CP-602

TECHNOLOGY - SOLUTION FOR THE NEXT GENERATION OF AFFORDABLE STRIKE FIGHTERS

Frederic C. Schwartz
Technical Director
Joint Strike Fighter Program Office
1745, Jefferson Davis Highway
Suite 307
Arlington, Virginia 22202, USA

SUMMARY

An essential element of the Joint Strike Fighter Program is the specific application of technologies to significantly reduce the life cycle cost of the weapon system. The strategy is to aggressively attack those attributes and features, which are high cost drivers for a strike fighter weapon system through various innovative approaches. The Joint Strike Fighter Program has addressed this by: 1) Identifying those specific features and characteristics which are high cost drivers so that one can apply scarce resources to the most leveraging attributes; 2) applying the Strategy-to-Task-to-Technology methodology and Quality, Function and Deployment(QFD) analysis to logically prioritize investment strategies; 3) identifying and leveraging opportunities for common technology demonstrations which apply to multiple weapon system concepts and 4) coordinating activities across the various Science and Technology(S&T) communities to target significant life cycle cost drivers for strike fighter platforms. (Key words: Joint Strike Fighter, JSF, Technology Maturation, Affordability.)

WHY THE JOINT STRIKE FIGHTER

In 1993, the Secretary of Defense, through the Bottom-Up Review process acknowledged the Services' need for an affordable solution to the aging strike fighter fleet. He also declared that the separate services solutions to this dilemma- the Navy Advanced Attack Fighter (AF/X) and the Air Force Multi-Role Fighter (MRF) programs were unaffordable and a joint solution must be found. Thus in Jan. 1994 the Joint Advanced Strike Technology (JAST) program was formally chartered to pursue advanced technology applications for future strike weapons systems. To further complicate the technology challenges facing JAST, Congress legislated in FY1995 the merging of the Defense Advanced Research Projects Agency (DARPA) Advanced Short Take-Off and Vertical Landing (ASTOVL) program with the JAST program. Just prior to entering the Concept Demonstration Program, the JAST Program was renamed to the Joint Strike Fighter (JSF) Program to reflect transition from a technology to a weapon system development program. In May 1996, the JAST Program was designated a major acquisition program.

ACQUISITION REFORMS

Numerous studies and commissions have been chartered to examine methods to improve the acquisition process. The 1986 Packard Commission highlighted areas that have become the foundation for the way the JSF program conducts its business. Key to a number of those recommendations is the focused application of technologies to achieve affordable solutions:

- Get the warfighters and technologist together to enable leveraging cost-performance trades.
- Apply technology to lower cost of the systems, not just to increase performance.
- Adequately mature technology prior to the start of engineering and manufacturing development (E&MD).

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- Ensure that the solutions are joint.

- Instigate and catalogue acquisition reform.

Another key to ensuring proper application of scarce resources to leveraging technologies is the application of the strategy-to-task-to-technology (S-T-T) process supported by Quality, Function, and Deployment (QFD) analysis (figure 1). The STT, a top-down process, maps the relationships between the joint strike warfighting objectives, operational tasks, weapon system attributes and technology needs

