KOREAN AEROSPACE INDUSTRY AND T-50 ADVANCED TRAINER

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Overview

Although Korea is not well known as an aerospace nation, Korea has actively pursued this field with strong determination and support from government and private sector. With growing deficit and imbalance of civil vs. military programs and productions, Koran government has consciously pursued more sophisticated aerospace programs. The culmination of this long-term, national strategy is the development of the T-50 Total Training System, including the T-50 Golden Eagle Aircraft and the related training system. In this paper, I present the status of Korea's aerospace industries and capabilities and further present more detail about the T-50 program.

1. Korean Aerospace Industries

1.1. Status of Korean Aerospace Industries

Despite the world's 12th largest economy, the aerospace industry is still relatively small compared to other known industrial sector in Korea. Korean Aerospace Industries has recorded the total turnover of U$ 4.6 billion in 2006, up 40% from the year before. This increase is mainly due to the expansion of aerostructure works and T-50 program entering the serial production delivery. The KHP program and continuous increase of the commercial aerostructure works, the domestic turnover was around U$ 1.5 billion. (Table 1).

Table 1. Total Business Volume (U$ mil.)

	2004	2005	2006
Domestic Production	1,187	1,398	1,515
Imports	1,410	1,902	3,118
Total	2,597	3,300	4,633
Domestic Demand	2,226	2,911	4,161
Exports	371	389	472

Table 1 also shows that Korea supplies most of its aerospace requirement from imports, and there is large disparity between imports and exports. However, with the increase of commercial aerostructure with more active participation in the new Airbus and Boeing programs and prospects of military trainer aircraft sales oversea, this disparity is expected to decrease.
But the dependency in the military program (see Table 2) is a continuing issue as most of the military programs are quite cyclic and keeping the nations resources, especially the technologies and human powers, at a sustainable rate is quite challenging.

Table 2. Civil vs. Military Production (U$ mil.)

	2005	2006	2007(exp.)
Miliatry	1,129	1,174	1,408
Civil	269	341	429
Total	1,398	1,515	1,837

Table 2 shows that over 80% of domestic production is in the military side thus heavy dependency in the defense programs.

Most of the domestic products are in the aircraft sector with complete aircraft production turn out is increasing steadily. Space launch and satellite programs are still quite small (Table 3.) The ratio between aircraft and space programs are 98:2. However, Korean government is also expanding space related programs with its KOMPSAT programs and construction of space launch facilities in Oeinaro island complex.

Table 3. Product Breakdown (U$ mil.)

		2004	2005	2006
Aero	A/C	518	577	637
	Structure	235	261	317
	Engine	2,873	64	405
	Avionics	67	68	51
	Subsys.	53	74	71
	Material	3	3	3
Total		1,163	1,247	1,484
Space	Vehicle	11	4	5
	Satellite	13	47	26
Total		24	51	31
Grand Total		1,187	1,398	1,515

Nevertheless, aerospace sector is still one of the largest trade deficit fields for Korea. In 2006, the total trade deficit in the aerospace was over U$ 2.2 billion (import U$ 3.1 billion with U$ 892 million export.) This deficit is growing as rapidly as the growing demand of aerospace equipments increases. With annual spending of over U$ 800 million in military aircraft import and over U$ 300 million on aircraft leasing, the overall trade deficit each year is exceeding U$ 3

billion. With less degree of vertically integrated industry structure in the aerospace, this trend will most likely keep increasing with further demand on material and subsystems for complete aircraft production and export.

There are also some brighter aspects as Korean aerospace industries continuing to secure its works with new orders in 2006 of U$ 4.6 billion, 18% increase over 2005. Total backlog of 2006 also rose 51% over 2005 with U$ 9.2 billion. Increased participation of Korean industries in the international programs such as B787 and A350, and the serial production of T-50, new development program such as KHP all attribute to this increase of order and backlog.

The continuous success of the KT-1 and T-50 in the international market will certainly be the main stream of Korea's aerospace export for many years to come and it is expected that these programs will change the positioning of Korea in the international aerospace sector.

