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EVOLUTION OF THE LAVI FIGHTER AIRCRAFT

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ABSTRACT

The LAVI* fighter was specified by the Israeli Air-Force (I.A.F), once the Government of Israel (G.O.I) decided to develop an Israeli fighter aircraft. The decision was taken in February 1980.

The definition of the aircraft in its final configuration is based on a preliminary design process in which the requirements and the technological capabilities and constraints were traded-off. The outcome of this trade-off was the final configuration of the LAVI fighter.

This paper presents this evolution process concerning the impact of the different approaches, technologies, features and trade-offs on the configurations characteristics.

Finally the evolved design concept and philosophy for the LAVI is presented.

I. INTRODUCTION

Evolution of the LAVI is based on configurations study research which was initiated in 1971. This study continued with short interruptions up to the end of 1979, when the Lavi full scale development was given a go ahead. In the time period up to the end of 1982, the configuration was modified and refined during the preliminary design stages. Between 1971 to 1982, different configurations were defined, evaluated and wind tunnel tested.

Different design approaches were the basis of those configurations. Those approaches have been changed during the years. Several configurations sizing were investigated, dependant mainly on engine characteristics, and performance goals. One and two engine configurations were investigated. Different inlet definitions were evaluated considering inlet type, position, shape and control. Different wing planforms, including flying wing concept were investigated. Different vertical tail layouts were tested including tail booms configurations.

Configurations study took into account different approaches to external stores carriage, including conformal carriage concepts. Internal layout of the configurations was investigated for different landing gears solutions.

II. HISTORICAL REVIEW

After completion of the flight test program of the KFIR* prototype, at the beginning of the seventies, Israel Aircraft Industries (I.A.I) began examining the possibility of developing an Israeli fighter aircraft that would succeed the KFIR.

The development process, which prefaced LAVI final definition, can be divided into four stages, as presented in Figure 1.A brief summary of these stages is presented herein.

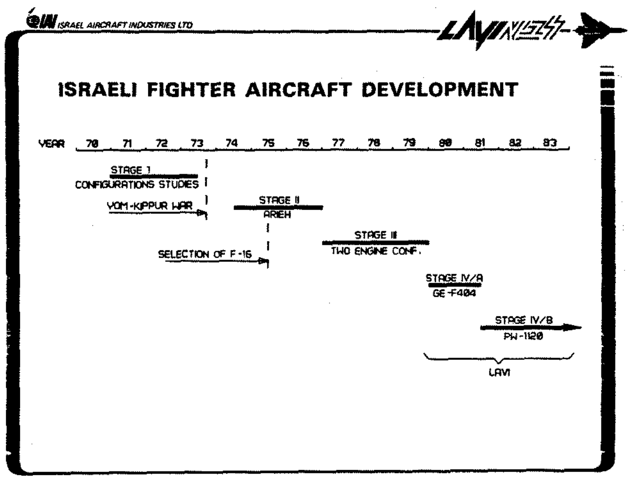

FIGURE 1

STAGE I

The general approach at the end of this stage was to find solutions to a small size low cost aircraft dedicated mainly to air-to-air missions. The configuration was based on an advanced aerodynamic design enabling exceptional close combat performance, by exploiting the available high maximum lift due to vortex lift. This technology was known to I.A.I, after its incorporation in the upgraded version of the KFIR, the KFIR-C2, the latter having a pair of fixed canard surfaces. See Figure 2.

* LAVI - "Young Lion" in Hebrew

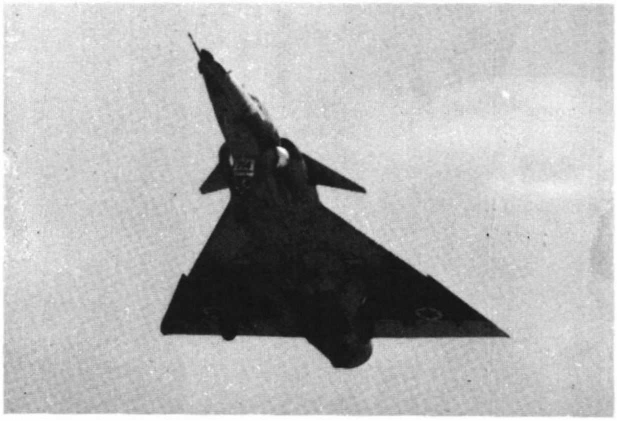

FIGURE 2

The incorporation of the canards significantly improved the high angle of attack performance of the aircraft. The maximum lift increased by more than 50%, due to a combination of additional lift and increased angle of attack envelope up to about 30 degrees.

The development was basically a private venture of IAI without any specification provided by the I.A.F. Figure 3 presents one of the proposed configurations.

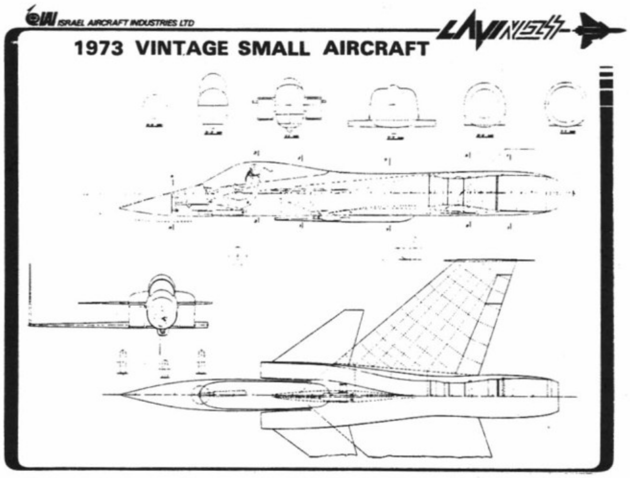

FIGURE 3

It should be mentioned, that the design goal of a small size, light weight and low cost high performance aircraft was once again considered approximately 8 years later as the basic guideline for the LAVI specification.

The activity at that stage was virtually stopped as a result of the Yom-Kippur war.

* KFIR - "Lion Cub" in Hebrew

STAGE II

A further effort to initiate the development of a new fighter aircraft took place in the years 1974 to 1976. This aircraft was named the ARIEH (Lion).

The design principles are summarized in Figure 4.

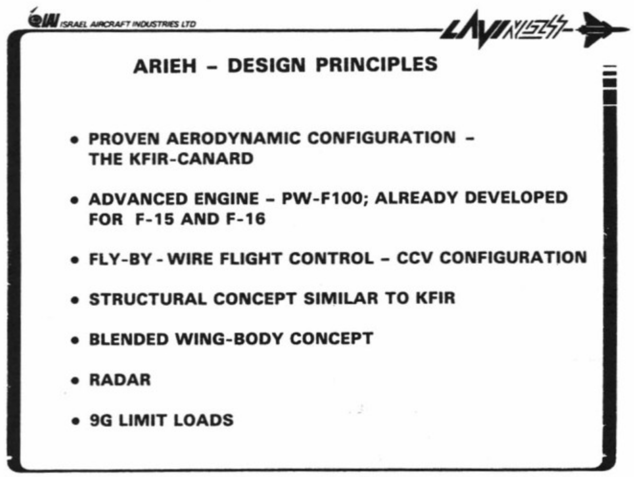

FIGURE 4

The aircraft was based on the proven aerodynamic design of the improved KFIR-C2 (with the canards), on an advanced engine (the PW-F100), and on the incorporation of an advanced Fly-By-Wire flight control system, to permit design on an unstable configuration.

The preliminary design was based on the basic KFIR while considering only minor modifications to the fuselage mainly in the aft section. The wings were identical, although located further outboard, increasing the wing reference area. The structural concept blended the almost unchanged OML (Outer Mold Line) of the fuselage with the slightly outboard located wing. Figure 5 presents a typical ARIEH configuration.

