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The Unmanned Helicopter on the Israeli 'Saar' Corvettes – Innovation that was Ahead of its Time

Itsik Bilia

Introduction

In the 1980s, the need arose for the Israeli navy to upgrade the detection and control systems on its corvettes. This followed the installation of American sea-to-sea 'Harpoon' missiles whose range was much longer than that of the corvettes' integrated detection systems. This ability was achieved by the introduction of aerial fixed-wing systems. In this context, an appraisal was also carried out of developing vertical takeoff platforms, such as unmanned helicopters. The project that was considered was called 'MITNOSES' and was based on the American DASH (Drone Anti-Submarine Helicopter). The DASH was developed in the 1950s for anti-submarine warfare and was used by the US in the 1960s during the Vietnam War and elsewhere. The idea was innovative in several ways: the operation of unmanned vehicles that take off and land from a Saar corvette; its technological characteristics, such as a double rotor; and the exploitation of a helicopter's unique traits as part of naval warfare tactics. In the end, the Israeli project was cancelled in the early 1990s. Both then and now, the Navy has neglected the idea of unmanned helicopters on its vessels in favor of manned helicopters.

The need for a helicopter in the Israeli navy

One of the main lessons learned by the Israeli navy from the Yom Kippur War (1973) was the difficulty in coordinating with the Air Force during wartime, which is dense with events and missions. The navy formulated its tactics as a response to the gap between the range of the Israeli 'Gabriel' missile and its rival in the navies of Egypt and Syria – the Soviet 'Styx' missile. The 'Styx' had a range of 45 km as opposed to 20 km for the 'Gabriel'. The Navy's tactics included various means that would allow the Israeli ships to close the gap to an enemy vessel without being threatened, until it was possible to launch the 'Gabriel'. This included various types of electronic warfare and the role of the Air Force to deter and delay enemy ships from launching missiles in the initial stage. This tactic, developed by Israeli Rear Admiral Hadar Kimhi, in the end led to the desired outcome with respect to being able to cause harm to enemy ships without the Navy's ships being threatened. However, despite the numerous training exercises, during actual warfare the Air Force's planes did not take part in the sea battles—except on one occasion—since they were overburdened with other

missions. The lesson learned was that the Israeli navy is in need of tactical aerial means that are designed specifically for its own unique missions.

Another development that influenced the aerial component of sea warfare was the arrival of the American 'Harpoon' (KANARIT) missile in Israel at the end of the 1970s. It had a range of more than 90 km, which was beyond the range of the radar on the Navy's ships. There thus arose a need for aerial detection systems that could identify targets over the horizon and guide weapons toward them. In addition, this system should not give away the location of the mother ship and therefore an aerial vehicle was ideal since it could be operated far from the ship that launched it.

The combination of the need for air support in order to detect targets over the horizon and the fact that naval missions are not the Air Force's first priority led to the conclusion that the Navy should develop an ability to operate a vertical takeoff vehicle. This vehicle would be tailor-made to the dimensions of the Navy's ships and would provide the ship's commander with independent control over its aerial abilities.

A historical survey of helicopters in the Israeli navy

The first test to land a helicopter on a 'TARSHISG' 'Saar 4' ship was carried out successfully in 1997, using a special structure built into the ship's stern. After that, two 'HOHIT' model 'Saar 4' ships were built which were approximately 4 meters longer than originally planned and they were built with a designated landing platform in the stern and a hangar for storing the helicopter. Obviously this was at the expense of weapon systems that had to be removed from the ship, such as the 76 mm cannon in the stern. Various helicopters participated in the initial missions, including the 'SAIFAN' (Bell 206), 'ANAFA" (Bell 212) and 'LAHATUT' (Hughes 500 MD Defender). In August 1984, the idea of using helicopters was put into practice during the 'NEKUDAT ZINUK' (starting point) operation in which two of the Navy's HOHIT model ships took part. Each of them had a pair of LAHATUT helicopters armed with antitank missiles. They sailed toward the Lebanese-Syrian border at a distance of about 180 km from Israel. Due to the close proximity to the Syrian border, the Air Force decided not to attack with fighter planes. The small helicopters attacked terrorist targets with great success and returned to the mother ships and to their bases without harm.

