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JONATHAN MASS, THE FATHER OF ISRAELI REMOTE SENSING SATELLITES

Abstract

A German born, Dr. Jonathan Mass (1922-2003) fled Germany on 1933 after Hitler's accent to power. He was a brilliant engineer at RAFAEL, Israel's leading military R&D organ for decades. He was involved with various missile projects, and won Israel's Security Award for his accomplishments. He started to dream about Israeli space endeavors long before a national space program became a reality. Since the early 1960's he was advocating for Israeli space activities, including a satellite ground station. He was a visionary and pioneer of the idea of building an Israeli satellite, and in 1980 he proved that a light weight remote sensing satellite could provide the high quality images, like those of a much larger and heavier satellite. Mass's work was adopted to a PDR status, before turned over to RAFAEL's competitor - Israel Aircraft Industries, where the basic design was used to build the first Israeli satellite in 1988. On April 1995, Israel has launched "*Ofek 3*", its first operational remote sensing satellite, based heavily on Mass design. Mass was named "the father of Israel's remote sensing satellite" even though the satellite was not built at RAFAEL. Mass was awarded a special honorary award from the Israeli national R&D council on 2001.

Introduction

This paper's aim is to commemorate the important role of one of Israel's space pioneers, Dr. Jonathan Mass, who played a significant role at the cradle of Israel's space endeavor. He was acknowledged in his last years as the father of Israel's reconnaissance satellites, although his design was not built; And since he spent his entire career at the national research and development labs of RAFAEL – the national laboratories for defense systems – his true achievements remained secret until into his work.

Early life

Jonathan Mass was born in Berlin to a Zionist family and immigrated to Israel (then under British mandate) with his family on 1933, at the age of 11.

He went to the Hebrew Gymnasium (highly esteemed educational school at the time) and later studied at the Technion – Israel's institute of technology. On 1943 he graduated as electrical engineer. He volunteered to the Jewish brigade of the UK 8th army, and fought against the Nazis on the Italy front. He got married in Holland and returned to Israel in 1946. On 1947-1948 he worked at Lod airport[1] communication unit. His passion for radio and communication will play a major role in his career ever since. On the break of the 1948 war for independence, Mass joined the small unit at the newly established IDF (Israel Defense Forces) – the *Heil Mada* (Hebrew for Science Corps). The Science Corps of the IDF was founded in late 1947, by David Ben Gurion, who will become Israel's first Minister of Defense AND Prime Minister. The idea was to bring together the brightest scientists and engineers from all over Israel, and their aim was to conceive. Develop and build a verity of weapons and military hardware.

Figure 1: The insignia of the IDF's Science Corps

The unit did came out with several inventions, including rudimentary capabilities in propellant design and construction of small tactical rockets. Mass was responsible for the development of a radio controlled unmanned boat, designed to attack enemy ships. The prototype of the boat was destroyed and its development within the science corps stopped – and the unit itself dissolved on 1952 – when most of the personnel were drafted to the newly formed ministry of defense Research and Design branch – which operated until 1958, and then became RAFAEL – Armament Development Authority. Mass was among the men who made the transformation from the military unit to MOD and then to RAFAEL.

[1] From 1974 – Ben Gurion international airport

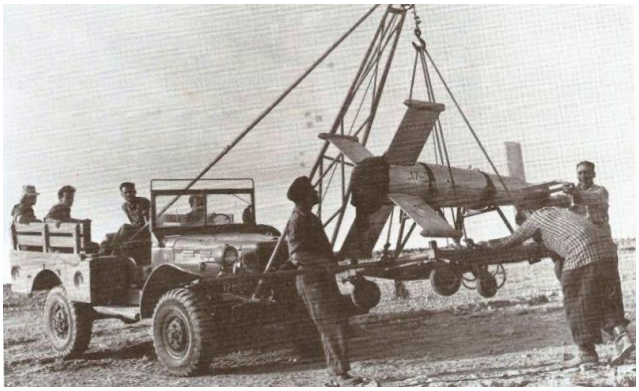
The early years at RAFAEL

Mass was a true visionary. And his ideas were not only ahead of its time, but unimaginable for the young state of Israel. For instance, as early as 1952 he approached (prime minister and minister of defense) David Ben Gurion and demanded funds to develop small radar homing devices for missile. Needless to say this request was rejected.[2]