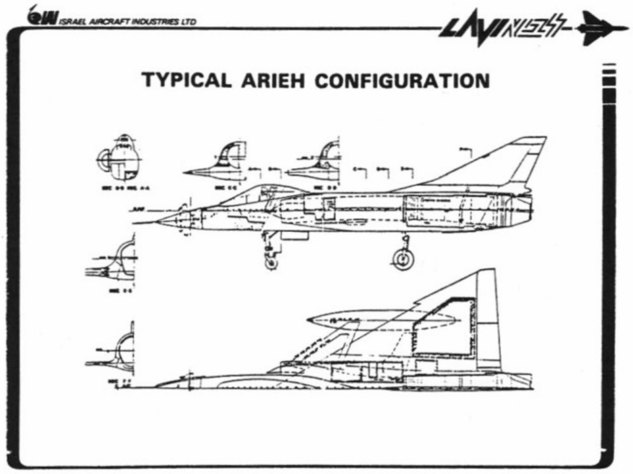

FIGURE 5

During the definition stages, the original structural layout of the KFIR was modified in order to improve structural efficiency and to be compatible with the systems installation requirements.

The ARIEH configuration was generally inferior in its capability compared to the F-16 which, at that time was being evaluated by the I.A.F.

The development of the ARIEH came to an end by the decision to procure the F-16 for the I.A.F.

The performance of the ARIEH compared with the F-16 is presented in Figure 6.

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ARIEH/F-16A BASIC PERFORMANCE CAPABILITIES

	ARIEH	F-16A
PERFORMANCE (RELATIVE) H = 10,000 FT		
· SUSTAINED TURN RATE	0.80	1.00
· INSTANTANEOUS TURN RATE	1.17	1.00
EXTERNAL STORES CAPABILITY		
· NUMBER OF STORE STATIONS	7	9
· MAXIMUM EXTERNAL PAYLOAD (LB)	14900	12000
· MISSION RADIUS (8xBOMBS, LLH)	0.80	1.00

FIGURE 6

Conclusions of the "ARIEH Era"

To improve the performance of the aircraft, the following steps should be taken:

(A) Increase of the thrust is necessary. This can be achieved by a twin engine configuration . Both the Rolls Royce RB-199 and the GE-F404 should be considered.

(B) In order to improve air-to-air point performance and air-to ground mission performance, improvement of the aerodynamic configuration is required. This should be done by considering new aerodynamic planforms different from the basic KFIR canard configuration.

STAGE III

The main effort at this stage was concentrated towards the definition of twin engine configurations. The various configurations that were studied had different wing and air inlet options.

Inlet Options

For all the configurations examined, the engines that were intended to be used were of the turbofan type. This type of engine is more sensitive to the air flow distortions induced by the inlet. Thus a special emphasis has been put on the inlet type selection. The inlets that were assessed had better high angle of attack distortion behaviour and were of the type:

(a) Pitot type
(b) Two-dimensional
(c) Axi-symmetric with moving spikes

All inlet types were incorporated in the configuration in their lowest possible positions, in order to reduce the wing induced upwash at high angles of attack. The various inlet configurations and their wind tunnel tested distortion behaviour are shown in Figure 7.

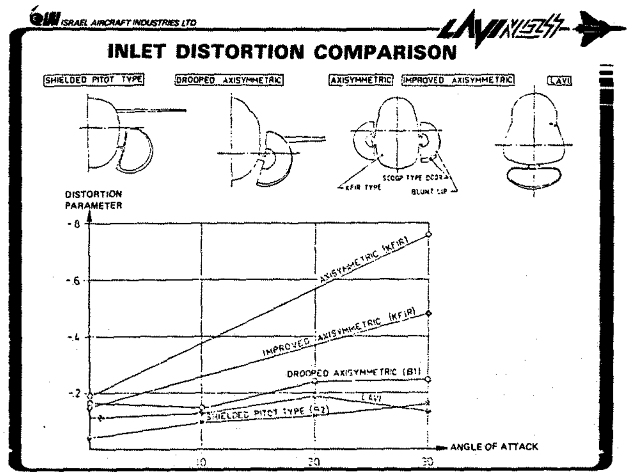

FIGURE 7

Twin Engine Configurations

Based on different inlet definitions, various twin engine configurations were investigated, as depicted in the following Figures.

Layout-26 (LO-26): Twin pitot inlet configuration shielded by canards (Figure 8).

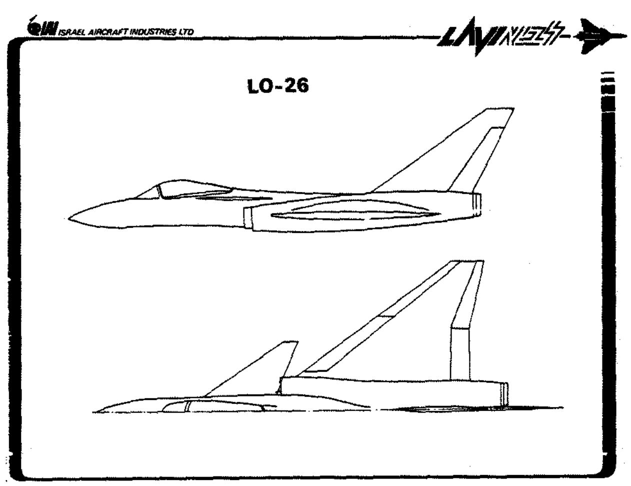

FIGURE 8

Layout-28 (LO-28): Twin horizontal two dimensional inlets with variable ramps (Figure 9). Wind tunnel model of LO-28 is presented in Figure 10.

Layout-34 (LO-34): Twin axisymmetric inlets with moving spikes (Figure 11).

All those configurations were wind tunnel tested with different wings, canards and vertical tails combinations as presented in Figure 12.

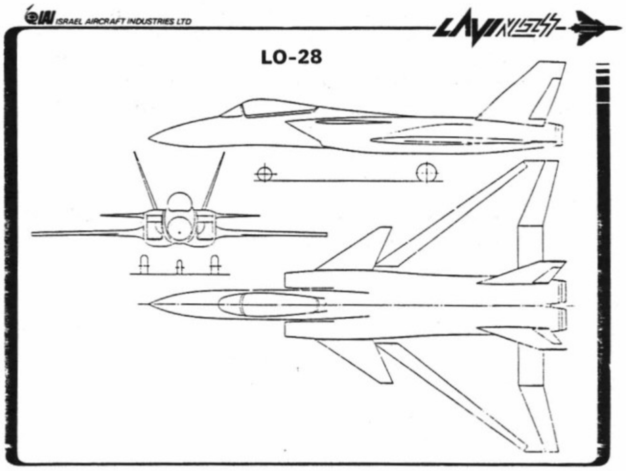

FIGURE 9

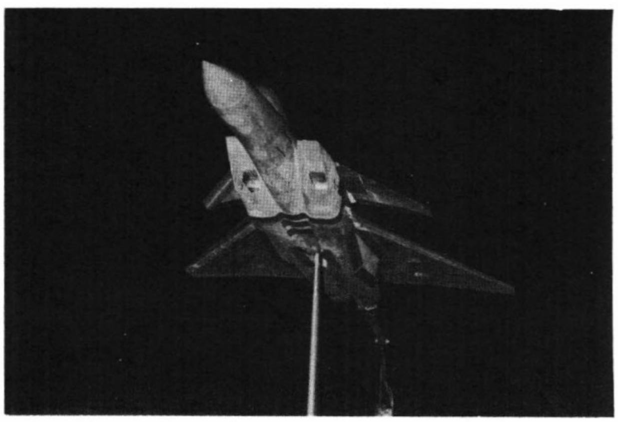

FIGURE 10

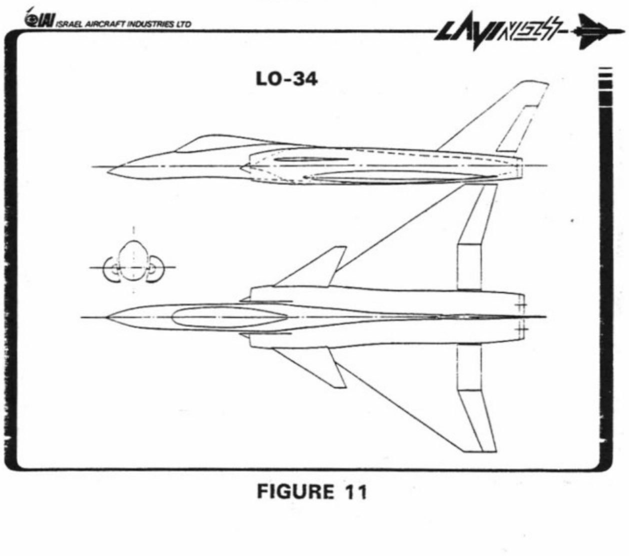

FIGURE 11

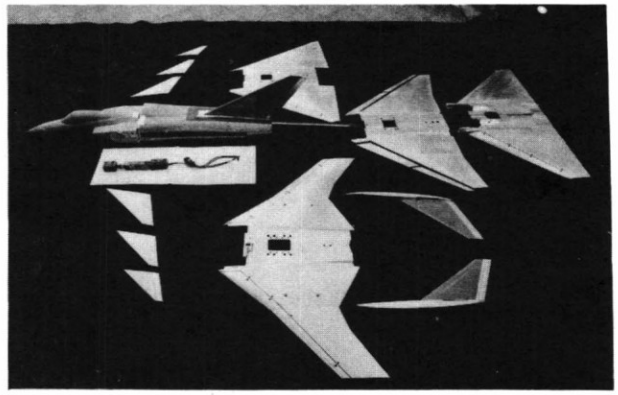

FIGURE 12 TWIN ENGINE CONFIGURATION W.T. MODEL ELEMENTS

In order to enhance air-to-ground mission effectiveness, different external stores carriage layouts were investigated. Under-fuselage conformal carriage as illustrated in Figure 13 was considered for LO-28.