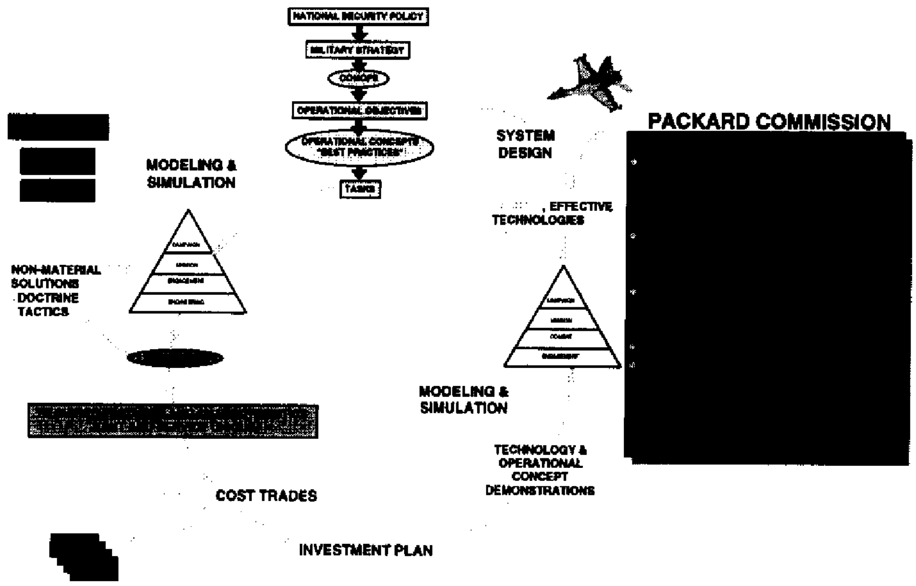

Figure 1 Strategy-to-task-to-technology process

In addition, the STT process quantifies the relative strength of the above relationships so as to identify: leveraging operational objectives and tasks; key weapon system attributes; leveraging technology areas and potential future trade areas. The JSF STT analysis established explicit linkage between the strike "warfighter" needs and technology needs. The JSF Program Office then employed the Quality, Function, Deployment (QFD), a McDonnell Douglas Corporation developed analytical tool, for prioritizing potential solutions to the services' needs. QFD is a multivariant analysis technique to aid in the decision making process. It also provides a method of bookkeeping ideas, definitions and evaluations of relationships between desires and suggested solutions. It also provides a means of auditing the progress toward a set of solutions and method for determining why a potential solution is preferred. The STT analysis in combination with the QFD flowdown provides products at every level, which aid the program in prioritizing and formulating technology maturation strategies. By using these tools you provide a technology investment "stack-up" regarding their relative contributions to affordability- the balance between sustained operational effectiveness and reduced life cycle cost.

An important tool for assisting the JSF technology investment strategy is the weapon system Life Cycle Cost (LCC) components chart (figure 2) which identifies which elements of LCC contribute the largest percentage to the total life cycle cost. The LCC components represent recent historical data on the F-22, B-2, F-15E, and the F/A-18 C/D, E/F.

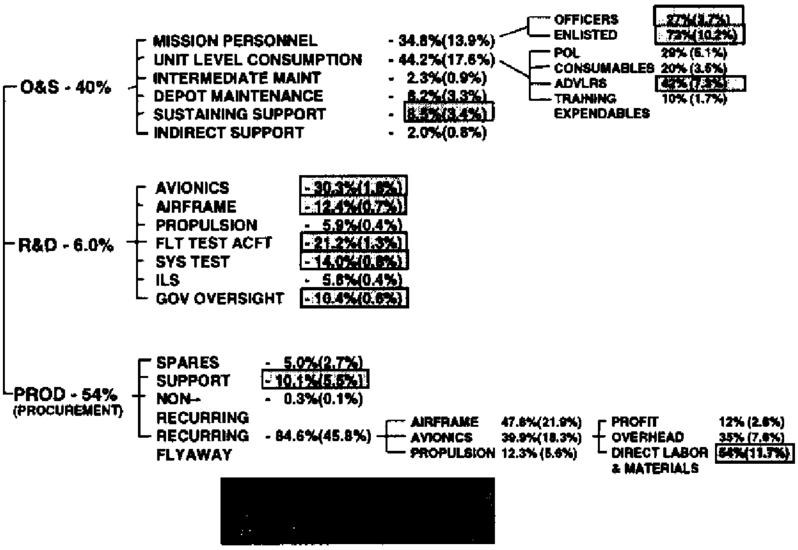

Figure 2 Historical Fighter Aircraft Life Cycle "Components"

Recent development /production programs have been characterized by low procurement quantities and rates, stealth technology and increased technical sophistication. The combination has resulted in the procurement costs representing 58% of the total weapon system LCC, with Research and Development costs rising to 15% and Operations and Support representing the remaining 27%. Armed with this information, the JSF program has targeted its scare resources at those areas/components which are very leveraging for reducing the overall Life Cycle Cost of the weapon system and not chase those technologies which did not show a major contribution to reducing the services' cost of ownership.

TECHNOLOGY MATURATION

The JSF technology maturation process is based on identifying high-leveraging technology initiatives and associated demonstrations, which meet the following criteria:

1. The technology must clearly have the potential of reducing the cost of ownership for a future strike fighter system and be targeted at a principal life cycle element. Savings goals must be established and a credible path for documenting those savings must exist.

2. The JSF program is not in the business to develop technology but build on existing technologies. The program goal is to mature those leveraging technologies through additional demonstrations such that it may be transitioned to E&MD at low risk.

