago there was the failed launching of the "Ofeq 6" satellite, which fell into the sea.

What is the benefit of an independent space program? The advantages of a space program can be divided into three categories: military, economic and social.

Military facets

First of all, I would like to focus on intelligence. Satellites widen the area for intelligence gathering. In the Israeli context, satellites allow the gathering of information on countries further away, such as Iran, and improve the ability to gather intelligence and reduce the feeling of uncertainty - without violating the sovereignty of other countries and endangering lives. Furthermore, an independent presence in space provides independent intelligence. This means Israel can conceal the identities of targets of interest, protect information sources and receive readily available information without relying on external forces. In a number of instances in the past, including in the Yom Kippur War in 1973, during the preparations for the bombing of the reactor in Iraq in 1981 and during the first Gulf War (1991), Israel received negative responses when it requested updated intelligence information from American photography satellites. Thus independent ability in this field is important to Israel's intelligence gathering capability.

Secondly, independent capability in space helps increase deterrent ability. In an era when it is harder to deter via military might it is important to deter by demonstrating technological abilities such as the ability to launch and develop satellites, which attest to substantial strategic ability. The fact that countries hostile to Israel know its abilities in space and that Israeli satellites are orbiting above, but do not know exactly what they are targeting contributes to Israel's deterrent ability. All this is doubly important when countries hostile to Israel seek their own foothold in space, as evident from the facts presented above.

Thirdly, ability in space contributes to improving attack and defense capability. In this context, Israel has unique technology that relies partly on a presence in space and aids its defense capability. This system is known as the "Arrow" Missile System, which provides protection against surface-to-surface missiles. As for attack capability, space facilitates the use of precision guided weapons. An example of

this ability can be seen in the war in Iraq in 2003, where most of the weapons the Americans used were precision guided (about 68 percent of all weaponry), and a large amount of the precision guided weapons were based on satellite guidance systems resulting in direct hits with an accuracy of a few meters.

Fourthly, the issue of raising modern military standards - since the establishment of the state, Israel has followed the principle of "quality over quantity." Space is now considered one of the four basic components of modern warfare in the information age, with western armies, headed by the U.S., relying more and more on advanced technology and changing their warfare patterns and the structure of their military forces accordingly.

To wind up the discussion of the military aspect of space I would like to relate to an issue that is fundamental to Israel - the problem of strategic depth due to Israel's narrow dimensions. Being in space allows Israel to overcome the strategic depth problem to a certain extent, as it provides it with an additional arena. A space presence and the view from space increase Israel's strategic depth as they allow Israel to see what is happening in the vicinity, even at a great distance.

Economic facets

Developing independent ability in space aids in reaching cooperative agreements with other countries. Israel's proven ability in space is a source for cooperation with countries developing their own space technologies and which are interested in exchanging knowledge and joint development. It also attracts countries that have no such independent ability but which are interested in acquiring space technology. The result is the strengthening of relations with various countries that invest in Israel and purchase technologies. In recent years there have been many news reports regarding joint space-related ventures between Israel and countries such as India, Turkey, Singapore, France and Germany.

These joint ventures, in and of themselves, encourage foreign and domestic investment in these industries. For example, one of the off-shoots of the development of the "Ofeq" military satellites is the "EROS" civilian satellites, made by Israel Aircraft Industries, whose photographs are sold on the civilian market and contribute to Israel's exports. In recent years Israel's security exports have grown substantially, reaching over \$2 billion. Israel's expertise in space is, as stated, in the two most popular domains in the world space market, intelligence and communication, so there is potential for integrating into the world market. In addition, these advanced technologies are a foundation and a springboard for the development of further advanced technologies, development that can contribute to the growth of the economy.

This also finds expression in the employment of workers on the highest levels. In 2002 throughout the world there were some 250,000 people in the space industry. The revenues of this industry amounted to \$105 billion, or \$420,000 per worker. To this must be added the second tier of workers, such that about half a million households earn their livelihoods from the space industry. In Israel, too, there are thousands of households that are supported by this industry.