One of the unconventional options that was evaluated, was Layout 31. The configuration presented in Figure 14 incorporates a flying wing with externally podded engines.

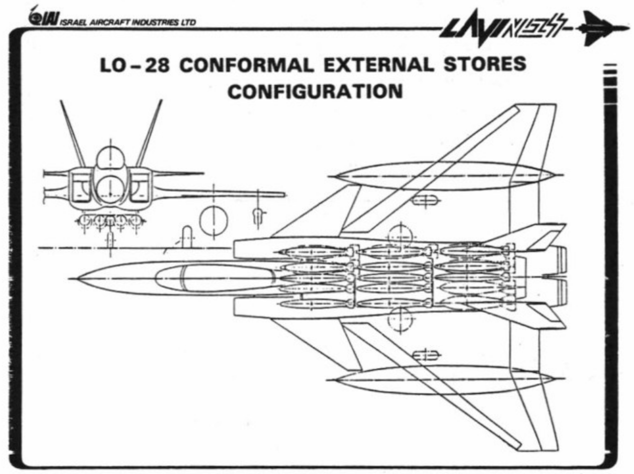

FIGURE 13

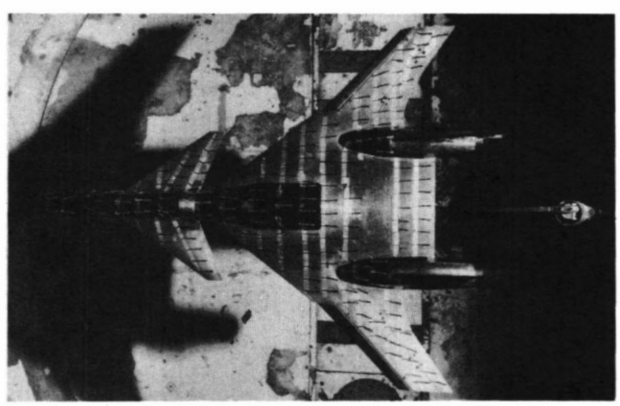

FIGURE 14

Just as the ARIEH configuration was intended to be a substitute for the F-16, the twin-engine version was considered to be a competitive replacement for the F-18, which was one of the long term IAF purchase options.

In order to meet the operational requirements, which were based on good air-to-air and air-to-ground performance with a high external stores carriage capability and incorporating a large avionics package, a larger size (twin engine) configuration was needed.

Despite this trend, by the fall of 1979 the potential of a single engine, small size configuration was reinvestigated. The main driver was budgetary constrains.

STAGE IV

Based on the studies of stage III, that assessed different types of wings and inlets, a single engine small size configuration named L.O. - 33 (Layout -33) - was initiated. It is presented in Figure 15.

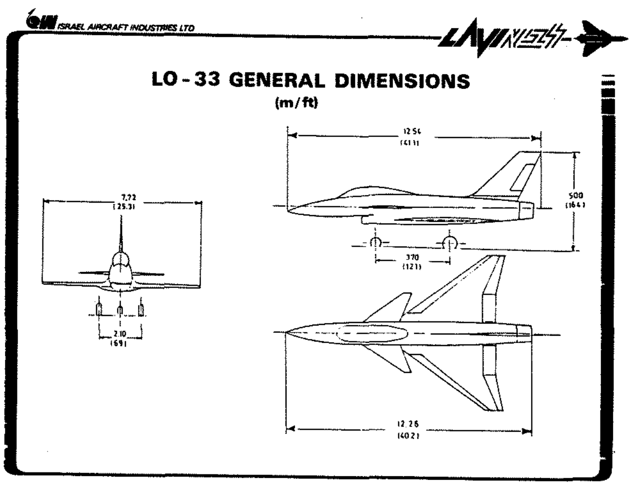

FIGURE 15

This configuration incorporated a "delta" wing, close coupled moving canards, a low chin inlet comparable to the F-16 and an advanced turbo-fan engine in the class of the GE-F404. The configuration, although small in size, exhibited a very promising performance potential.

The preliminary defined concept was intended to replace the I.A.F Skyhawk A-4 and the KFIR. Their comparable characteristics are presented in Figure 16.

The new configuration effectively blended in a small aircraft state of the art technologies such as aerodynamics, propulsion, flight control, avionics and structure.

The basic air-to-ground performance capability of this configuration is compared to other aircrafts in Figure 17.

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LO-33 CHARACTERISTIC PARAMETER COMPARISON

	LO-33	KFIR-C2/C7 (*)	A-4M (*)
EMPTY WEIGHT (lb)	11110	16060	10800
INTERNAL FUEL (lb)	4600	5670	5440
FULL CLEAN (lb)	16430	22960	16470
EXT. PAYLOAD (lb)	12070	12740	10950
MAX T.O (lb)	28500	35,700	27420 (**)
COMBAT WEIGHT (lb)	14520	20,700	15230
ENGINE	GE-F404-400	GE-J79 J1E	J52 - P-408
ENGINE A/B THRUST (lb)	16090	17860	11200
WING AREA (ft^2)	272	375	260
COMBAT THRUST/WEIGHT	1.11	.86	.74
COMBAT WING LOADING (lb/ft^2)	53.4	55.2	58.6

(*) BASED ON PUBLISHED DATA
(**) LANDBASED LIMIT

FIGURE 16

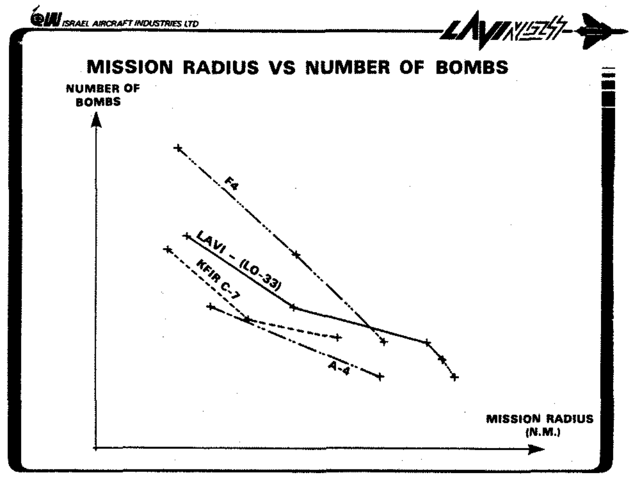

FIGURE 17

The new technologies enabled overcoming of most of the shortcomings of the small size configuration, that during the previous stage has pushed towards larger twin-engine configurations.

By the end of 1979, Israel MOD (Ministry of Defense) recommended giving a go-ahead for the FSD of a small fighter aircraft based on LO-33. On February 1980 the GOI approved MOD's recommendation.

Based on I.A.I.'s proposal, a combined effort of I.A.I, I.A.F and the Ministry of Defense led to a configuration definition process that continued till definition freeze at the end of 1982.

Within this period the operational requirements and the prime item specifications were defined by the I.A.F.

III. OPERATIONAL REQUIREMENTS

The IAF operational requirements called for two aircraft configurations, according to the following priorities:

Single Seater For

(a) Medium range air to ground missions

(b) Air defense missions

Two Seater For

(c) Advanced flight and OTU training.