In 1985, the Navy received its first naval helicopter, a French-made Dolphin (Eurocopter HH-65). The two helicopters that were acquired suffered from numerous breakdowns and in 1996 a training accident occurred at sea in which one of them

crashed during a night exercise and its crew of three were killed.[1] In 1997, a number of Panther AS-565 (A'TALEF) helicopters were acquired from Airbus Helicopters. These helicopters are in use until today by the Navy. The naval helicopters are operated by the Megenei HaMaarav squadron from the Ramat David base and are under the command of the Navy, in coordination with the Air Force. The Navy decided to acquire eight Seahawk SH-60F helicopters made by the Sikorsky company at a cost of $300 million. These are second-hand helicopters that were part of the US Navy's surplus and which underwent renovation. A major delay in this deal has been reported and apparently the helicopters will not be supplied in 2020 but only at the end of 2021. It appears that the condition of these helicopters is worse than was expected and the price of their renovation is millions of dollars more than the original forecast.[2]

The birth of the MITNOSES project

At the beginning of the 1980s, the possibility was raised of using unmanned helicopters. The operational requirements for an unmanned helicopter include the following: vertical takeoff and landing ability of a small vehicle deployed on the ships used by the Navy during that period; ability to carry a significant load, including various types of detection equipment, such as maritime radar and sensors; and an ability to remain in the air for several hours in order to provide the mother ship with a prolonged solution.

In those years, the military industries in Israel had about 15 years of experience in the development of unmanned aerial vehicles; however, that experience was in fixed-wing vehicles. Israel did not possess knowhow in helicopter development and therefore the possibility of developing an Israeli unmanned helicopter was not particularly feasible. Also in the global aviation world, there was a noticeable technological lag of several decades between the development of unmanned helicopters relative to unmanned aerial (fixed-wing) vehicles. It was therefore decided to initiate a project involving a number of partners. The Navy was the customer and it defined the operational requirements, and the Air Force was naturally a partner in the process. Israel Aircraft Industry (IAI) was chosen as the

1 Lieutenant Colonel Ben Tzion (Bentsi) Becher who was the captain of the helicopter and commander of the squadron, Captain Shahak Sela who was the copilot and Captain Eran Garbiyah, the Navy's Helicopter Patrol Officer. The body of Captain Shahak was found in the searches carried out already that night. Four months later, in January 1997, the body of Lieutenant Colonel Becher was found. The body of Captain Garbiyah was never found (Wikipedia).

2 Udi Etzion (July 5, 2020), The helicopters from the US will be delayed; there will be a cost overrun in the millions, *Calcalist*. [Hebrew]

supplier who would actually do the development and the Ministry of Defense, by means of MAPAT (abbreviation in Hebrew for the Authority for the Development of Weapons and Technological Infrastructure), which would provide support for the project.[3] The IAI established a development group of about 30 engineers led by Shmuel Arbel, the Director of Development. The project was supported by MAPAT, and liaison officers were assigned to it from the Air Force and in particular from the Navy, since the developers were unfamiliar with the naval theater and its unique characteristics.

As part of the feasibility study, various options were examined – kits to self-assemble miniature helicopters; a search for a small manned helicopter that can land on the Navy's small ships with the goal of converting it into an unmanned helicopter; and the consideration of, among others, the Schweizer model 330 helicopter made in Switzerland. At that time, there were unmanned helicopter solutions offered by Schiebel, an Austrian company but these were small and did not have the ability to carry a large load and remain in the air for an extended period of time, as required by the Navy. The manned helicopters that were in the service of the Air force at the time (SAIFAN, ANAFA, and LAHATUT) did not have the ability to remain aloft for the time required by the Navy either. MAPAT and the Navy also carried out a search for a helicopter with a long-distance remote navigation and control system and found a potential candidate in the American DASH which was in use in the 1960s. After carrying out a number of investigations, the option based on the American unmanned helicopter manufactured by Gyrodyne was chosen. This vehicle was in active service with the US Navy during the 1960s and in the Vietnam War. It had a double coaxial rotor system, which eliminates the need for a tail rotor, thus saving valuable space. An agreement for sharing of knowledge was signed and it included an American export license. Peter Papadakos, the owner of Gyrodyne, worked closely with his Israeli counterparts, and provided the drawings and documents needed to produce the systems in Israel. The mechanical system had the following specifications, which met the Navy's operational requirements: maximal liftoff weight of 1,100 kilograms, of which cargo and fuel would be 600 kg; maximal speed of 100 knots; and time in the air of about six hours.

