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STUDENT ROCKETS OF THE TECHNION IN THE 1980'S AND 1990'S

Abstract

The paper will portray the activities of rocketry as an educational and research tool at the Technion - Israel's Institute of Technology, in the 1980's through the 1990's - the late period of this type of activity at the Technion. 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 paper is the third in a series of articles 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.

Technion 84

After a decade long brake[2] since the launching of "Technion 73", the rockets returned to the Technion. This time the project was more sophisticated (as might be expected, since the huge advancements in electronics and various instruments incorporated into the rocket, since the 1970's) and had a very different purpose from other rockets previously built at the Technion: instead of reaching the highest

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

[2] For a detailed account on the 1970's activities in rocketry at the Technion, see the author's paper "Student rockets at the Technion in the 1960's and 1970's, IAC14 E.4.3.4

altitude possible, the rocket contained 5 unpowered sub-caliber arrows.[3]

The Technion-84 rocket was a single stage rocket, that flow to a relatively low altitude of 4 kilometers, and reached a downrange distance of 12 kilometers.[4]

The pedagogic purpose of the project was aerodynamic design, and trajectory prediction.

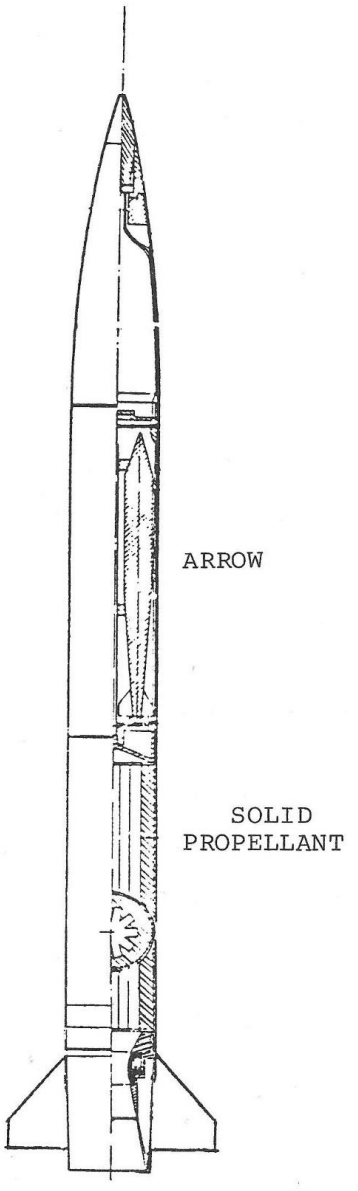

Fig. 1: Technion 84 layout

As mentioned, the payload of the rocket was five metal arrows, each weighting 2.06 kg, 55 cm long, with four small fins. The rocket was equipped with an electronic timer which initiated a pyrotechnic charge 49 seconds after the launch. The charge opened the container of the arrows, which, in turn, continued to fly unpowered parabolic flight until reaching the ground.

The students designed the rocket and the arrows, and conducted all the necessary calculations of the aerodynamics, trajectory and alike. The Propellant for the solid rocket motor was provided by RAFAEL.[5]

One can see the accuracy of the trajectory prediction, by looking at Fig. 2, which shows the predicted trajectory vs actual one.

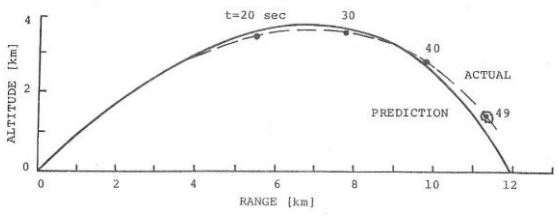

Fig. 2: Predicted trajectory vs actual trajectory of Technion 84

The rocket was launched in the Negev desert, in the southern part of Israel, at the RAFAEL proving ground, and was tracked via the radar of the test site.

[3] For a detailed technical account of the Technion 84, see IAF-92-0488 paper by Professor Alon Gany, "Student rockets at the Israel Institute of Technology"

[4] Ibid

[5] As was the case in most of the Technion's student rockets.

Fig.3: Launch of Technion 84

After the successful launch of Technion 84, there was another pause in the rocketry activities at the faculty of aeronautics, until 1990, when a two stage, high flying rocket emerged.