Technical Specifications

The demanding technical specification of the aircraft challenged the designers as reflected in Figure 18.

The small size LO-33 gradually evolved into a larger and more sophisticated design.

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LAVI - TECHNICAL SPECIFICATIONS PRINCIPLES

- AIR-TO-AIR MANEUVER PERFORMANCE - F-16 CLASS
- AIR COMBAT PATROL PERFORMANCE - F-16 CLASS
- EXTERNAL STORES CAPABILITY - F-4 CLASS
- AIR-TO-GROUND MISSION RADIUS - F-4 CLASS
- RADAR FOR A/A AND A/G MISSIONS
- HIGH SURVIVABILITY BY INTEGRATION OF
  - INTERNAL ECM
  - LOW OBSERVABLES
  - HIGH MANEUVERABILITY AND PENETRATION SPEED

FIGURE 18

IV. DEFINITION OF THE LAVI CONFIGURATION

The operational requirements and the specifications established by the IAF led to the design ground rules of the LAVI.

The main role of the aircraft, as an air-to-ground fighter was instrumental in the aircraft definition. The operational requirements and specifications dictated the following design considerations:

(a) Priority in design for air-to-ground missions.

(b) Advanced high performance configuration

(c) Maximum commonality of the single and the two-seater versions.

I.A.I's accumulated experience in configuration design during 1971-1980 period, helped in the substantiation of the design of an aircraft with a high performance potential. Its design principles are presented in Figure 19.

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LAVI DESIGN CONCEPT

- DELTA-CANARD CONFIGURATION
- ALL MOVING CANARDS
- CHIN INLET
- BLENDED WING-BODY
- INHERENTLY UNSTABLE CONFIGURATION CONTROLLED BY A FLY-BY-WIRE SYSTEM
- MOST ADVANCED TECHNOLOGY ENGINE AVAILABLE

FIGURE 19

V. DESIGN PRINCIPLES

Delta Wing With Close Coupled Canard

Based on the experience of the KFIR and on earlier technical studies, a delta wing with close coupled canards was selected.

The canards were defined as all moving surfaces, as compared to the fixed mounted canards of the KFIR.

Chin Inlet

The LAVI high angle of attack performance requirements called for an inlet configuration that has the optimum performance in such a mode. The chin mounted inlet, typical of the F-16, was found to be the optimum selection considering the turbofan engines relative sensitivity to inlet induced distortions.

The inlet chosen was of the simple pitot type. Such a configuration is compatible with the maximum Mach number requirements of the aircraft.

Blended Wing-Body

The selected blended wing-body configuration has the following advantages:

(a) Decrease in friction drag due to reduced wetted area.
(b) Addition of volume which is always "missing" especially in a small aircraft.
(c) Structural weight reduction due to a more efficient wing to fuselage attachment.

Fly By Wire Flight Control System

The trimming and controlling of a delta wing-canard configuration is obtained mainly by deflection of the elevons of the wing.

The payoff of an unstable platform to this type of configuration is significant and relatively much higher than that of an aft tail configuration.

The performance improvement per 1% decrease in aircraft stability is approximately 1.5% for the maximum sustained turn rate, and 3 to 4% for the maximum instantaneous turn rate and take-off lift coefficient for a given angle of attack.

The Fly-By-Wire flight control system enables integrated and synchronized control surfaces deflection, yielding favorable aerodynamic characteristics especially for an aircraft with multi role requirements.

Advanced Aerodynamic Design

In order to meet the specification, yet keeping the size of the aircraft as small as possible, an optimized aerodynamic design approach was chosen. By fully exploiting the potential of the aerodynamic design, the aircraft performance can reach its highest achievable levels in the following aspects:

(a) Maximum instantaneous and sustained maneuvers.
(b) Transonic and supersonic acceleration.
(c) High low level penetration speeds at Mil. Power.

In order to meet such a wide range of requirements, a special effort was directed towards a balanced compromise between the zero-lift-drag, supersonic wave drag and optimization of transonic sustained maneuverability.

The optimal solution was a wing of the following characteristics.

- Aspect ratio of 2.25
- Leading-edge sweep angle of about 54°
- Three-dimensional geometrical definition of the wing (comprised of 50 different profiles).
- Control surfaces deflection scheduling according to the flight conditions (Mach number and angle of attack) and the external stores configuration (air-to-air or air-to-ground).

  The following control surfaces deflections are synchronized by the FCC (Flight Control Computer):

  * All movable canards
  * High authority leading edge flaps
  * Independent deflection of the inboard and outboard elevons.

  By means of those devices, improved air load distribution on the configuration was achieved, resulting in a very close to ideal lift-drag polar for a wide range of angle of attacks.
- Supersonic "area-ruled" geometrical design of the configuration, compatible with the supersonic performance requirements.

The LAVI incorporates a "double-waisted" fuselage, along the interfaces of both the canard and the wing with the fuselage.

Figure 20 summarizes the LAVI main aerodynamic features.

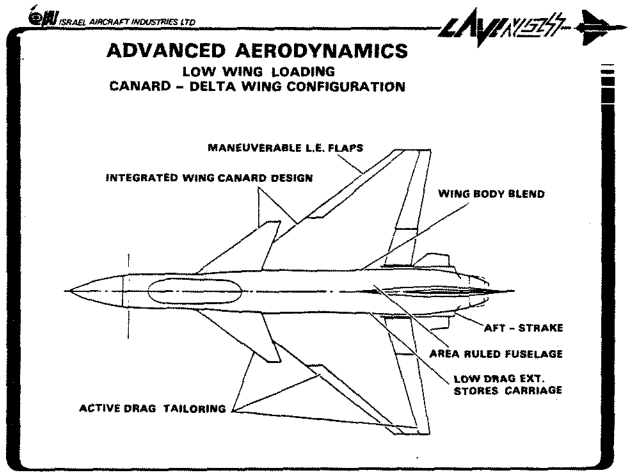

FIGURE 20

Advanced Engine

The first proposal for the LAVI, based on LO-33, incorporated the General Electric GE-F404 engine.

During the evaluation phase of the design, Pratt and Whitney submitted a proposal for an F-100 engine derivative, the PW-1120.

Figure 21 summarizes the characteristic parameters of those two engines, compared with the F-100 and the older technology GE-J79 engine.

The engine and its characteristics play a key role in the aircraft performance.

The PW-1120 engine was subsequently selected for the LAVI. The impact on the configuration is described below.

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ENGINE COMPARISON

	S.L.S. A/B MAX THRUST	S.L.S. S.F.C. A/B - INT	ENGINE WEIGHT	ENGINE T/W	AIR FLOW	LENGTH	MAX. DIAMETER
J79-J1E	17860 lb	1.97 1/HR 0.84	3835 lb	4.66	170 lb/sec	208.7 IN.	39.1 IN.
F100 PW100	23840 lb	2.17 0.72	3036	7.85	228	191.0	47.0
F404-GE-400	16090	1.85 0.800	2141	7.52	143	155.0	34.5
PW 1120	20640	1.86 0.8	2840	7.26	178	161.8	39.0

FIGURE 21

VI. AIR-TO-GROUND ORIENTED DESIGN

The F-16 and the F-18 fighter aircraft are derivatives of the YF-16 and the YF-17 respectively. Those aircraft designs were clearly oriented towards an air superiority role. Air-to-ground mission requirements were integrated into those aircraft, later in the F.S.D stage.

The LAVI fighter was designed form the beginning as an air-to-ground aircraft, meeting IAF's demanding operational requirements, in the following areas:

(a) Many different external stores configurations (bombs, missiles).

(b) Very large external payload (18,500 lbs)

(c) Long missions radii and loiter times

(d) High penetration speeds at Mil power with a full external payload.

The LAVI design met and even exceeded those requirements, owing to the incorporation of the following design features:

(a) Efficient wing design
(b) Integrated landing gear design
(c) Semi conformal external stores reduced drag
(d) Large external drop tanks
(e) Inclusion of moving canard surfaces in an inherently non stable configuration.

