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History of Israeli contribution to astronautics (3)

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STUDENT ROCKETS OF THE TECHNION IN THE 1960'S AND 1970'S

Abstract

During the 1960's, a fascinating, "hands-on" approach was introduced into the Technion – Israel's technology institute – student built rockets. The aim of this paper is to describe the activities of rocketry as an educational and research tool at the Technion in the 1970's. From a modest beginning at the late 1960's, the faculty for aeronautics used to build student research rockets, as a hands-on project. The rockets became bigger and more sophisticated, and many new features were included - such as telemetry, avionics and multi-staging. The rockets of the Technion were designed by faculty staff and students, and some assistance in the field of casting solid propellants was provided by the Israeli defense industries, and the military gave permission to use its test ranges. The small rockets were a very humble beginning of Israel quest for space, culminating decades later, when Israel loft its satellite to space by its indigenous designed "Shavit" (Comet) launch vehicle. The paper is a second in a series of article by the author, tracking the research rockets projects conducted in Israel since the 1960's to the late 1990's and beyond.

Introduction

From the mid 1960's, the undergraduate students from the aerospace engineering faculty at the Technion – Israel Institute of Technology, were involved in rocketry projects.

As part of their academic requirements, students have to select an engineering projects which were relevant to major areas of aerospace engineering. Many projects never left the drawing board, and at the best were simple models tested in wind tunnels. It was an exceptional at the faculty, to see student project roared into the skies – as were the rockets portrayed in this paper.

Students were involved with all the aspects of the rocket project – the design, the machinery of the rockets (and launch equipment), operations (launching the rocket) and evaluation of the tests after the flights. All the rocketry projects were supervised by the faculty stuff, and some by experts from the industry.[1] Most of the rocketry project were conducted during a one academic year.

"Nahshon 1" (Daring) - the first in line

The first student rocket built at the Technion was *Nahshon 1*. There are no photographs of the rocket that are known to the author, nor an official drawing. The technical data available shows that it was a tiny rocket, 40 centimeters in length, and a diameter of just 3 centimeters. During its test flight in July 1966, the rocket reached an altitude of 500 meters. From

[1] Most from RAFAEL, then an MOD unit for development and manufacturing of various weapons

testimonials of the professors who led the project it was clear that *Nahshon 1* was just the beginning of a series of larger, more advanced rockets envisioned by the faculty staff. [2] This rocket was not a pure academic endeavor of the Technion – the initiative to build it came from a number of enthusiastic members of the Israel Society of Astronautics – of which most were also members of the Technion's faculty for aerospace engineering.[3]

"Barak" (Lightening) – going "high tech"

Barak was a remarkable advanced rocket in comparison with *Nahshon 1*. Its robust design incorporated a 3.1 kg of propellant, a steel nozzle, and a smoke grenade in internal compartment to allow an easy visual tracking of the rocket. The design was also used by the annex technical school, *BOSMAT*, as the basis for its student's rocketry courses. [4] This rocket was able to reach an altitude of 5 kilometers – ten times the height achieved by the first student built rocket at the Technion – a year earlier.