Social aspects

The military and economic might combine to form social strength that leads to the development of a sophisticated information society. The development of space capabilities and the demand for workers in this field leads to the establishment of technological, scientific and academic infrastructures that not only add to Israel's international prestige, but develop and retain its human capital. An investment in a space program and the creation of jobs encourages the quality work force to stay in Israel.

In conclusion, the Israeli space program was forced to struggle for its very existence every step of the way. Even today, after the latest failure in the launching of Ofeq 6, the program is struggling for its life, in the shadow of the many cuts to the state budget and the defense budget.

Space is central to national security in the information age and contributes significantly to technological strength; the development of space technology contributes to a country's national security and strength, from the classic military strategic perspective and from economic and civilian perspectives. The program challenges the neighboring countries' sense of national security and provides it with international prestige. Therefore, even though Israel is a small country with limited resources, the development of independent capability in space is a strategic national asset.

The accomplishments of the Israeli space program are the result of vision, awareness and willingness, but the program in its current format is limited and does not allow Israel to realize its full potential and maintain its relative advantage over other countries. This format is a direct result of the lack of a solid prioritized policy concerning space. The space industry requires constant innovation. Israel can not make do with the accomplishments that have been achieved so far and must preserve them and maintain the qualitative gap that separates Israel from its neighbors. Without the decision makers' understanding and awareness of the importance of Israel's intensive activities in space, Israel will be left behind and will lose the advantages it has gained until now.

Israel must therefore turn the space program into a national project and formulate a national policy concept concerning space and set a list of priorities for activities in space. As a small country with limited resources Israel cannot afford to develop totally independent capabilities in space, but must do so in critical areas such as the ability to develop and launch intelligence and communications satellites. In other areas, such as navigation satellites and warning satellites, Israel must continue to

rely on existing systems. As a national program, it should include the involvement of other ministries, such as the Ministry of Industry and Trade, the Science Ministry, the Education Ministry and the Communications Ministry. Israel must invest in human capital, including investments in science and technology education, increase the knowledge centers in academia and industry, invest in research and development and increase the number of satellites at its disposal. Israel must likewise address the issue of protecting the Israeli satellites and interfering with the operation of hostile satellites, fields in which Israel will probably need expertise in the future. In order to meet these needs the order of priorities must be changed and appropriate resources allocated.

As can be seen from the figures presented earlier regarding world investments in space, it is possible to obtain results in this field not only via superpower-league investments, but also with the very modest investments of the smaller countries. For this, however, a policy must be determined and the national priorities changed. The need for this becomes even clearer in light of the budget cuts at Israeli universities, resulting in their struggle for existence and the existence of academic research.

I would like to conclude with a quote from the column by author Meir Shalev in "Yediot Aharonoth" newspaper, after the successful launching of the "Ofeq 5" satellite in May 2005:

“Moving, floating high above, orbiting, seeing all below. Gazing with cold digital eyes at the murky sphere that miraculously and in spite of everything conceived and built and dispatched it, in a launch that overcame not only gravitation, but also its own weights and chains.”

Finally, I would like to thank Prof. Isaac Ben Israel who has guided me these past three years and introduced me to a new, enchanting and fascinating world; Prof. Haim Eshed, who, along with Isaac, has been helping me in my research, and of course, Prof. Yossi Shain, who provided the stage for this position paper, and you, who have given me the opportunity to speak about a subject I find very interesting. Thank you very much.

Prof. Chaim Eshed

Good evening. As you have heard, the basis for entering space was security, the need for intelligence and the need to monitor distant borders, distant countries and the increasing terror activities. The capability that has been achieved is quite impressive. I have chosen to present the civilian usefulness of Israel's entry into space. I see a parallel between the growth of high-tech in this country and the military and defense infrastructure from which the high-tech industry sprang. If the Ministry of Defense and the IDF had not made all the investments they did in high-tech, there would be no civilian high-tech in Israel. Now we have to find a way to turn this infrastructure into an engine that will pull education, science, technology and the economy. I appear before Knesset committees and the government and people are surprised. Some of them are unaware that there is an Israeli presence in space. There seem to be a lot of "astronauts" there.