At the end, three units were purchased – two were used as prototypes and a third for spare parts. They were delivered to RAMTA in Jerusalem, IAI's helicopter maintenance facility. This process made use of the innovation of a different navy;

3 MAPAT is responsible for research into innovative capabilities and also supports the development of projects initiated by the various corps that involve development and acquisition. The support is in the form of both budgets and professional consultation.

essentially, the Israeli navy had acquired an unmanned helicopter that was in use in the US Navy[4] and continued to develop it and modify it to its own needs.

The Gyrodyne QH-50 DASH

The American destroyers in World War II were equipped with advanced sonar which kept them relevant in the battlefield of the Cold War, primarily in the context of anti-submarine warfare. However, they suffered from a problem of insufficient space with respect to the ability to land helicopters on their decks. The US Navy therefore sought a small unmanned helicopter for these missions. The program began under the command of Admiral Burke in the late 1950s. At the time, the U.S. Navy had the ability to detect enemy submarines from a much greater distance than the range of their torpedoes. Therefore, tactics were developed that included early detection by the destroyer's sonar and then guiding an unmanned helicopter, armed with one or two torpedoes to the target. The unmanned helicopter could get to within a range that allowed for the firing of a torpedo and the destruction of a distant enemy.

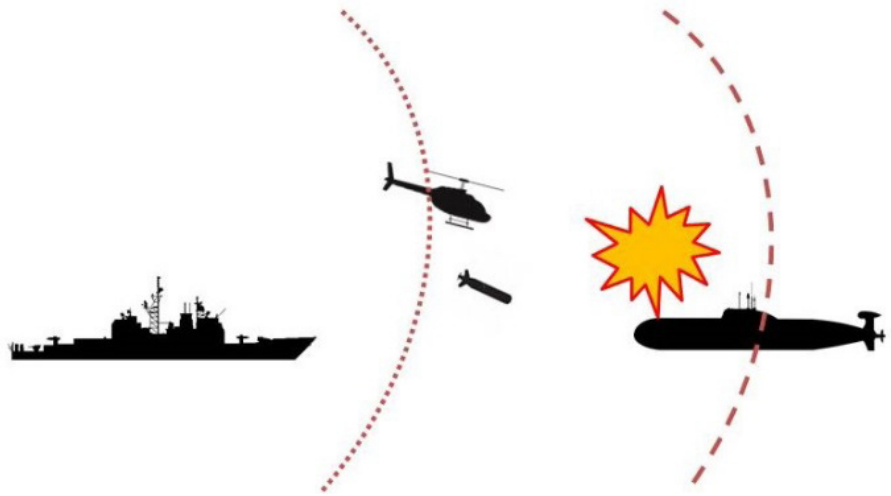

Figure 1: Tactics for use of a DASH unmanned helicopter against submarines

The maiden flight of the DASH helicopter took place in January 1960 and was jointly planned by the US Navy and the Gyrodyne company. In 1962, it was first deployed operationally on naval vessels. The plan included takeoff and landing by means of a remote operator on the deck and later control was to be transferred to the ship's command and control center.

4 The Americans during this period used the remaining helicopters as missile practice targets.

An additional model, called the SNOOPY, which was equipped with a camera that broadcasts a picture in real time back to the mother ship, went into service in January 1965. It provided information on the accuracy of fire from the ship's 5-inch guns. An officer serving on a destroyer came up with the idea, which he saw as enhancing the destroyer's firepower. The use of this model in the Vietnam War was considered to be a success, and this was essentially the first time that use was made of an unmanned aerial vehicle for intelligence purposes.