Efficient Wing Design

The following features as presented in Figure 22, were considered in the design of a wing compatible with the specified air-to-ground requirements:

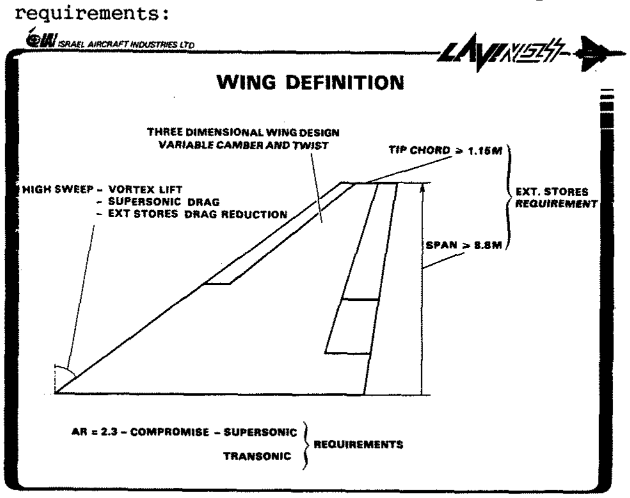

FIGURE 22

The Wing Tip Chord - Is 1.15 meter long in order to carry air-to-air missiles.

- Addition of wing tip missiles increases the effective aspect ratio and thus the aerodynamic efficiency of the wing.

- A large chord decreases the air flow separation on the outer wing, improving the drag polar.

- Tip missile has lower zero lift drag penalty compared to under-the-wing mounted missile.

- The wing-tip missile has a smaller influence on the center of pressure shift v/s an under the wing missile installation.

Wing Span - The 8.8 meter span enables sufficient distance between the store stations. Taking into account interference drag and safe external stores release, 1.2 to 1.25 meters was the recommended distance between two adjacent store stations.

Low Wing Position - The low wing position eliminates the interference drag between the inner wing store and the fuselage. Usually the inner wing store is a large size fuel tank which in the presence of an adjacent fuselage (as for a high or a mid wing position) results in higher interference drag.

Low wing position is also more efficient considering landing gear integration as described below.

Swept Leading Edge

- Swept leading edge lowers both the interference drag between the external stores, as well as the transonic wave-drag. This drag reduction is achieved due to the better "area-ruling" of the configuration.

This characteristic is very important considering the penetration speed requirements.

Wing Area - The area of the wing is an outcome of the above mentioned demands, as well as the wing loading (the latter is an outcome of the maneuver, take-off and landing requirements).

Landing Gear Integration

Generally, the main landing gear is either attached to:

(a) The fuselage (F-16, F-18, Mirage F-1)

(b) Or the wing (KFIR, MIRAGE 2000, F-4, F-5...)

Those designs enabled the carrying of large racks either under the wing or under the fuselage respectively.

The LAVI possesses a unique solution. The landing gear is attached and folded up into the "blend" between the wing and the fuselage. Thus enabling large external stores carriage capability under both the wing and the fuselage.

This feature is particularly important especially for a small size aircraft. Figure 23 depicts the different landing gear attachment solutions. The design adopted for the LAVI is possible only for a low wing design.

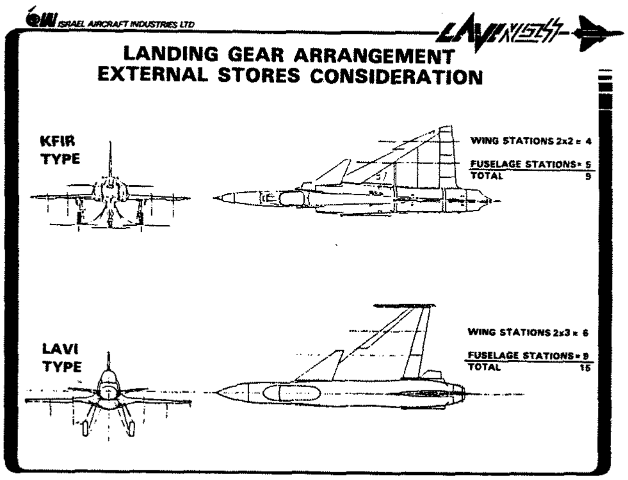

FIGURE 23

Semi Conformal External Stores Reduced Drag

The above solution for the landing gear attachment leaves a "clean" belly for external stores installation.

Figure 24 illustrates semi conformal carriage of six bombs in two rows, three bombs in a row, compared to a conventional carriage method as presented in Figure 25.

Figure 26 shows a relative gain in drag of 40% compared to conventional carriage.

External Fuel Tanks

In order to meet the mission radius requirements, relatively large external fuel tanks were incorporated.

Two 600 USG wing tanks and a 350 USG center line tank bring the external to internal fuel ratio to 1.7.

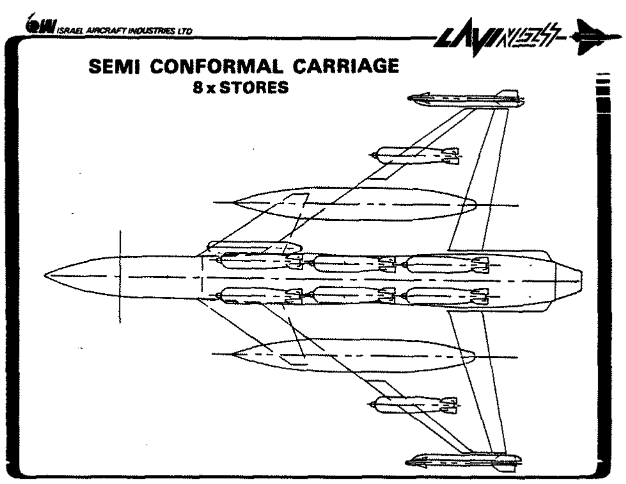

FIGURE 24

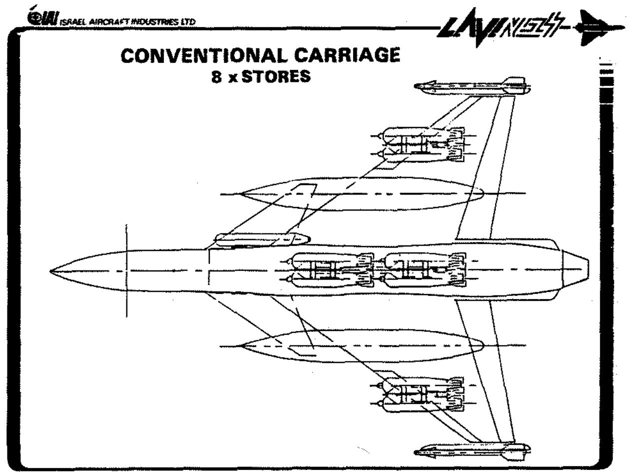

FIGURE 25

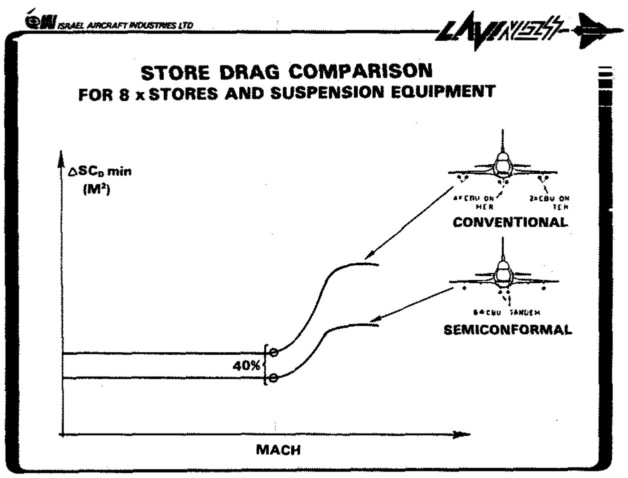

FIGURE 26

All Moving Canards

Figure 27 depicts the external stores stations arrangement of the LAVI.

Three stations under each wing and nine stations under the fuselage for total of 15 store stations.

The high number of store stations, affect the configuration characteristics due to:

(a) A wide range of center of gravity positions
(b) A wide range of center of pressure variation as a result of under the wing external stores.

Figure 28 presents the variation of those two parameters as a function of the external stores configurations.