Satellite launches are not always successful - but one does not stop traveling the roads when there are traffic accidents, and does not stop flying after an airplane crash. We must not give up because of occasional failures. The satellites have so far been 100% successful. What failed were the launchings, and even that is a familiar phenomenon, even for veteran space agencies.

I would like to begin with a review of Israel's activities in space, and I will start with the electro-optic satellites (the photography satellites). Ofeq 3 was the first satellite that made a breakthrough and surprised everyone. We did not know it would be such an astounding operational success in its ability and mainly in its resolution. After this success ISI hastened to build the civilian version of the first generation of military satellites: EROS A. After that came Ofeq 5, which is a second generation satellite, and again ISI developed EROS B in its wake. Ofeq 6, which was supposed to be a backup satellite, yielded Ofeq 7 and the technological model of the radar satellite, which is already the third generation of satellites. We are now at the forefront of technology, with the infrastructure for radar satellites. A few other companies around the world initiated such projects, too, but apart from the Americans (the National Science Foundation, NSA satellite) no other country has an operating radar satellite.

It turns out that Elta researchers put the systems that will serve the satellite on an airplane and photographed landscapes under poor weather conditions, as well as the space station, and the results were impressive. Even without processing one can distinguish the general lines of the photographed object with a reasonable level of accuracy, considering the photographs were taken at night. All this from the TechSAR satellite, which will weigh 320 kilograms and which will perform better even than satellites that weigh 1.5 tons.

As for communications satellites, the Amos 1 is a success. It has functioned for 10 years at full output; not one system has ever broken down; it is being utilized to the fullest and will probably function for another two years. Amos 2 was launched in 2003 and transmits to North America and Europe. The Amos 3 had its kick-off in March of this year, and of course there is the Technion's TechSat, built on the assumption that it would work for a year, and which is already in its seventh year of operation. According to Prof. Guelman, head of the Asher Space Research Institute, it will probably go on for at least another hundred years. We forgot that at an altitude of 800 kilometers friction is very slight, so TechSat is still alive and kicking.

How did we manage it? We focused on small high resolution satellites and communications satellites. When we started out our colleagues at NASA said that satellites that size were toys and would not achieve high resolution. They said that about the UAVs too, and now they are considering building such satellites themselves. Of course we do not build space stations, settlements on the moon or on Mars or space shuttles, and do not conduct scientific research from space. We lead the world in performance for cost. We are cheaper by two thirds or more. As for the ratio of performance to weight - to this day NASA experts come to us to see how to obtain performance at such weights. The secret is simple - our people are involved in end-user technology, looking for things that have just hit the market, planning them and testing them. We have achieved technological independence because others did not want to give us the technologies or even the photographs.

Civilian uses of space that are within Israel's capabilities

The first offshoot is the EROS A imaging satellite, the first generation of civilian satellites. ISI initiated this endeavor and launched EROS A in December 2001, about 12 months after the launching of Ikonos - the American satellite considered to be the best there is. ISI was the second company in the world to build a high resolution civilian satellite. The satellite cost \$50 million and the company is now issuing stock at a market value of \$500 million.

The third generation is the "Ofeq 7". In the future we would like to see a dual use satellite - serving both the defense establishment and the civilian market. In the military arena our sales are restricted, as we have seen from deals with China that the Americans did not like, so we must turn to the civilian market in order to expand the marketability of Israeli technologies. Even the investment companies are recommending investments in space. In Israel there are investors with hundreds of millions who are prepared to invest in space because it is a profitable market.

Another important area that is currently developing is 3D imaging. When an object is photographed from two directions one can produce a 3D image. It is also possible to mount two cameras on one satellite and, among other things, to update flight simulators, in real time. We have offered this plan to Bill Gates and he sent people to Israel to examine it. They were enthused with the idea but in the

meantime it has not progressed any further. This technology aids in urban planning and monitoring, tourism, mapping information systems, etc. Another field is multicolor imaging, which can be used for monitoring vegetation growth and forests.