From 1951 to 1960, Mass was the head of command and control and of remotely operated vehicles – and was responsible to the development of a radio guided ground vehicle named "Kelev 2" (dog), and a radio controlled explosive boat named "Kelev Yam 2" (Seal). The latter had an option of range extension using radar, and a final homing mechanism.[3]

He was responsible for the RAFAEL group of development of missiles, and within this unit, he was a key figure in the development of the LUZ (Walnut) missile, a ground to ground missile, against a verity of targets. The missile was further developed and became GABRIEL – anti ship missile. Mass won the Israel Security Award for his accomplishments on the LUZ, in 1960.

During the development of the LUZ missile, Mass was among the very few RAFAEL engineers who led the foundation to test and evaluation of missiles – and helped to establish the proving grounds at the NEGEV desert.



A prototype of the Luz missile – circa 1956

From 1957 to 1960 Jonathan Mass was the head of the experimentation equipment development and communication. He took an active part in designing RAFAEL's tests of missiles.[4]

Early interest in satellites – the 1960's

As early as 1964, Mass approached the US and advocate the need to create a satellite tracking station in Israel.[5] He went to continue his academic studies (while at RAFAEL) and got a PHD from the Sorbonne in Paris (Magna cum Laude) and returned to his work at Rafael. His PhD thesis was about methods to study the ionosphere by the use of communication satellite – a truly innovative idea for the time. His work titled "Ionosphere research using satellites" describes work done in

[2] Less than a decade later RAFAEL will produce a prototype radar guided missile.
[3] This data was published in the internal RAFAEL bulletin, "Our Rafael", on April 2004.
[4] Ibid.

[5] Mentioned in Uri Dromi's obituary to Mass, titled "An Israeli satellite? Why not?" in HAARETZ, 2.12.2003, a few days after Dr. Mass's death.

continuation of research on the ionosphere's influence on satellite radio signals. Calculating the influence of the TEC (Total Electron Content) on the errors in the NNSS Satellite Navigation System, results are given in graphical form for different passes and TEC's. The theory for evaluating Faraday rotations without postulating quasi-longitudinal conditions is given. The research was conducted by Mass under the auspices of the Radio Observatory National Committee for Space Research in Israel.[6] He was a constant participants in COSPAR (Comity on Space Research) meetings during the 1960's onwards, advocating his ideas.[7]

Mass space program proposal

As early as 1963, Mass started to work on his roadmap for space research in Israel. Together with a small group of colleagues, he planned a step-by step vision for an extensive space program for the state of Israel. He submitted his report officially on November 2nd, 1964. The program was evaluated and meticulously evolved for nearly a year. The report was submitted to Dr. Ernst David Bergman, the chief scientist of the ministry of defense, and the father of defense research and development in Israel.

Figure 2: Dr. Jonathan Mass, circa late 1960's

The pillars in Mass's space program vision were as follows:

- To incorporate scientists and engineers from Israel in the global effort of mankind's quest for pace exploration;
- Pushing forward the fundamental R&D in many emerging technologies – with full understanding that the outcome will be reached only after many years;
- Practical use of satellites and rockets for CIVILIAN applications (Communication, Navigation,

[6] The National Committee for Space Research was replaced in 1983, by the Israeli Space Agency.

[7] There was only ONE interview with Dr. Mass that was published in his lifetime. It was printed in the (then) biggest newspaper in Israel, MAARIV. Its title was "rocks from the Moon, Communication with satellites" The interviewer was Isaac Ramba and the date of publishing was June 7, 1968. In this interview the public got a short pick to Mass's work at RAFAEL, and his passion towards space research.