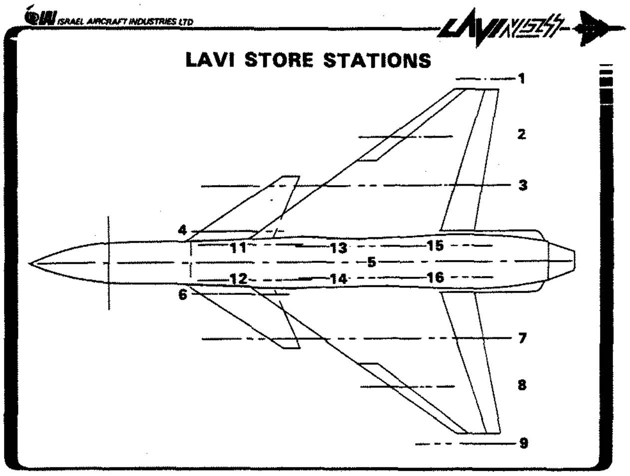

FIGURE 27

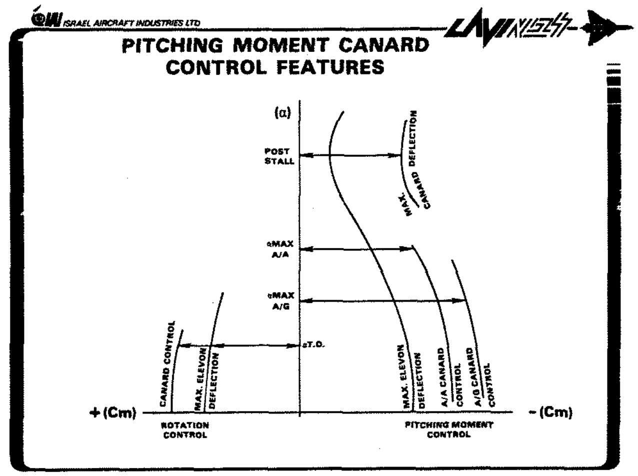

FIGURE 29

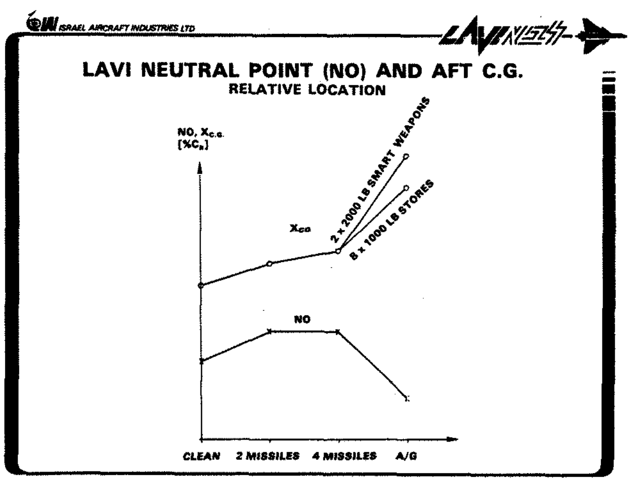

FIGURE 28

The flight control system has to cope with a wide range of (negative) stability margin variation.

The above presented situation dictates high control authority for:

(a) Pitch-down moment for aft c.g. locations - This requirement is critical especially for inherently unstable configuration.

(b) Pitch-up moment at rotation speeds prior to take-off.

This is necessary in order to exploit the takeoff performance mainly for heavy and for forward c.g. configurations.

Figure 29 presents the rotating canard additional relative pitching moment for aft c.g. location and for take off rotation, compared with the conventional only-elevons capability.

VII ENGINE SELECTION FOR LAVI

The basic LAVI was based on the GE-F404 engine. The general arrangement of this configuration is presented in Figure 30.

This configuration evolved from the basic LO-33 configuration presented in Figure 31.

The PW-1120 engine, the characteristics of which were shown in Figure 21, was more suited to the specifications defined by I.A.F. Figure 32 compares the silhouettes of the two engines.

Figure 33 relates to the general arrangement of the configuration based on PW-1120.

Figure 34 compares the geometrical sizes of the two configurations, whereas Figure 35 compares their characteristic parameters.