Total aerospace investment in 2006 was U$ 790 million, 62% increase over 2005. The increase of this investment is mainly for participation of the international risk sharing programs and facility and equipment investment for the KHP program. The increase in the area of R&D investment also continues due to, again, the technology development for the international risk sharing programs and export version aircraft development.

There are total of 7,152 people working in the aerospace sector in Korea and this is the same level of human resources that Korean maintained for past several years. However, in order to continue major development programs that are in the pipeline, there is a continuous need for highly trained, educated, personnel in many government and private sector facilities. (See table 4.)

Table 4. Aerospace Man-power

	2004	2005	2006
Ph.D	106	108	105
M.S.	720	700	746
B.S.	2,715	2,000	2,737
Others	3,761	3,577	3,564
Total	7,302	7,000	7,152

1.2. Aerospace as National Strategic Industries

As it is shown in the status of the Korean aerospace industries, there are several issues that are continuing problems and requires remedies through nation's long term strategy and planning.

- Need to improve trade deficit
- Need to sustain its technology and man-power base
- Need to have better balance between civil and military programs
- Need to have emphasis on system integration and high value added programs
- Need to upgrade from built-to-print to design and development programs

Korea aerospace industries has followed a very typical aerospace industry development path. During 1960's Korea's aerospace was barely in existence supporting air force's requirement of support and maintenance, albeit done mostly by military and civil airline companies. With more military equipment import, Korea adopted strict direct and in-direct offset policies that would secure steadily increasing aerospace participation from Korean side, especially with the knoc-down assembly of F-5's and UH-60.

1.3. Aerospace as National Strategic Industries

Korea Aerospace Industries, Ltd. (KAI) was formed in 1999 through consolidation of three major aerospace interests; Samsung Techwin, Daewoo Heavy Industries, and Hyundai Space and Aircraft companies. Although the combined business strength of these three commercial giants are huge, the size of the market and duplicate investment and personnel called for an industry wide restructuring. Thus, KAI was born with consolidation of all the facilities, personnel and programs into one.

Figure 1. Korea Aerospace Industries

The Korean government also enticed this consolidation with strong support and incentive to make the KAI as an exclusive aerospace industry to carry out most of government

programs and industry development plan. Today, KAI, with its 2,800 personnel is the single aerospace system integrator with diverse aerospace programs ranging from fixed-wing (KT-1, T-50, UAV), rotary wing (KHP), aerostructure, and space programs (See Figure 1.)

KFP (Korea Fighter Program) was a monumental program where ROKAF decided to purchase KF-16, Block 52 F-16's through license program where a Korean company is to assume the responsibility of the prime contractor. Through this program, Korea was able to attain and secure, program management, production, mate-through-delivery, including supplier chain management. An offset program from this KFP was the conceptual design of a new aircraft development program, that has now become the T-50 program.

With the T-50 program, Korea has finally achieved most of its technological and industrial structure that it wanted. Air Force managed, industry developed program of T-50 produced the most successful advanced trainer aircraft of our generation.

2. T-50 Advanced Trainer Aircraft

2.1. T-50 Meets the New Training Requirment

Despite ever increasing sophistication and demands on fighter pilots for operating current and future front-line fighters, most of the current trainers are of obsolete technology, which creates a performance/skill gap for trainees. Specifically, these aircrafts cannot provide the appropriate skill level for $4^{th}/5^{th}$ generation fighters. Therefore, additional training on Operational Conversion Units (OCU) is needed, which is quite costly and time consuming.

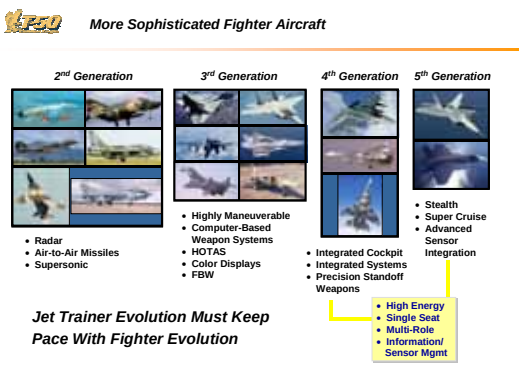

Figure 2. New Fighters Demand More

This gap is covered by the T-50, with the Air Force of Korea (ROKAF) managing the T-50 program, defining requirements, conducting flight tests and providing subject matter experts. KAI is the prime contractor and is responsible for the design and integration, manufacturing of major components and mate-thru-delivery of the T-50. Lockheed Martin is the primary sub-contractor, responsible for development of the FBW flight control system and the wings. The T-50 International (TFI) is responsible for worldwide marketing and sales of T-50.