Mapping, Meteorology and applied research.

- Use of space for security needs and foreign policy of Israel.[8]
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Roadmap for space – Mass's vision

To make the vision of a Four years space plan (from 1965 to 1969) Israeli space program a reality, Mass, always the practical engineer, envisioned these milestones:

- 1965: launch of several sounding rockets[9] with a 2 kg payload to a height of 60 km;
- 1966: Launch of sounding rockets with a 12 kg payload to a height of 80 km, and several rockets to a 250 km altitude;
- 1967: launch of rockets to an altitude of 750 km with a 12 kg payload;[10]
- 1969: launching a 10 kg satellite to a low earth orbit (LEO) of 300 km in height.

In his proposal, Mass made a comparison of various countries on space exploration, as a percentage of their national 1963 budget. He came to the conclusion that Israel must invest a 1.3 million USD (1963 value) per year, as a minimum.

The four year space plan he envisioned was to cost a total of 15 million Israeli Lyra (1963 value) – or roughly 5 million USD. To put these figure into perspective, one man year of RAFEL employee was 15000 Lyra – 3000 USD. Mass calculated that to implement his plan – the effort will require 80 man years for each of the four year period.

Mass plans for satellite tracking and applications

On the compact space plan he submitted (only 15 pages in all) he portrayed a remarkable plan for applications of ground tracking stations. The first satellite tracking station was to be based in Haifa. These included:

- Measuring of propagation of electromagnetic waves in space;
- Receiving and analysis of telemetry from satellites (including non-Israeli satellites);
- Geodesy experiments and measurements;
- Navigation (use of various foreign satellites in space);

[8] Quotes from Mass's vision for Israel in space were made available to the author through Mass's son, Oren Mass, on September 2015. The paper on which Jonathan Mass plan are portrayed were written by RAFAEL veteran E. Shvily, on May 9th, 2004,

[9] Based on the RAFAEL built SHAVIT (Comet) 2, rocket of 1961, and see the authors paper*:* ***Reaching for the stars: 50th anniversary of the Shavit 2 rocket***, IAC-11 E.4.3.5

[10] Despite the height, the rocket did not have the energy for orbital insertion of the payload

- Tracking of satellites and missile using a giant radar;
- Communication with foreign satellites; and
- Use of the ground station for tracking Israeli satellites.[11]

For a variety of reasons, some trivial (budgetary constraints), the grand plan – which was feasible, except for the satellite launch vehicle, which would take more time and money to be built – and some not so trivial, such as political pressure from within the defense establishment, and to be specific. Within the ministry of defense itself. Or, one could argue that Jonathan Mass was decades ahead of its time.

An interesting side note on satellite ground station at RAFAEL – on December 1982, a daily newspaper in Israel informed the public for the first time that a ground station for tracking and receiving data from satellite was built at RAFAEL – almost 20 years after Mass advocated the idea.

As early as 1970, Mass wrote a report on calculation of navigation and bombing, using satellites.[12]

Project ABIR (Knight) – A satellite design at RAFAEL

During the time period of 1977-1978, after the visit of Egyptian president Sadat to Jerusalem and the Israel-Egyptian negotiations towards peace accord, several teams within the Israeli defense establishment begun working on an earth observation satellite. At RAFAEL, it was Dr. Jonathan Mass, responsibility to conduct a feasibility study that claimed that a small and light satellite, weighing only 240 kilograms, could provide very high imagery capability.[13]

Together with Dr. Marcel Klajn, the team developed the idea for a satellite into the ABIR (Knight) satellite proposal. The intelligence branch of the IDF (who, independently began to characterize a satellite with its own seed money back in 1979) adopted Mass's study in 1981.[14]