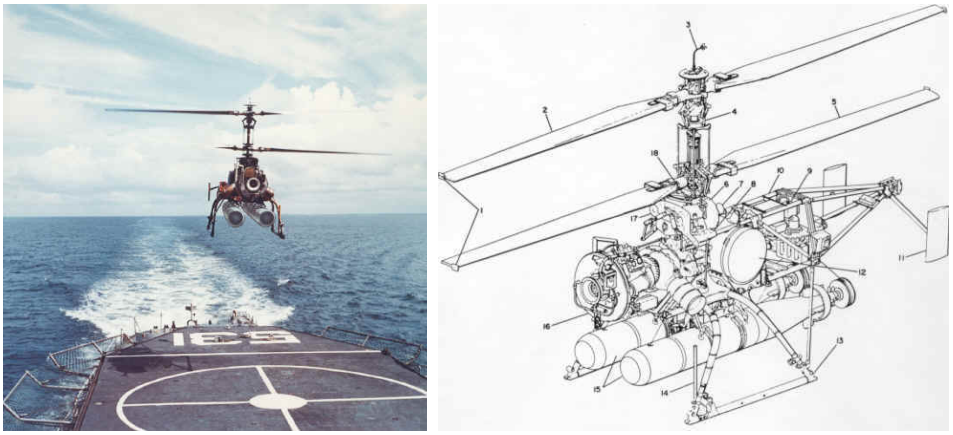

Figure 2: A DASH helicopter carrying a pair of torpedoes on an American destroyer (Gyrodyne.com)

Figure 3: A SNOOPY helicopter equipped with a camera and a transmission device (Gyrodyne.com)

Unmanned helicopters were in use during the 1960s and in the Vietnam War. Up until 1970, 750 units had been produced and had flown hundreds of missions. Their production was halted in that year. The data show that about one-half of them were lost while in service. Both the successes and failures were of great benefit to the advancement and development of unmanned helicopters.[5]

The development process in Israel

The development process in Israel began in 1988. At the IAI, the unmanned helicopter was given the name HellStar. The Navy chose the name MITNOSES for the project. There were several reasons for the choice of the American unmanned helicopter as the basis for the Israeli development project: First, it avoided the need to plan a new design, which saved development time through the use of an off-the-shelf item. Second, the design was based on an existing unmanned helicopter that had already proven itself in various missions (as in the case of the development of the 'GABRIEL' missile which was based on the already existing 'LUZ' missile).

The development process can be divided into two parts from the point of view of technological complexity. The first included an upgrade of the unmanned helicopter based on the existing American mechanics. This meant using the dynamic system and rotors of the existing unmanned helicopter and adding to them the avionics and electronics of leading Israeli systems. Also added was the designated equipment that the unmanned helicopter would carry, including maritime radar, day and night vision devices, communication components and other detection and weapons systems developed in Israel. The technological challenge was to provide high-capability systems on the one hand but not to exceed the maximal weight of the designated equipment, which would directly affect the helicopter's performance with respect to maximal time in the air, on the other hand. At that time, some experience had been accumulated in Israel with unmanned vehicles and components of this type were already to be found in various configurations. This part of the development process is complicated and also included known components that had been planned on paper, but never built by the IAI. Therefore, there was a need for a major modification followed by several more cycles on a smaller scale; this process would involve two or three cycles of development. The complexity of the development process was ranked as "2" on the Bonen Scale.[6]

5 Benjamin Armstrong (2013), Unmanned naval warfare: retrospect and prospect, *Armed Forces Journal*.

6 The Bonen Scale is a method for planning and tracking a development process. It was invented by Dr. Zeev Bonen, former CEO of Raphael Industries. "Raphael: from Laboratory to System", Dr. Zeev Bonen and Dan Arkin. *NDD Media* 2003, p. 126. [Hebrew]