Figure 1: A 3D rendering of the rocket – prepared exclusively for this paper

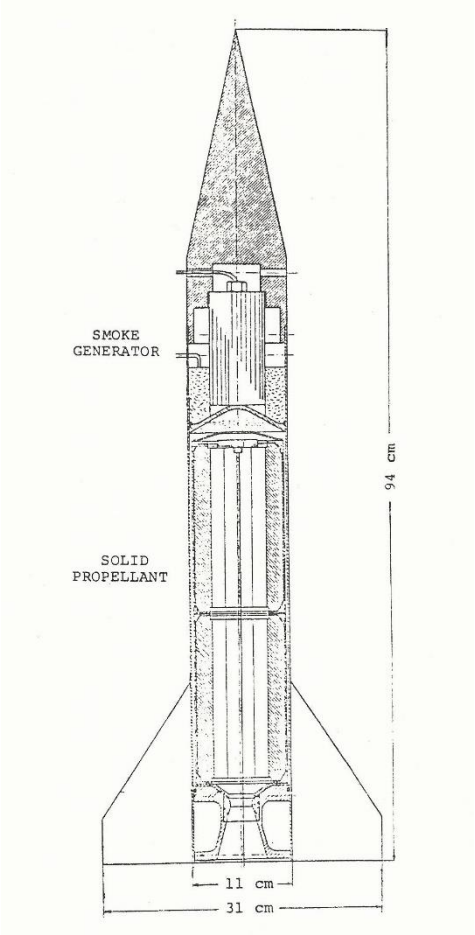

Figure 2: Barak schematics. Note the smoke grenade as the rocket's payload

[2] Student rockets at the Israel Institute of Technology, IAF-92-0488, by Professor Alon Gany

[3] See the Author's paper "Aiming High, first steps of Israeli research rockets, IAC-14 E.4.2.5, page 2

[4] See the authors article "Aiming High – first steps of Israeli research rockets in the late 1960's", IAC-14 E.4.2.5

Netz 1 (Hawk) - Aiming high

A major improvement of the arsenal came in the shape of the *Netz 1* (Hawk) of 1968. For the first time. Telemetry was incorporated, and a detachable equipment and instrumentation bay was parachuted to the ground.

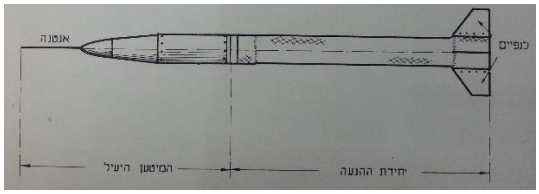

Figure 3: Netz– 1 general layout

There is a conflicting information regarding the results of the flight – while the IAC paper from 1992 states that the rocket reached an altitude of 11 km, the Israeli bi-monthly 'Mada" (Science) state that the separation of the instruments bay occurred at an altitude of 1.1 km, and was partially tore. The rest of the rocket lost its stability and reached an altitude of 3.5 kilometers. [5]

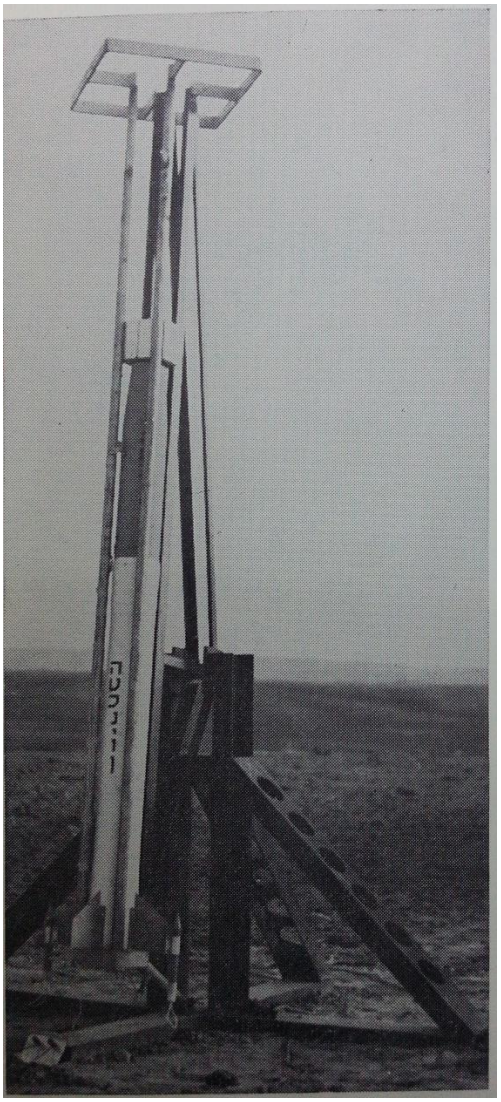

Figure 4: the Netz-1 on the launch pad

A deeper dig into the archives of Israeli newspapers revealed that the rocket indeed didn't performed as expected. The DAVAR daily newspaper states that "the rocket didn't reach its original flight height of 10 kilometers".[6]

[5] "Mada" (science), November 1968. Unavailable online, and was scanned by the author from a copy at the "Beit Ariella" library in Tel Aviv, April 2014