3. Commonality and modularity provides significant savings when attempting to meet all the services needs and needs to be addressed up front in the design process. Also, todays' manufacturing capabilities provide significant cost savings through cost commonality.

4. Technologies not yet mature enough to make the low risk entry into E&MD, yet have the potential to significantly reduce cost of ownership, may be candidates for future upgrades to JSF and will be addressed in the overall architecture of the weapon system.

The maturation process consists of appropriate demonstrations to validate the functional, performance, and LCC impacts of the selected technologies. The process occurs at the component, subsystem, and system level through modeling, simulations, ground and flying testbeds and concept demonstration aircraft. The following is a synopsis of a select number of the technical maturation projects which offer the potential to significantly lower the cost of ownership of the next generation strike fighter weapon system.

Structures, Materials and Manufacturing:

Advanced Lightweight Aircraft Fuselage Structure (ALAFS)

This project is focused on identifying and developing concepts, methods and procedures that will facilitate much greater structural integration of both composites and metallics. Traditionally, aircraft design practices are based on the use and application of metallic and monolithic materials with the resulting design being composed of a large number of sub-components and sub-assemblies which then must be fastened together to form larger airframe structure. This is a multiyear project involved in taking the F/A-18E/F center fuselage-wing section and conducting a "clean sheet" design effort exploring new methodologies to significantly reduce part count, structural weight and life cycle costs and minimize fatigue and corrosion potential. The overall goals of the program are to demonstrate a 30% reduction in cost, 20% reduction in weights, which translates into approximately a 6-8% reduction in cost of ownership.

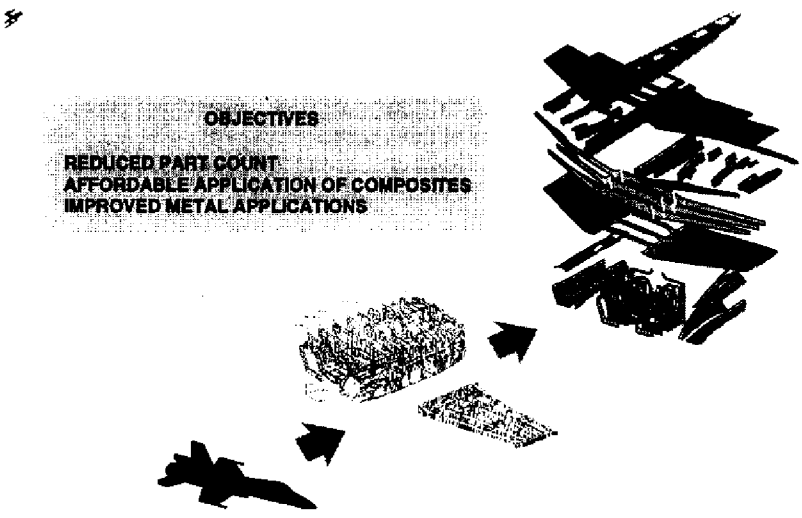

Figure 3 Advanced Lightweight Aircraft Fuselage Structure (ALAFS)

Composite Affordability Initiative (CAI)

CAI is a joint government-industry initiative focused on improving affordability through the increased use of composites in aircraft design. This initiative is composed of three components: A "fast track" demonstration, a technology transition component, and a pervasive technology effort. The fast track effort is targeted to demonstrate composite design and manufacturing concepts that offer break through in both cost and weight by increasing the structural fraction of composites in fighter airframes. The demonstrations will consist of both a ground structural demonstration and a flying demonstrator. The technology transition component is focused on demonstrating and transitioning high risk, high payoff "proprietary" composite solutions into the competing JSF designs. The pervasive technology efforts address common composite affordability issues facing the Industry. It focuses on maturing composite designs, materials, tools, processes and assembly technologies essential to implementing significant advances in composite applications.

Lean Manufacturing

JSF is leveraging the work coming out of the Lean Aircraft Initiative sponsored by AF Wright Laboratory, Industry and academia. The initiative is focused on research which will lead to fundamental changes to the way the aircraft defense industry manufactures weapon systems. Products of this initiative will include best manufacturing practices, techniques for employing just-in-time inventory, manufacturing tools which significantly reduce variability and early identification of improved manufacturing processes. The overall goal is to convert the US aerospace industry into a "lean enterprise" the way of the automobile industry.