Figure 4: The MITNOSES (generously provided by Leor Margolin)

The second part, from the viewpoint of technological complexity, included capabilities that were lacking in the original system, which were not available from the defense industry in Israel and furthermore were technologically complex on their own at that time. The development of automatic takeoff and landing ability essentially involves the development of a digital automatic pilot for the helicopter, which was developed in Israel for the first time and was among the first to be developed in the world. To this end, thousands of digital simulations of a landing on a corvette were carried out on a small landing pad under various sea conditions, including a ship being rocked randomly and travelling at various speeds. In addition, the process required the development of a device for the automatic anchoring of the unmanned helicopter on the ship after landing.[7] Automatic landing of an aerial vehicle on a ship out at sea constitutes a complex engineering problem involving a moving platform (the helicopter's three degrees of freedom opposite the ship's three degrees of freedom). The need for an automatic takeoff and landing system, which had never been developed in Israel and only to a limited extent abroad, increased the complexity of the project to a ranking of "3" on the Bonen Scale. Even if there is an existence theorem for the suggested solution, it is not always chosen as the correct solution and therefore there are a number of development iterations that include unsuccessful solutions and another approximately three iterations until the final solution is achieved.

7 There was a need for changes in the ship that would enable the deployment of the helicopter. These included a telescopic hangar system and an elevator. To this end, contact was made with a Canadian company called Indal, which specializes in anchoring and conveyance of helicopters on board ships.

The trial stage and the termination of the project

The first test flight was in June 1990, and in total there were 13 of them. In some of them, the unmanned helicopter was tied to the ground and it took off up to a certain height and then landed. In addition, there was a test of running the engine on the deck of a ship at sea.

In one of the tests, a flaw was revealed in the gyro system and the helicopter was damaged during a "heavy" landing. There are those who believe that this failure led to the decision by the Navy to cancel the project in 1992. Members of the IAI claim that the project was cancelled due to a lack of financing since the Navy found it difficult to fund its share of the development costs. In the end, the MITNOSES project was canceled in early 1992 and since then the Navy has used only manned helicopters in its various missions.

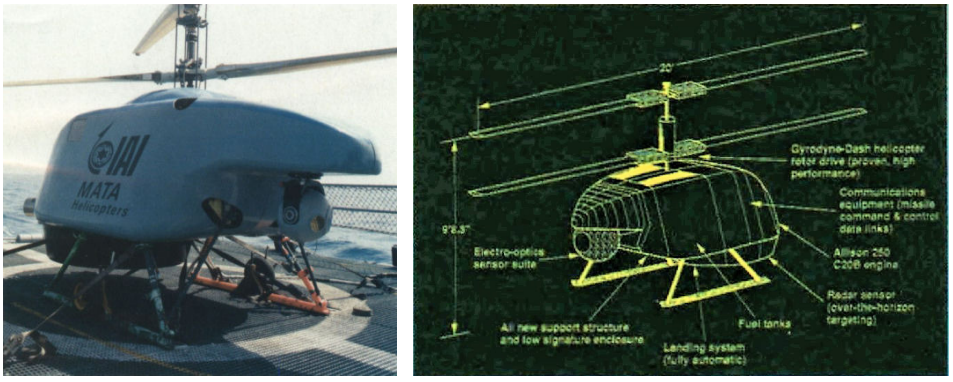

Figure 5: On the right is a test of the unmanned helicopter on a Navy ship. On the left is a drawing of the MITNOSES (generously provided by Shmuel Arbel)

An analysis of innovation

Israel's MITNOSES project and its "father", the American DASH were innovative in several aspects. First, **innovation in time**: The American unmanned helicopter was developed in the 1950s when helicopters and their use in combat was in its early stages. Late in World War II, the first use was made of helicopters for military purposes. The widespread use of the military helicopter came later and reached a peak during the Vietnam War in the 1960s. During that war, the helicopters served as a primary platform in all aspects of the fighting. The development of an unmanned helicopter during that period was certainly considered to be innovative. It is worth

mentioning, for purposes of comparison, that the use of unmanned aerial vehicles became widespread only after decades of using planes for various purposes.