2.2. T-50 as Total Training System

The Total Training System includes the aircraft, the Ground-Based Training System (GBTS) and the Integrated Logistics Support, and their developments have been completed with the U$ 2 billion, 8 year Full Scale Development (FSD) program. The general characteristics of the T-50: MTOGW 29,700 lb (13.472 kg), Empty Weight 14,200 lb (6,441 kg), Internal Fuel 4,860 lb (2,204 kg), Service Ceiling(Mil) 49,000 ft and Max. 55,000 ft, Max R/C 39,600ft/min, Max, Mach 1.5 and g-Limit -3/+8g. The speaker said that the aircraft has a look and feel of Frontline Fighters.

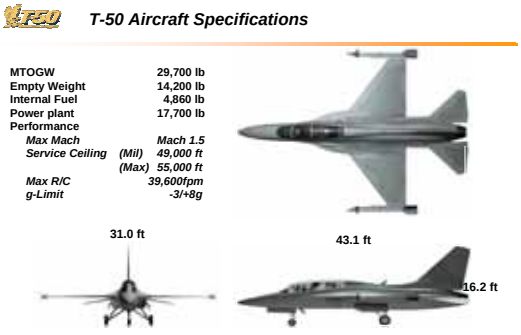

Figure 3. T-50 Aircraft Specification

The aircraft design concept includes wing/body blend of variable camber wings, LERX, digital flight controls, modern fighter-like cockpit, modern avionics and Com/ Nav / IFF systems, seven store stations, on-board oxygen generating systems, (OBOGS), and the F404-GE-102 engine of max thrust 17,700 lb (78.8 kN). The LIFT version also includes the APG-67(V)4 radar, an internal 22mm gun and the possibility of incorporating a wide range of weapons.

T-50's performance diagrams show that the wide performance envelope provides unparalleled flexibility to perform a wide variety of training missions, while high performance and stability

can close the gap between basic trainer and frontline fighter. Also, the T-50 exhibits excellent energy management characteristics. There are strong resemblance of the cockpit to the advanced F-16 Block 50/52 cockpit, with three color displays MFD 5x7 in (12.7x17.8 cm), instead of two 5x5in of T-50 of ROKAF.

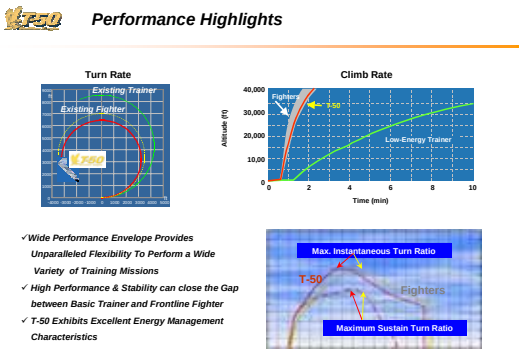

Figure 4. T-50 Performance Highlights

In reference to its operability, the digital flight control system has a care-free-fly-by-wire, active coupled sticks and lots of safety features for the trainer. Specifically, it includes over-rotation prevention in the takeoff phase, AoA/g limiter and entry mode for student pilots in the maneuvering phase, while at high AoA maneuvering it is extremely departure resistant and is easily recovered from intentional departure. The T-50 offers secure landing with cross winds over 25 kts and outstanding low speed handling qualities, at 131 kts.

The avionics of the aircraft T-50 supports the full spectrum of fighter pilot training with its service life is over 10,000 hrs. The specific training packages include the mission planning and debriefing systems, the data transmission to the aircraft and the Enhanced Embedded Training System (EETS) of the T-50. The EETS consists of Sensor Radar Simulation, Weapon Simulation and Scoring, Target/Threat Simulation, Digital Moving Map & Digital Terrain System and In-Flight Video Playback.