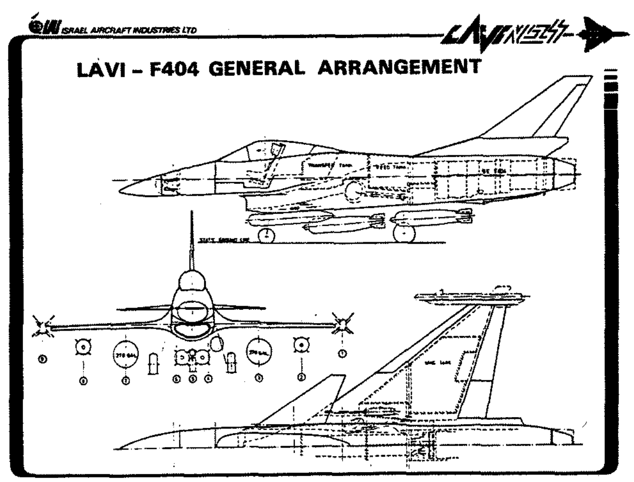

FIGURE 30

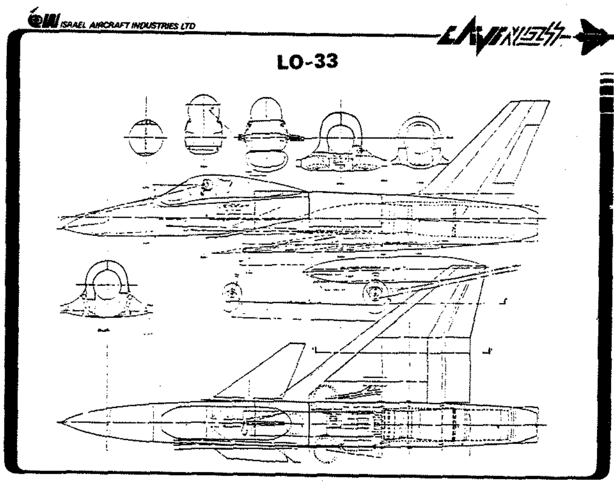

FIGURE 31

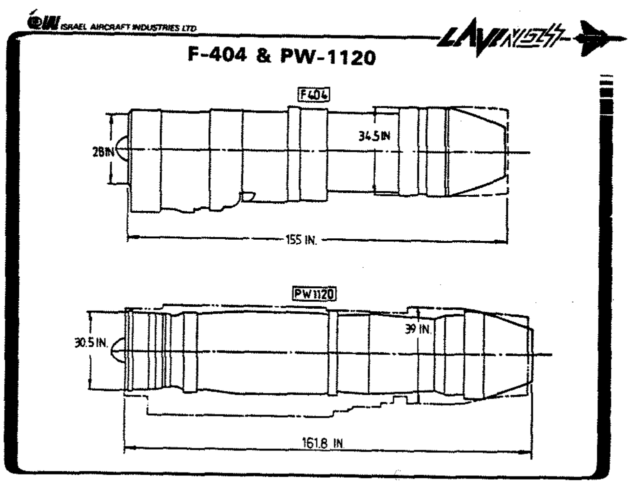

FIGURE 32

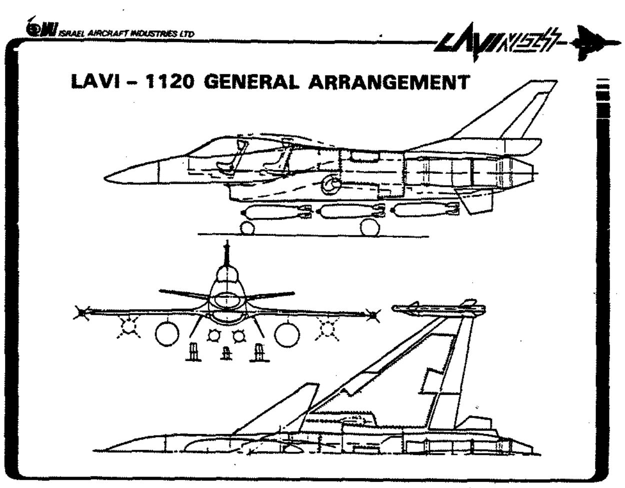

FIGURE 33

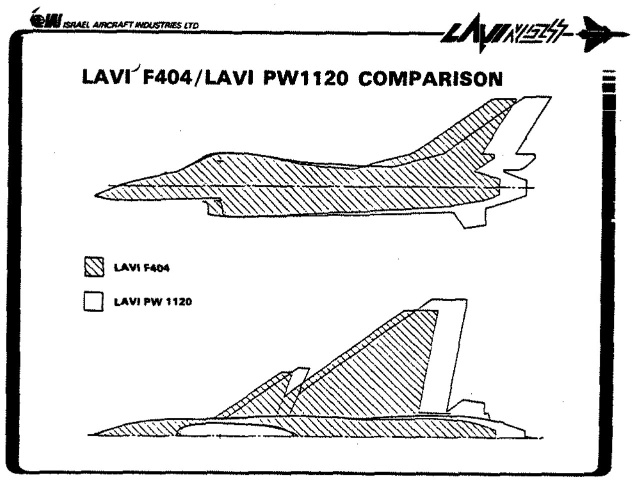

FIGURE 34

LAVI CONFIGURATIONS COMPARISON

	LAVI/1120	LAVI/F404
EMPTY WEIGHT	1.15	1
INTERNAL FUEL	1.22	1
FULL CLEAN	1.17	1
MAX. TAKE-OFF	1.29	1
MAX. PAYLOAD	1.46	1
AVIONICS WEIGHT	1.5	1
WING AREA	1.2	1
WING SPAN	1.09	1
ENGINE	PW-1120	GE-F404 - TUNED A
MAX A/B THRUST	1.22	1
MILITARY THRUST	1.20	1

FIGURE 35

Incorporation of a higher thrust engine enabled the following improvements:

(a) Increased maximum takeoff weight, thus, increasing maximum external store carriage capability.

(b) Significantly larger avionics package.

(c) Larger wing area and span thus permitting larger & heavier stores especially on the outboard wing station.

(d) Longer fuselage, permitting easier integration of the semi-conformal fuselage mounted stores.

(e) Utilizing the basic core engine of the PW-F100 results in a relatively high Mil power thrust and high penetration speeds.

VIII. ADDITIONAL CONFIGURATION CONSIDERATIONS

In parallel to the definition process of the LAVI aircraft, additional configurations options were investigated.

The additional concepts evaluated, included:

(a) Aerodynamic variations

(b) Possible cooperation with US partners

Aerodynamic Variations

Two additional concepts were investigated:

(a) Twin Inlet Configuration (LAVI-5X) shown in Figure 36.

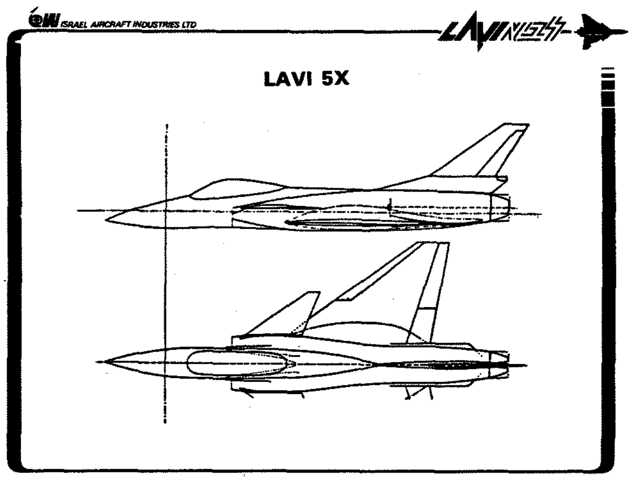

FIGURE 36

This configuration is based on low fuselage-position pitot type side inlets rather than the center line "chin" inlet of the LAVI.

This configuration was defined and wind-tunnel tested for compatibility with the operational requirements.

The basic aerodynamic characteristics of this option were fairly similar to the chosen design. This design indicated a slightly better under-fuselage external stores carriage capability.

However, inferior basic inlet characteristics and weight penalty compared to the chin inlet configuration precluded continuation of this direction.

(b) Configuration "TB" -

The nominal LAVI aircraft features a fuselage mounted single vertical stabilizer, resulting in limited high angle of attack directional stability.

In order to improve this limitation, a tail-boom configuration as presented in Figure 37 was investigated.

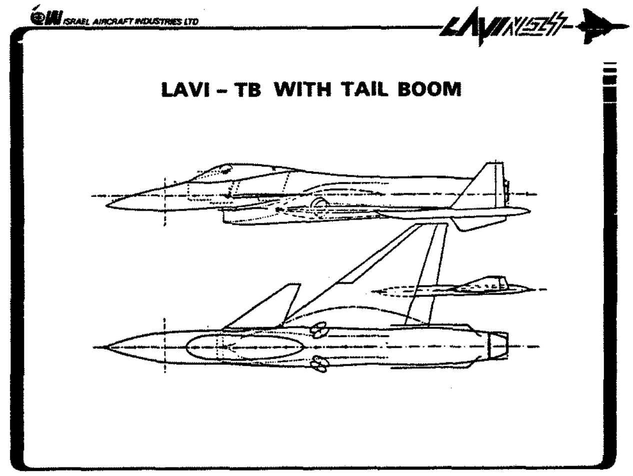

FIGURE 37

In this version, a pair of vertical stabilizers were located on booms emerging from the trailing edge of the wings. In this position, the stabilizers are in the free air-stream especially at high angle of attack, thus, improving directional stability. This was clearly demonstrated by wind-tunnel tests.

Figure 38 compares the low - speed stability characteristics of both the nominal and the tail-boom option.

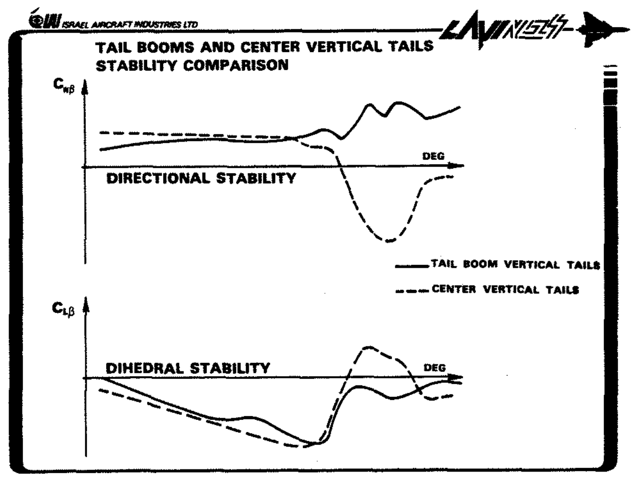

FIGURE 38

Development risk considerations mainly in the structural aspects, as well as the tight schedule of the LAVI program, precluded further investigation of this otherwise promising configuration.

IX. COMPATIBILITY OF THE AIRCRAFT WITH THE OPERATIONAL REQUIREMENTS

The design concepts briefly presented above converged into an advanced fighter aircraft with exceptional air-to-ground and excellent air-to-air capability.

Figure 39 presents the LAVI final configuration basic characteristics as frozen at the end of 1982.

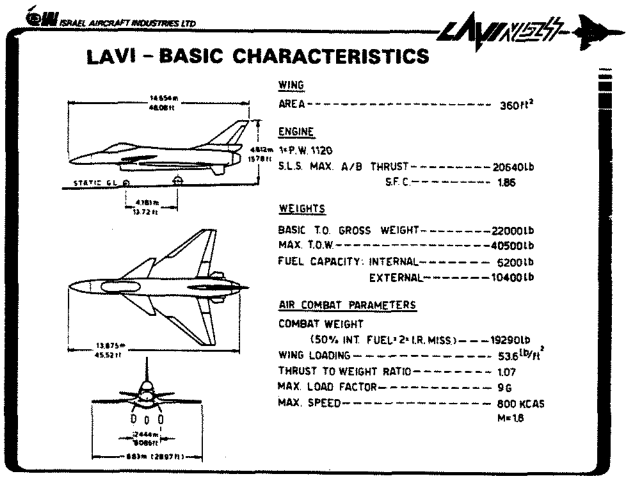

FIGURE 39

The following Figures summarize the aircraft relative capability compared with other fighter aircraft:

Figure 40 presents mission radii of a "8x1000lb bombs" arrangement in a typical ground attack mission profile. Also indicative is the dry engine relative penetration speed.

LAVI configuration arrangement for this mission is presented in Figure 41.

Figure 42 compares the mission radii for a similar mission profile with "2x2000 lb bombs" payload.

Figure 43 presents patrol time in a typical combat air patrol mission.