Technion 90

The Technion 90 was the only large scale rocket activity of the Technion in the 1990's. It was a 360 cm long, 16 cm diameter rocket, with two stages. The first stage was equipped with a solid rocket motor which contained 39 kg of propellant, and the second stage has a solid rocket motor with 5.3 kg of propellant.[6]

Total impulse of about 100,000 N-s was provided by the rocket's first stage.[7] The rocket's weight at launch was 113 kg.

The payload of Technion 90 rocket included meteorological instruments for measuring atmospheric pressure and temperature, an accelerometer for recording the rocket's acceleration during the flight, a telemetry equipment for real time transmission of the data, and a radar transponder, used by the ground radar on the test range, to track the trajectory of the rocket.

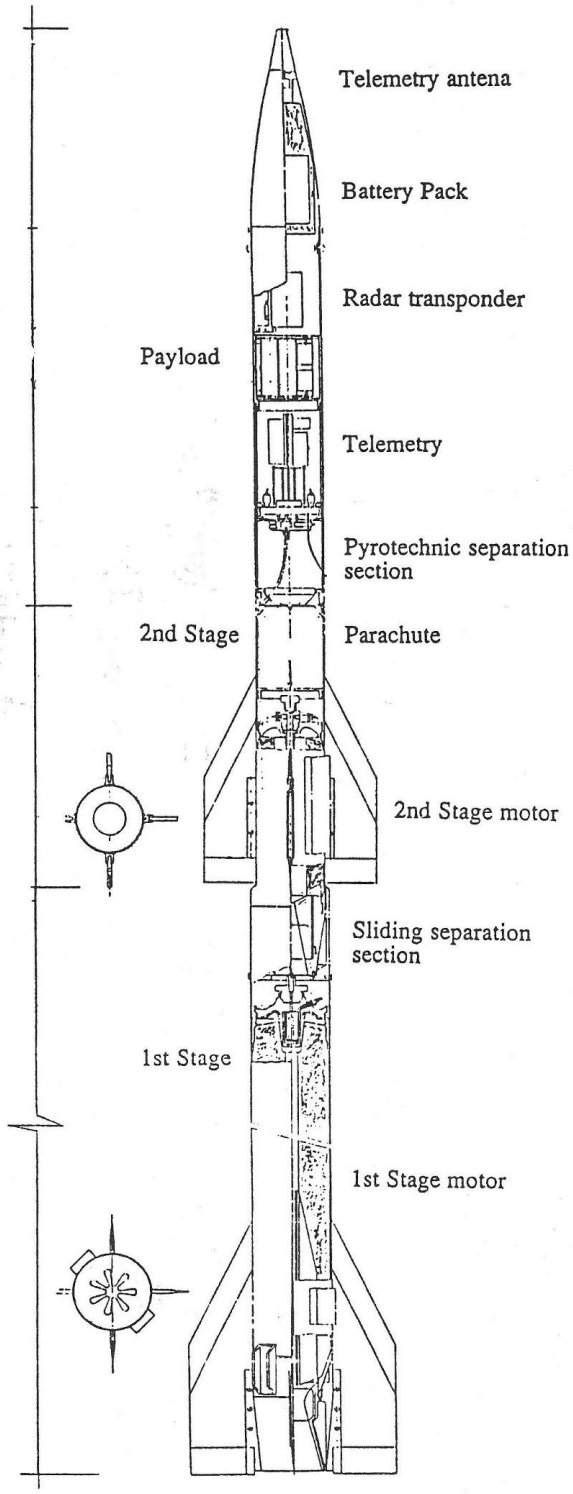

Fig. 4: General layout of Technion 90 and internal structure

[6] A. Gany, Student rockets at the Israel Institute of Technology, IAF-92-048 and Y.M.Timnat and A. Gany, Lessons learned from the launch of "Technion 90" student rocket, IAF-93-P.1.352

[7] Ibid

The instrumentation package was the same in many of the Technion rockets, and provided good, but limited data. There was no cooperation with other faculties of the Technion, for provided scientific payloads.

The rocket was tracked by radar and several cameras (high and low speed).

Fig. 5: Integration of the Technion 90 rocket, at the Propulsion Lab of the Technion. In strips shirt: Professor Alon Gany, head of the project.

Events during the flight

- Ignition of the first stage solid rocket motor, followed by a 7 second burn; (speed of 720 m/s was achieved and an altitude of 3 km)
- burnout of the first stage rocket motor
- sliding separation and jettisoned of the first stage;
- Un-powered cost phase of the second stage for 23 seconds;
- Ignition of the second stage rocket motor and a burn of 3 seconds; (a peek altitude of 21 km was reached)
- pyrotechnic separation of the second stage and payload section;
- parachute ejection of the payload section;
- slow decent of the payload to the ground.