[6] Davar, 13.6.1968, p. 4. Scan available at the national library of Israel

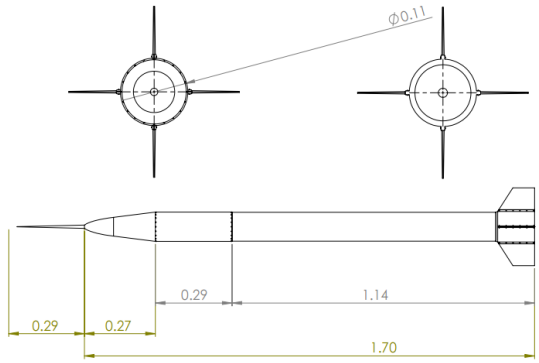

Figure 5: The rocket dimensions a current reconstruction prepared exclusively for the paper[7]

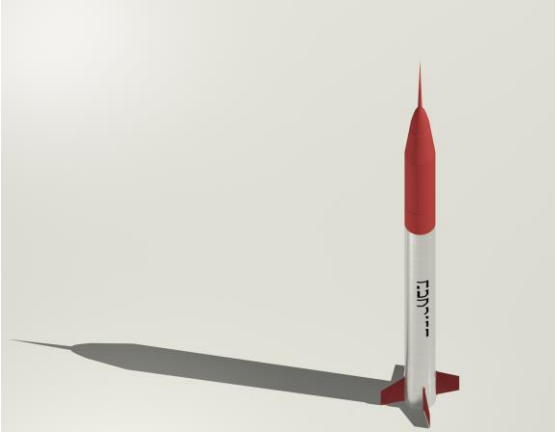

Figure 6: A 3D rendering of the rocket – prepared exclusively for this paper

Technion 4

The *Technion 4* was almost identical to the *Netz-1*, but with slightly longer body. It was also the first in the line of rockets to use the Technion's name. The rocket was equipped with pyrotechnic tracers to ease optical tracking of the rocket. The sensors package contained accelerometer, atmospheric pressure gage, and atmospheric temperature gage – coupled with telemetry equipment to transmit data to the ground. This will be the standard instrumentation set for the next rockets of the Technion. A report on a leading daily newspaper gives a detailed account of the flight: The height reached was 15 kilometers, and on this height the instrumentation package was separated – and soft landed some 2000 meters from the launch site.[8] An interesting information that was not included in the Technion account of the flight[9] is that prior to the launching of *Technion 4*, there was ANOTHER launch of an identical rocket – but with no instruments onboard. The launch of the un-instrumented rocket (of which the name is not known) occurred on the same date of the *Technion 4* launch – about an hour earlier.

The 1970's – Higher goals, multi staging, supersonic gliders

The 1970's brought more advance rockets to the Technion. The rockets (*Technion 70* and *Technion 71*) became two stage rockets, were much heavier than the previous rockets and the solid rocket motors became much more powerful. The design of the rocket motors was very advance in comparison to the previous generation of rockets at the Technion: the first stage of the rocket operated with two levels of thrust. Boost phase of 1 second, with a 27000 Newton, and a sustain phase, lasting 3.7 seconds, at a thrust level of 8000 Newton. The second stage rocket motor gave an average of 8000 Newton for 2.9 seconds burn.

Alongside the *Technion 70* and *Technion 71*, a separation system for staging was also developed. It was a pyrotechnic device that was triggered automatically after the first stage burn out.

Technion 70 was launched on July 7, 1970. The first phase of the flight went smooth – the rocket motor operated for five seconds as planned. The separation mechanism dropped the first stage and the rocket's second stage continued to climb for 12 seconds, when automatic sequencer

[7] By Gil Hezkia

[8] Davar daily newspaper, 23.7.1969.

[9] The IAC paper IAF-92-0488

triggered the upper stage motor – which burned for 2 seconds. Then an anomaly occurred – and the nose cone (containing the experiment package) was separated from the second stage – and stopped transmitting data.[10] The second stage (minus the forward section) continued its unstable ascent at a height of 20 kilometers.[11] The original flight plan of the rocket stated that the separation of the nose cone will be conducted at a 40 kilometers height.