T-50 is also developed with full weapons certification in both air to air and air to ground capabilities, enabling T-50 be used as a dual role aircraft with light attack capabilities.

The maximum weapons carriage load is 10,500 lb (4,763 kg) and it can include missiles AIM-9 at the end of the wings, 4 missiles AGM-65 Maverick and 5 bombs Mk82/83/84, units Mk20 and CBU-58, rockets LAU-3/68/131, training pods SUU-20 and AGTS-35, and 3 external fuel tanks of 568 liters. The T-50 can have a range of 220 nautical miles range for CAS missions, with loiter time of 124 min out of 150NM range for CAP missions.

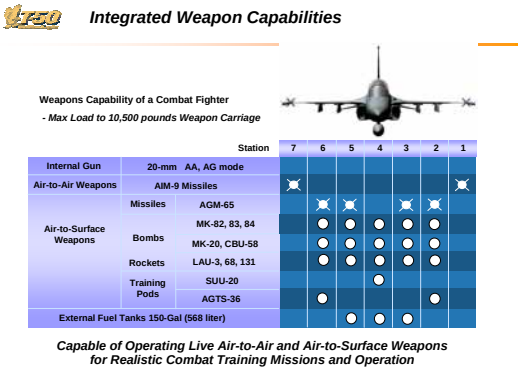

Figure 5. T-50's Integrated Weapon Capabilities

The full scale development (FSD) program of the T-50 was completed in December 2005. In total, 4 flight test aircrafts flew 1,411 sorties, while 2 ground test aircrafts completed static loads testing and second lifetime durability tests, successfully. The initial order was for 25 aircrafts for ROKAF, amended in December 2003, followed by the second batch order in October 2006 for 47 aircrafts. Deliveries have reached 17 aircrafts, while 6 are to follow this year. Further contracts will follow for the complete development of the F/A-50 and the procurement of 60 aircrafts of this version, and an additional 10 T-50 for the acrobatic fleet. The total commitment of ROKAF is for more than 140 aircrafts. In the meantime, T-50 has entered the IOC (initial operation capability) training at Gwang-Ju Base of ROKAF.

First student squadron entered the training in February 2007 with flawless training being done with the expected graduation in November.
The initial result of the training is amazing with high degree of training effectiveness. Students are showing early adaptation of the flight, entering much earlier first flight and solo flight training in the air. The training base includes electronic classrooms, simulators, and training of instructor pilots and maintenance training.

2.3. T-50 as the Most Effective Training System

Compare to the legacy trainer, or any new subsonic/transonic trainer aircraft, the high energy T-50 trainer can attain the highest training effectiveness with significant reduction of training time and flight sorties (see Figure 6.)

T-50'capabilities for energy management, realistic cockpit and machine-man interface,

information management and mostly sufficient flight skills enables any air force in the world to streamline with one platform aircraft for all advanced jet, fighter-lead-in and OCU download training.

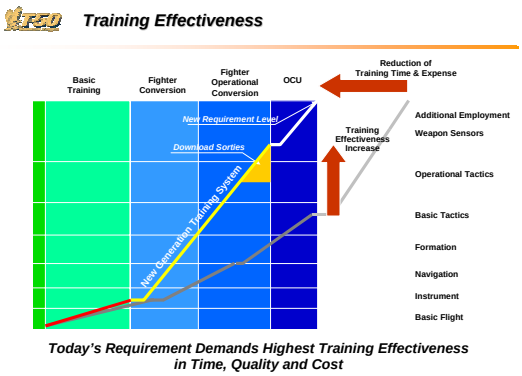

Figure 6. T-50 as the most Effective Training System.

3. Conclusion

T-50 program is the culmination of Korea's long-term strategic plan for the establishment Korean indigenous aerospace capabilities. With the program, Korea was able to establish overall aircraft design and system integration, complex program management, more vertically integrated domestic supplier chain. And mostly, with a product that would be exportable in the world market place.

T-50 is the only new generation Total Training System available today. There are over 3,000 advanced jet/LIFT and light attack aircraft requirement in the world for next 30 years. The T-50 is poised as the most capable and highly effective trainer aircraft to meet this market demand. T-50 is and will be the most important aerospace program for Korea for many years to come.