It is also worth considering satellite constellations - if we figure out how to make satellites for \$5 million, we can launch 10 satellites that will do their jobs while communicating with one another. We can develop and launch environmental survey satellites, like those being developed by the University of Surrey in England, which began a project at the same time as the Technion and has so far launched 32 satellites for developing nations.

Now to communications satellites. The space company issued stock at a market value of \$27 million, and is about to issue more at a value of \$160 million. This week we heard about the joint effort between "Rafael" and "Israel Aircraft Industries", with the encouragement of the Israel Space Agency, for the development of the Venus satellite. This is a breakthrough and international recognition of Israel's space activity. "Venus" is actually a satellite that we developed in the past at ISA, in a project called David, and now we are reaping the fruits. There is also TAUVEK, the project Tel Aviv University began 12 years ago, for which Prof. Yuval Neeman and I raised \$13 million to build. The Russians were supposed to launch it, but the company involved went bankrupt and next year an Indian company will launch it.

I would like to present you with the first unveiling of the pico-satellite, which weighs up to one kilogram, and is a project of the Engineering School, directed by Dr. Ana Heller. The role of this satellite will be to monitor a larger satellite, for example, to check if its solar panels are configured properly. If such a satellite had been at the disposal of the Columbia space shuttle astronauts, it would have been able to orbit the shuttle and discover that there was a problem with the left wing.

Another proposal we received from students is the development of a GPS network using constellations of satellites weighing up to 4 kilos. This system would detect its location via a signal it would receive from a number of satellites, and since this type of satellite tends to stray from its path, the system would be updated via the Internet as to its exact location in order to correct its calculations.

In conclusion, space is a technological engine: for universities, for education projects, for industry, offering a direct contribution to the work culture at high standards. There is also the technological contribution provided by the development of unique components. Why has this not happened? The ministries are not making an effort, not recognizing the importance of space. This is why Isaac Ben Israel and I will help to push this civilian engine, just as we pushed the military one.

Thank you.

Dr. Reuven Pedatzur

Good evening. I will relate to what has been said and will try to clarify a few points concerning what was said and what was not said. The main problem I see in what Chaim Eshed said about Knesset members not knowing that Israel is active in space, is that this stems from the lack of supervision and control over the defense establishment, since all the activities in this field occur in the defense arena. The decisions on space matters are made only by the defense establishment, and due to the lack of supervision there is a danger that at this stage has not manifest itself, except for in a few areas: just as the whole defense establishment wants the best, the biggest and the most, sometimes moderation is exhausted and there is a drive for things that are beyond ability and beyond need. This did not happen concerning the satellites, but if the absence of external control continues, it is liable to happen.

The Israeli space project has made a substantial contribution to military matters, but not where most people usually think. The launching of the satellite in 1988 increased Israel's deterrent ability not because of the satellite, but because of its very launching. Until 1988 no one in Israel addressed the question of whether we have ballistic missiles. The very launching of the satellite into space was a declaration: "Look, we have ballistic missiles." How could we send a satellite into space without ballistic missiles? Behind the launching of the "Ofeq" was a very important strategic proclamation that no one mentioned and no one related to, and of course the other side received this message, just as the Americans understood in 1957 that if someone launches "Sputnik" into space, he can send missiles to the U.S.

The second contribution is expressed in the development of weapons systems. It turns out that if we do not develop a particular type of weapons systems, the Americans do not give us technology in that field. The development of the satellites resulted in the Americans giving us access to space technology. On the other hand, we need to consider the required investment. If we are talking about low orbit satellites, one or two satellites cannot provide us with continuous intelligence. We need a large group of satellites and the question is how much this will cost us and what purpose it will serve. There is also the matter of the decision making process and outside supervision, as it is unreasonable that the state invest \$50 million in a space project. That is a ridiculous sum, because no decisions are made. This is a quarter of what is invested in tanks. But then the investment must be under the supervision and have clear goals. The mention earlier of the IDF's objections to the development of satellites shows that these matters must not be left in the hands of the military alone. In conclusion, I would like to comment on the issue of protection against missiles, which the space program is aiding. Here I think there is total waste, but that subject deserves a discussion of its own.