Technion 70 was constructed with the help of the Israeli Military Industries and RAFAEL (then a unit within the ministry of defense). It was launched in the Negev desert – on the proving grounds which served Rafael and the Military Industries.

The *Technion 71* reached an altitude of 31 kilometers – a record to date at the Technion. The 12 student team of the project were supervised by Professor Harry Wolf, a faculty member of the Technion, who worked in the United States on various rocketry project before coming to Israel on 1970.[12]

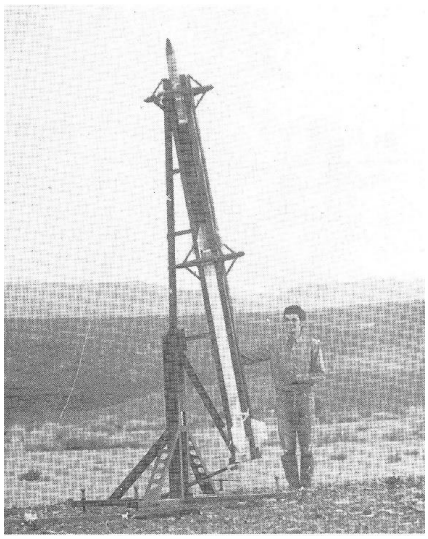

Figure 7: Technion 70 on the launch pad

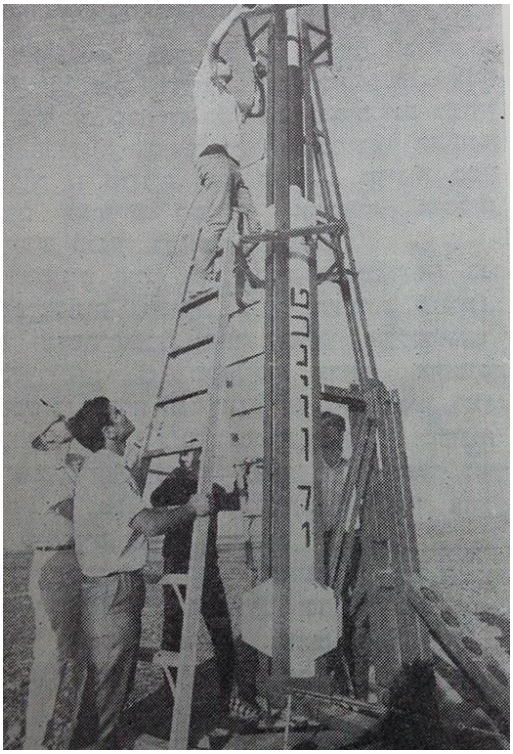

Figure 8: Technion 71 undergo launch preparations

Supersonic gliders: Technion 72 and Technion 73

The *Technion 72* and *Technion 73* were identical in design. They were the most complex rockets undertaking by the Technion at the time, and in each of the projects about 50 students were involved.[13]

The goal of the project was to launch and separate successfully an all metal, heavy, supersonic glider. The design of the glider was an immense effort, and many configurations were tested at the faculty's wind tunnel.

Each of the gliders was a 2.25 meters long, and weighted 50 kilograms. To launch them. An 85000 N/s solid rocket motor was designed and built.

To test these rockets, the Technion students and staff went to the Negev desert, on which a ministry of defense proving ground

[10] Most of the details were published on the daily newspaper DAVAR, of July 8 1070. P. 4

[11] Ibid

[12] Davar daily newspaper, 15.6.1971

[13] Considering the size of the faculty, it actually reached each and every students in these academic years of 1972 and 1973.

was provided for the tests – as well as an advanced array of tracking equipment. The actual height of the rockets (and the release of the supersonic gliders) were 6 kilometers (*Technion 72*) and 2 kilometers (*Technion 73*).