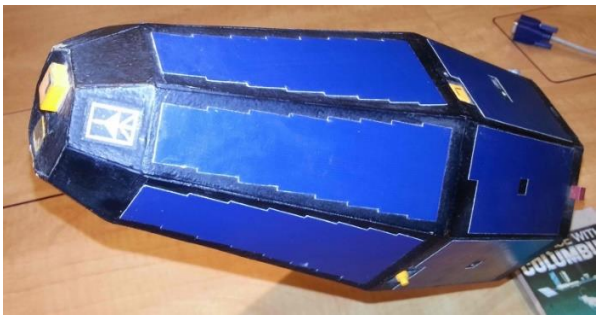

Figure 3: a cardboard model of the Abir satellite[15]

[11] Quote from Mass report of November 2nd 1964

[12] "Our Rafael", April 2004

[13] See RAFAEL – from the laboratory to the battlefield, Dr. Zeev Bonen (with Dan Arkin), N.D.D. Media Ltd. Tel Aviv, 2003. P.160

[14] Ibid, p. 161

[15] Photographed by the author at the ministry of defense space directorate on 2012

Due to political issues and inter-industry rivalries, the decision was made by the minister of defense, that all the data and technical materials produced at RAFAEL (more than 500 men years of work where invested in the satellite project at Rafael until January 1984) will be given to IAI (Israel Aerospace Industries) - which became the only defense contractor who built satellites in Israel.

This decision[16] was the end of a massive undertake at RAFAEL and (understandably) a huge disappointment.[17]

Figure 4: Dr. Jonathan Mass (right) and Dr. Marcel Klajn (left) of RAFAEL, present the minister of science and technology prof. Yuval Neeman a mode of the proposed ABIR satellite (1982)

Actual satellites (of the OFEK (Horizon) series which were built at IAI, bears a remarkably close resembles to the original RAFAEL design. It was not until 2003, when the picture of the Abir satellite was released, that the striking similarity between Rafael's design and the actual satellite that IAI built was seen.

Executive positions at RAFAEL

Dr. Jonathan Mass hold several senior positions at RAFAL. Among them:

- The First director of the missile division (1971)
- Head of Air to Air line of R&D and production (1971-1975)
- Deputy CEO for R&D at corporate level (1977-1979)
- Special adviser on advance R&D to RAFAEL's CEO (1980-1987)

Mass retired from RAFAEL on 1987, due to mandatory retirement policy of civil servant (RAFAEL was a state hold company) that was in effect at the time.

All in all, The career of Jonathan Mass at the edge of advanced defense R&D extended from 1948 to 1987.

[16] By the minister of defense, Moshe Arens, an Alumni of IAI

[17] For further reading about the ABIR satellite design, see the author's paper Knight, the satellite that almost was", IAC-10.E4.3.8 5

Civilian positions

While working at Rafael, Dr. Mass hold several prestigious positions (pro bono) including:

- Deputy Director of the Israeli chapter of Institute of Radio Engineers (later known as IEEE), 1954-1956;
- A member of the Israeli committee for space research, 1963-1964;
- The Chairman of the Israeli Astronautical Society, 1964-1966.[18]

The Israeli Astronautical Society was the first Israeli organization to join the International Astronautical Federation

Aftermath

In His memoir book, the director general of Rafael, Dr. Zeev Bonen, wrote: "….Mass, who's PH D thesis were on communication satellites, is defiantly worthy of the title THE FATHER OF THE ISRAELY RECONAISSENCE SATELLITE".[19]

On 2001, Mass was awarded with special appreciation diploma from Israel's committee for space research at the national council on research and development of the ministry of science and technology, for his visionary work on satellites.

Today, one of Mass's sons is an engineer at the Israel Aerospace Industries.

[18] Our RAFAEL, April 2004.
11. RAFAEL – from the laboratory to the battlefield, Dr. Zeev Bonen (with Dan Arkin), N.D.D. Media Ltd. Tel Aviv, 2003. P.160