Fig. 6: The rocket and the student team pose for the camera in the test range. Prior to launch.

The official record of the launch stated that "in general, all rocket systems operated according to plan, although the ignition of the second stage was delayed compared to the original timing of 5 seconds, causing deviation from optimal trajectory and reduction of a few kilometers from the predicted altitude".

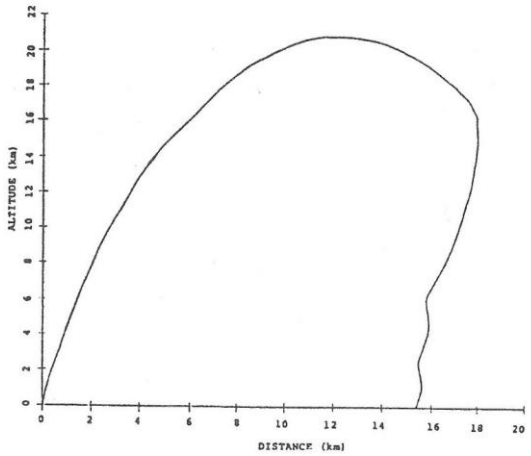

Fig. 7: the trajectory of Technion 90

Wind tunnel tests

The Technion 90 project team conducted 28 aerodynamic tests in the aeronautics faculty wind tunnels, using small-scale models of the rocket. The data collected

helped the students to validate the design, and to get exact measurements regarding the coefficient of the rocket and its stability. Separate tests were held to check the pyrotechnic devises of the rocket, and the ejection mechanism for the parachute.

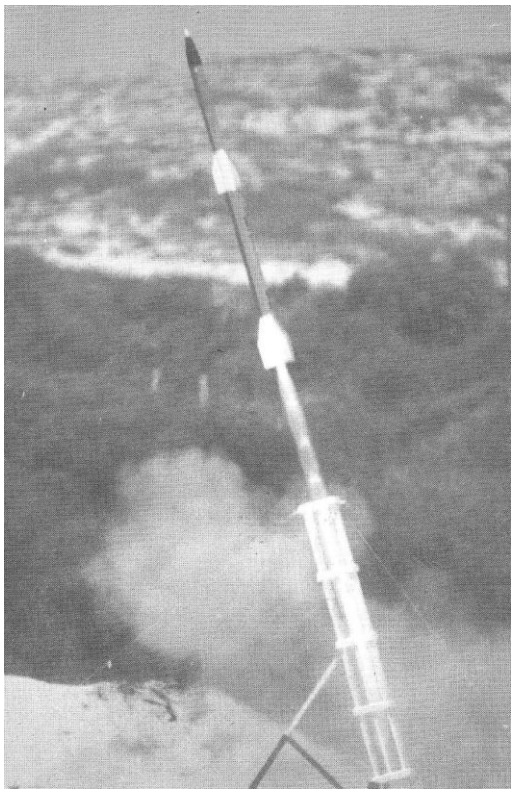

Fig. 8: Technion 90 during launch

A Second rocket

Near the aeronautics faculty at the Technion, there is a rocket on display, which looks identical to the Technion 90. The reports of the time do not state that TWO rockets were built (this was done in the 1970's, to increase reliability and the probability to launch – as the two were taken to the proving grounds). The rocket and its launch pad are displayed outdoor, so it is understandable that the condition of the exhibit deteriorate during the years. In figures 9 and 10 you can see the rocket, pictured by the author, as of August 2016.

After an interview with Professor Gany of the Technion, who led the team project to build Technion 90, it was determined that the second rocket was built as a buck up, but it is unclear if it was taken to the launch site. It is my hope that this rocket will be renovate, and put indoor to preserve it for future generations. Some preliminary effort to do it is in process.

Fig. 9: Backup Technion 90 rocket on display at the Technion. Pictured by the author on August 2016

Aftermath

It is hard to exaggerate over 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.

It will take 16 years from the launch of Technion 90 rocket, until the last (as of September 2016) student's built rocket will be launch, this time with a scramjet engine.

Fig. 10: Close-up on the second stage of Technion 90 rocket on display at the Technion. Pictured by the author.