According to a leading daily newspaper, the glider achieved a speed of 1400 km/h (about Mach 1.18), and at the end of its glide began to tumble.[14]

Figure 9: Technion 72 on the launch pad. Note the supersonic glider on the front end[15]

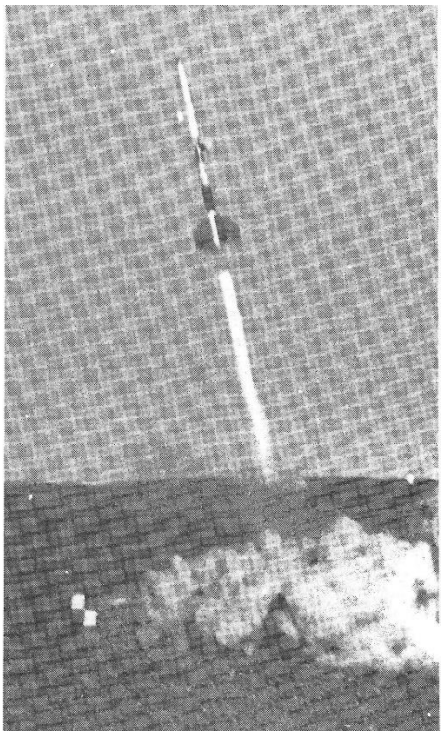

Figure 10: Technion 72 launch

The rocketry projects long hold

Technion 73 was launched on July 16, 1973. On October 6 of the same year, the Yom Kippur War broke when Israel was attacked simultaneously by Egypt and Syria. Many of the faculty staff were drafted for the war, and many students has to serve in active duty for a long time.

The war and its aftermath, the general feeling among the people of Israel, and the huge resources in time for the large projects such as sophisticated rockets, where some of the reasons to postponed further rocketry projects.

It would take a long 11 years to resume the work on a large scale rocket, the Technion 84. The rockets of the 1980's and 1990's will be portrayed in a future paper.

[14] Davar daily newspaper, 15.6.1972, p.6

[15] The picture was first appeared in Shalom, Danni, "above the horizon, 50 years of space in Israel", 2003, Ba'avir aviation publishing. Scanned with permission.

Aftermath

It is hard to tell what would have been the impact of the rocketry projects on the students from the faculty for aeronautical engineering. Many of them were eventually became engineers in Israel's defense industries such as the IAI (Israel Aerospace Industries), Rafael (advanced defense systems), IMI (Israeli military industries) to name the big three national industries in the field. Some of the students - later in their career - were involved in the design and building of Israel indigenously satellite launch vehicle (the Shavit). Others worked on a variety of missiles and rockets.

But it is unanimously agreed, that hands on projects (like these rocketry projects) are an essential part of the training of a young engineer. There is no simulation that could replace the experience of teamwork, vision and pride in the results of the project – nor its failure. Students at the Technion continue to work on various engineering and aviation related projects till today, although the last Technion rocket to date was launched on 2006.

Rocket	Launch Date	Stages	Mass (kg)	Length (cm)	Diameter (cm)	Total Impulse (N/s)	Payload	Actual altitude (km)	Remarks
Nahshon 1	July 1966	1	N/A	40	3	N/A	None	0.5	First Technion rocket
Barak	14.7.1967	1	15	94	11	6100	Smoke Generator	5	
Netz 1	11.6.1968	1	17	170	11	N/A	Parachuted capsule; Telemetry	See remarks	Separation occurred pre maturely at 1.1 km instead of 11 km. Rocket lost stability and reached 3.5 km
Technion 4	22.7.1969	1	19	180	12	N/A	Parachuted capsule; Telemetry; accelerometer; Atmospheric pressure gage; Atmospheric temperature gage.	15	
Technion 70	6.7.1970	2	75	400	16	N/A	Parachuted capsule; Telemetry; accelerometer; Atmospheric pressure gage; Atmospheric temperature gage.	20	Fiberglass motor case (made at the Technion. Prior cases were made of steel)
Technion 71	14.6.1971	2	73	400	16	75000	Parachuted capsule; Telemetry; accelerometer; Atmospheric pressure gage; Atmospheric temperature gage.	31	Fiberglass motor case
Technion 72	14.6.1972	1	127	419	16	85000	Supersonic glider	6	
Technion 73	16.7.1973	1	125	410	16	85000	Supersonic glider	2	

Table 1: Technion rockets of the 1960's and 1970's