Another aspect of innovation is **technological innovation** and the use of applied science to these projects. The unmanned helicopter being discussed here was the first unmanned vehicle in use during the very early stages. The ability to remotely operate a vehicle with this level of mechanical complexity was very advanced for that period. In addition to the remote control technology, it also involved the mechanical component of a double rotor, which has numerous advantages. One of them is the relatively small dimensions of the helicopter since there is no need for a tail rotor for stabilization – a major advantage when operating from ships. Another is that a (coaxial) double rotor provides higher levels of speed and agility.

The helicopter also provides **doctrinal innovation**, which is manifested in anti-submarine warfare tactics. These tactics answer an operational need by exploiting the advantages of existing sonar and solving the problem of the torpedo's short range at that time. The American unmanned helicopter was the link that made it possible to destroy distant enemy submarines. The Israeli navy had experience in the adoption of an innovative approach to naval warfare that employs detection by means of radar on the aerial vehicle, without exposing the location of the mother ship. In addition to this type of vehicle, the ability had been achieved to assist in the guidance of over-the-horizon missiles and to carry out battle damage assessment (BDA) without endangering human life.

The idea of independently operating an unmanned helicopter in the Navy was a manifestation of **organizational innovation**. The innovation in operating an independent aerial vehicle eliminated the need for a mechanism to integrate the Air Force in naval operations. The relations between the Navy and the Air Force are complex. In Israel, the development of independent air power for the Navy, as it exists in the larger navies, is not feasible from a budgetary point of view. Currently, the naval helicopters are maintained by the Air Force and its crew members are Air Force pilots. This has advantages with respect to the quality of training, the skill level and the abundance of experience. Additionally, the squadron that operates these helicopters is dedicated to the needs of naval missions. However, there are also disadvantages of the current format. One is the need to coordinate the operation of the helicopters with the Air Force, which limits operational independence, and this mechanism involves an operational cost in wartime.[8] The second is that operation

8 The operation of land-based unmanned aerial vehicles for maritime patrols (as part of the Maritime Patrol Branch of the Navy) also involves a level of coordination with the Air Force.

of a manned helicopter from a ship requires that attention be devoted to the risk to the pilots and this becomes a burden on the crew of the ship. According to one of the individuals interviewed for this article, the ship becomes encumbered by the helicopter to some extent. Furthermore, the Navy proposed that the operators on the ship who have the responsibility for operating the 'GABRIEL' missiles in the early stages of launch would be trained to operate the unmanned helicopter since they have the required skill for remote operation of that type.

The military use of innovation

The Israeli unmanned helicopter was meant to meet the following operational needs: 1) the use of radar and other sensors for the detection of targets without giving away the location of the mother ship; 2) in the case that the unmanned helicopter is detected, there is no danger to human life; and 3) the operation of aerial vehicles under direct control of the ship's commander without the need for coordination with the Air Force that limits control capabilities in combat. There is potential for using unmanned helicopters in maritime missions of various kinds: participation in naval combat – detection and identification of vessels for the Navy's corvettes; guidance of the Navy's ships to over-the-horizon targets; anti-submarine warfare; maritime search and rescue; air-sea transportation; participation in aerial-maritime patrol activities; etc.

The reasons for the failure of the MITNOSES

The interviews I held on the topic of the MITNOSES episode in the Navy left a feeling of missed opportunity. The evidence points to a major potential for the program, which was nonetheless cancelled. I will present some of the main factors involved that are related to innovation:

1. **Technological maturity**: Unlike the American project which was developed during the 1960s, the Israeli project was evaluated during the 1980s. This is an important point with respect to the claim of technological maturity and the question of innovation that was ahead of its time. In the American case, these claims had a foundation, as was discussed above. But the Israeli case was quite a few years later, during which the technology had advanced to a much higher level. However, there were two technological requirements that constituted obstacles in the development work. The first was the equipment load carried by the helicopter, which includes maritime radar and night and day vision devices, which had to be under the maximal weight threshold in order not to harm the performance metrics of the helicopter and in order to meet the Navy's condition for minimal time in the air. The second requirement was that it have

an automatic takeoff and landing system, rather than being controlled by an external operator. A digital automatic pilot was a relatively complex matter in those days and required a long and complicated development process, which had not been done previously in Israel. On one of the first test flights of the system, there was a technical mishap and the helicopter was damaged on landing. There are those who view this incident as the catalyst for the termination of the project. Furthermore, there is a not insignificant amount of risk in operating an automatic pilot system of this sort out at sea. Landing on a ship out at sea without human involvement increases the risk to the ship and its crew, although I have heard varying opinions with regard to the need for this capability. As mentioned above, the takeoff and landing of the Americans' unmanned helicopters was by means of a human operator. However, the decision makers in the IAI and in the army had concluded that this is the only option. One can speculate that this capability made the project more complex and required innovation that was ahead of its time. From the Navy's perspective, there were major problems that became clear during the development and in the marginal operational envelope demonstrated by the project.[9] It is important to mention that for the IAI and MAPAT the problem was not technological but rather budgetary.[10] MAPAT did not identify a technological lag that justified its intervention in the technological process; neither did it continue with the development of remote control technology since at that time there were no customers other than the IDF.[11] The approach that MAPAT adopted and continues to adopt is that any manned vehicle can be replaced an unmanned vehicle.[12]

2. **Budget and financing**: The budget that was made available for the development of the system did not match its complexity. The Navy found a creative solution through assistance in financing from a foreign country, which led to its interest in the potential of this project. That country was ready to invest the lion's share of the project's cost, but at the same time this made the process of determining the specifications more difficult and it tried to reduce development costs. From time to time, there was tension against this background between the IAI,

9 Interview with Brigadier General (ret.) Alex Eyal who was the Head of the Weapons Department during that period and who recommended the termination of the project.

10 Shmuel Arbel stated that despite the technological challenge it was possible to arrive at a solution if sufficient budget had been allocated. Indeed, during the years following the termination of the project, a number of unmanned helicopters of this type were developed by the IAI and other industries in Israel, some of them in cooperation with foreign companies.

11 Interview with Yair Gilboa who was the Head of the Air and Propulsion Branch at MAPAT during the years in which the project was developed.

12 Interview with Aryeh Tsur, supporting engineering at MAPAT.

the Navy and that country's navy. It is worth mentioning that although many projects that have been developed in the defense sector have suffered to some extent from under-budgeting, in this case there was a solution in the form of a third party. It is also worth mentioning that unlike the unmanned aerial vehicles used by the Air Force or by the Intelligence Corps, which are bought in relatively large numbers, the Navy is a small customer which orders a limited number of systems (in total there was two Hohit ships that can carry a helicopter in addition to three Saar 5 ships that was planned to arrive in the future).[13] There is also a potential for exporting the system and there is an interested customer. At the end of the day, the development was allocated financing from the IAI and the Navy. However, the attempt to persuade the foreign customer failed. The Navy decided to cancel its financing in view of the difficulties in development, the need for additional budget and the additional time needed for development.[14]

3. **Disagreement within the Navy:** During those years, the debate over the optimal size of the ships that the Navy should acquire was at its peak.[15] The "large vessel" approach, which supported the acquisition of the SAAR 5 model, won the argument in the end, which also had an effect on the MITNOSES project. This is because the SAAR 5 ships can carry large manned helicopters and it may that there were decision makers who viewed the unmanned helicopter as a kind of threat to the option of acquiring large ships.
4. **Lack of maturity in the Navy for this type of project**: The interviews with professionals in MAPAT and in industry identified a number of problems in the Navy with regard to this project. First, there was a problem convincing the senior echelon in the Navy that this is an essential project and accordingly that the financial investment was necessary. Second, the Navy did not have a fully crystalized operational strategy with regard to the operation of unmanned vehicles from the decks of its corvettes. Third, there was a conceptual difficulty in accepting the risk of landing unmanned vehicles on a ship out at sea. Finally, there was an impression that the dimensions of this project were beyond the capabilities of the Israeli Navy.