Question: We have so far proved high satellite capability, but more than once the launching methods have raised problems. To the best of my understanding our civilian satellites are launched from outside Israel, using foreign launchers. Why then should we continue launching?

Chaim Eshed: Further to what was said by Degani and stressed in Reuven's remarks, space is a national project. It is a national infrastructure, so we must invest in it. It has already been mentioned here that until we prove our ability, we don't receive outside aid. It is possible that if we were to request the launching of an imaging satellite that would also be used for military purposes, there is a risk that they wouldn't agree to launch it for us. What would we do then? We have to maintain our option of independent launching. Israel need not to be involved in the whole range of existing space technologies, but must preserve launching capability. The failures are part of the development process. Otherwise, it is not a development process. It is a very difficult field.

Reuven Pedatzur: I agree with Chaim that we must preserve our capability, but we must not overdo it. I don't think Israel has to achieve the ability to launch geostationary satellites.

Isaac Ben Israel: First, launching ability is no less important than the satellites. Second, there is a difference between satellites with a relatively short life span and when necessary they have to be launched, and satellites such as geostationary ones, whose life span is over 10 years. I therefore feel that we must maintain our independent ability to launch low orbit satellites, but really don't have to develop independent capability to launch high orbit satellites.

Question: Why did the IDF not support the launching of satellites?

Isaac Ben Israel: The budget is constantly shrinking in operational terms. If last year you undertook a certain activity in terms of man hours, flight hours or engine hours, there has not been a year in the past decade in which we could repeat that activity the following year. As a result, Ehud Barak, when he was head of military intelligence, deputy chief of staff, chief of staff, prime minister and defense minister, did not consent to budget the satellite because he felt there was a chance for the project to be recognized as a national project, and if he were to say no, it would be budgeted from other sources. In all those instances, various defense ministers took money from the army's budget and allocated it for the satellite. Reuven said here that there can be conflicts between military vision and political vision. The deciding body must be the political, civilian one. Where space is concerned, one could look at the cup as half empty and ask 'how could the army not have understood that it needs observation satellites?', or one could look at the cup as half full - at the recognition that the government acted correctly and did allocate the funds, although still within the framework of the defense budget.



Professor Yossi Shain welcomes the speakers and audience to the discussion evening



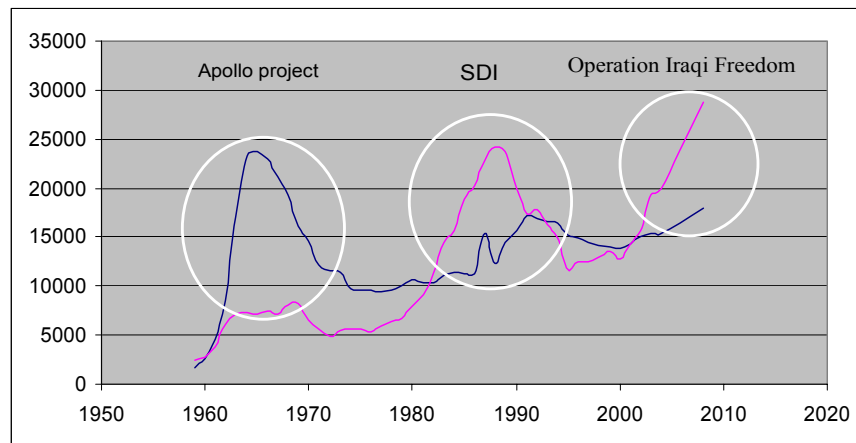
Ms. Deganit Paikowsky delivers her presentation



Professor Isaac Ben Israel making a point during the roundtable discussion. To his left, Dr. Reuven Pedatzur, Prof. Chaim Eshed and Ms. Deganit Paikowsky

Figure 1

USA Space Budget Constant \$



NASA ---- DOD ----