Figure 44 compares the instantaneous and the sustained turn rates of these aircraft, for "4XSRM" combat configurations (with 50% internal fuel).

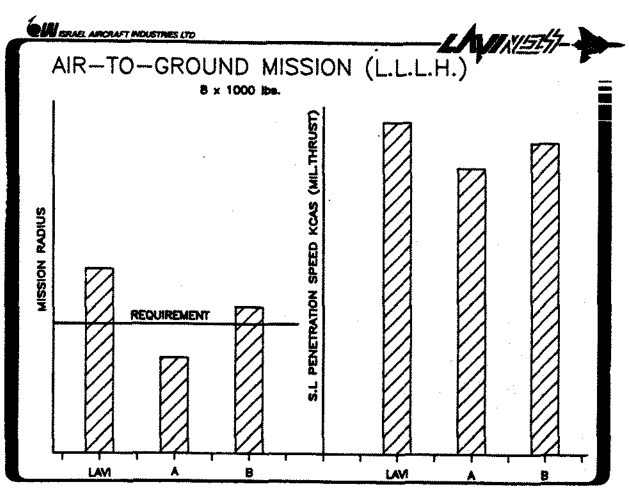

FIGURE 40

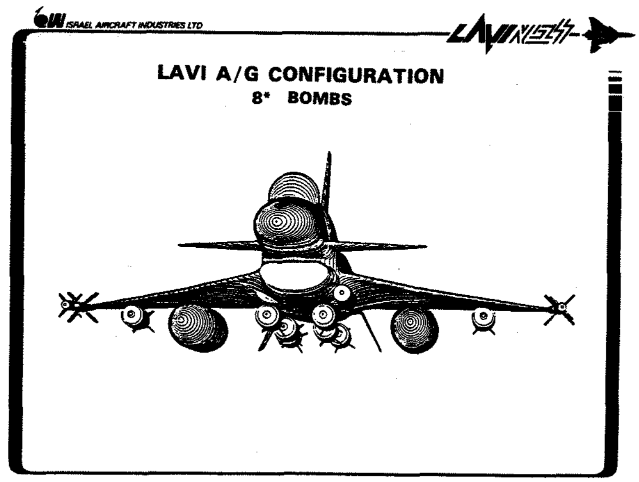

FIGURE 41

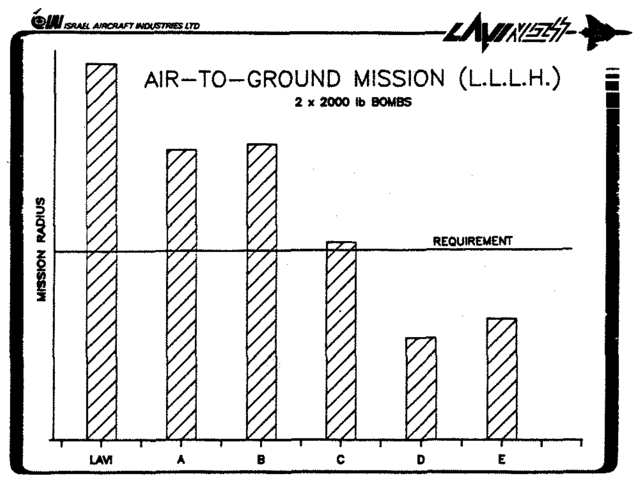

FIGURE 42

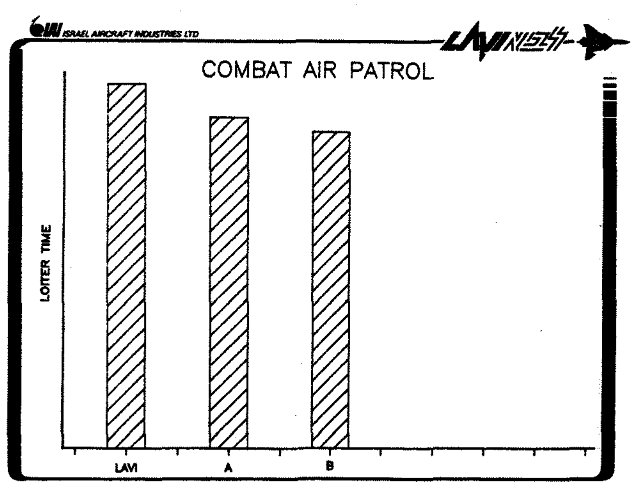

FIGURE 43

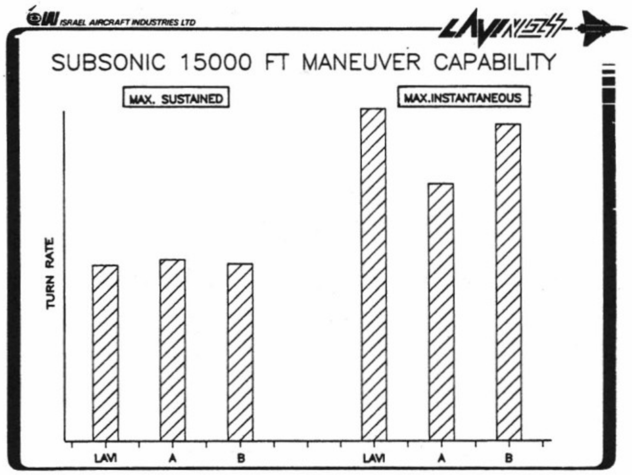

FIGURE 44

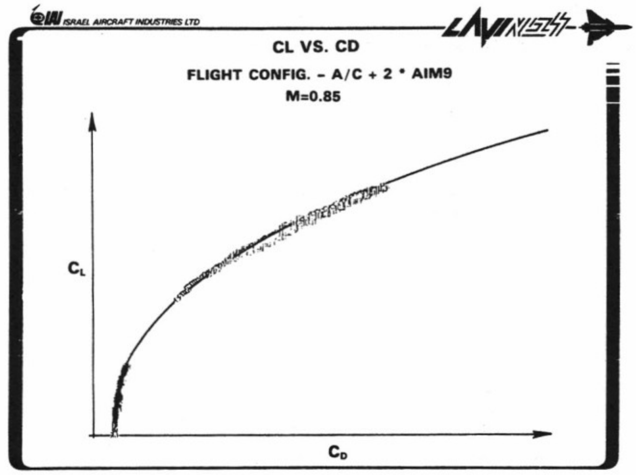

FIGURE 46

The performance figures for LAVI are based on wind-tunnel tests and preliminary flight test results.

The flight tests of the LAVI basic configuration confirmed most of the aero data base.

Figures 45 and 46 withdrawn form flight test data present the estimated lift drag polars, compared with flight test results.

Figures 47 and 48 present LAVI first P/T after T/O and prototypes in flight.

FIGURE 47

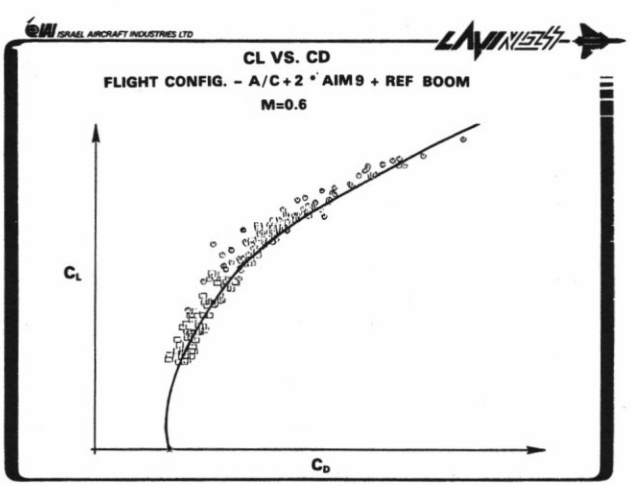

FIGURE 45

FIGURE 48

X. SUMMARY

The development of the LAVI indicated that by following sound design principles and utilizing state of the art technologies, even the most demanding operational requirements can be met.

The integrated design included a delta wing with close coupled moving canards, an inherently unstable configuration stabilized by a digital Fly-By-Wire control system. A very large external stores capability and an advanced engine. Those features and technologies, coupled to an advanced avionics package, sum up to an integrated weapon system.

The result is a relatively small aircraft, that can challenge larger sized more complex and expensive weapon systems.

Acknowledgements

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