13 The 3 Israeli corvettes (SAAR 5 model) entered operational force between 1993-1995

14 Shimon Eckhoyz, the CEO of RAMTA at that time, recounted that from the moment that the Navy halted the financing of its portion of the development, there was no possibility for the IAI to finance the project independently.

15 There were two schools of thought in the Navy. According to the first, it was preferable to acquire large ships with a long range at the expense of speed and also of quantity (since they are more expensive). The second supported the acquisition of a large number of small and fast ships.

5. **Conservative attitudes and opposition in the Air Force**: The approach toward the operation of unmanned aerial vehicles underwent a major transition. In the early 1990s, the Air Force operated a number of types of unmanned aerial vehicles, but its attitude to this issue was complicated since it viewed unmanned aerial vehicles as a threat to the use of the Air Force's pilots and the faith in manned planes. It is worth considering whether that approach—which no longer exists—was indeed the reason for terminating the unmanned helicopter project during that period. Furthermore, account should be taken of the fact that the Air Force naturally opposed any aerial solution that was not under its authority. A figure who was involved in this matter stated that from the viewpoint of the Air Force, "Anything that flies should belong to it" and that that is at the root of its opposition to such projects.

Opinions are divided as to the reasons that led to the failure of the project in Israel. The various entities involved in the project present different reasons and emphasize different obstacles. A fact that no one disagrees with is that even after 30 years there is still no unmanned helicopter on the Navy's corvettes and that investment is still channeled primarily to manned helicopters, namely the American Seahawks which are planned to replace the current 'ATALEF' helicopters.

Conclusion

The MITNOSES project described here involved innovation of various types: innovation in time both in the American context of development in the 1950s and in the Israeli context of the 1980s; doctrinal innovation in anti-submarine warfare and naval warfare; technological innovation and the use of applied science in double-rotor mechanics and the remote operation of unmanned vehicles; an attempt at organizational innovation by the Navy involving the independent operation of aerial vehicles; and the acquisition of innovation from the post-modern US navy.

The reasons for the failure in the US during the 1960s can be explained by the lack of technological maturity. But in the context of Israel at the end of the 1980s and the beginning of the 1990s this claim needs to be examined carefully. The developmental considerations included the choice of an existing system in order to save costs and time and then to upgrade it according to the Navy's requirements. The problem of the weight of the helicopter's equipment load to the point that the unmanned helicopter could not stay in the air for a sufficient amount of time is unclear, since the defense industry already had experience during that period in developing various systems for unmanned aerial vehicles. It can be hypothesized

that the requirement for an automatic landing system was ahead of its time and created a technological obstacle for the project. It may be that with a larger budget it might have been possible to overcome this obstacle; however, other considerations, namely conservative attitudes and tensions within the Navy and between the Navy and the Air Force, contributed to some extent to the termination of the project.

The Navy faces a complex reality, particularly in the Eastern Mediterranean. The Eastern Mediterranean is dense with the vessels of various navies, both those of the Middle Eastern states and those of the superpowers. New challenges have been added to the Navy's traditional challenge of protecting the coasts of Israel, including protection of maritime strategic assets, and in particular the various energy facilities. Considering all of the above, the question arises as to whether the Navy is optimally prepared for the various threats, some of which are asymmetric. Unmanned aerial vehicles are used on a large scale by the Air Force today and also in the maritime context; however, the issue of tactical unmanned helicopters and its potential raise the question of whether there isn't a major lost opportunity in this case.[16] Imagine a small, fast and unmanned helicopter, armed with sophisticated sensors and other equipment, that is permanently stationed on a ship and can be fully and independently controlled by its immediate commander, without the need for coordination with others, and which can serve as part of the intelligence and operational network in wartime, whether in defensive or offensive combat…

16 And in particular against the background of the naval helicopter accident in 1996 which also led to the shift to unmanned aerial vehicles.