Manufacturing Tools

The JSF program is evaluating and funding a number of demonstrations of various "virtual" manufacturing initiatives, which show promise in addressing affordability. Virtual design, manufacturing, assembly and checkout provide a synthetic environment to evaluate producibility, production capacity, risks and insertion of new technologies and processes at a relatively modest investment. Reduction in cost of design, increased production flexibility, reduced inventory and reduced recurring product costs are potential benefits from application of these tools.

JSF Integrated Subsystems Technology (J/IST)

The J/IST program is focused on demonstrating the feasibility and affordability of an integrated suite of subsystems to dramatically lower the weight, parts count, and improve efficiency of the current-technology subsystems. The specific subsystem technology areas are the aircraft electrical systems, auxiliary power, cooling, hydraulics, flight control actuators and other aircraft utility functions. The expected LCC savings of J/IST are projected to be 4% relative to an F-22 like subsystem technologies and up to 12% relative to F-16. The two principle components of the integrated subsystems concepts are the airframe-mounted Thermal/Energy Management Module (T/EMM) and an engine-mounted Switched Reluctance Starter/Generator (SRS/G). The T/EMM is a single turbomachine, which provides centralized control and management of secondary power and thermal cooling for the aircraft. The SRS/G is an electrical device, which can function either as a motor or generator. Together these to subsystems replace the central hydraulics system, airframe-mounted accessory drive (AMAD), environmental control system (ECS), and the auxiliary power unit/ emergency power unit (APU/EPU). The technologies involved in J/IST allow an aircraft designer to replace 13 current technology subsystems with 5, resulting in less space, weight, power, cost, etc. Figure 4 illustrates this point between the traditional subsystem approach and what the JAST program is pursuing.

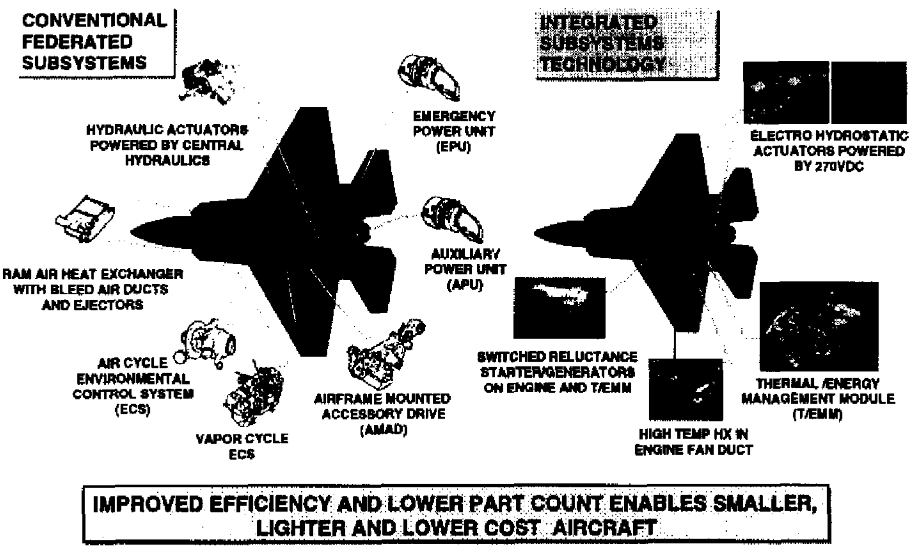

Figure 4 Comparison of Current vice J/IST subsystem Approach

Mission Systems

After surveying the Science and Technology areas for leveraging opportunities, further refining the candidates through the quality-function-deployment tool and receiving feedback from Industry and government experts in the field, the conclusions were to focus the demonstrations into four areas: Integrated core processing, integrated Radio Frequency (RF) sensors, integrated electrical optical/infrared sensors and weapons integration (figure 5). The following is a discussing of a few of the critical aspects of the mission systems focus areas. Integrated core processing is necessary to support an "open" systems architecture, which in turn allows for more affordable upgrades and significant growth opportunities. This demonstration program addresses critical technologies and software processes to support a single-crew aircraft in an information rich environment. The integrated RF sensor demonstrations are focused at reducing the risk of developing a low cost, lightweight multifunction nose aperture. Current weapon systems illustrate that an entire RF system can represent up to 59% of the avionics flyaway costs with a multifunction nose aperture at 19%. The overall demonstration objectives are to yield from 9-17% LCC savings when compared to an F-22 technology base.

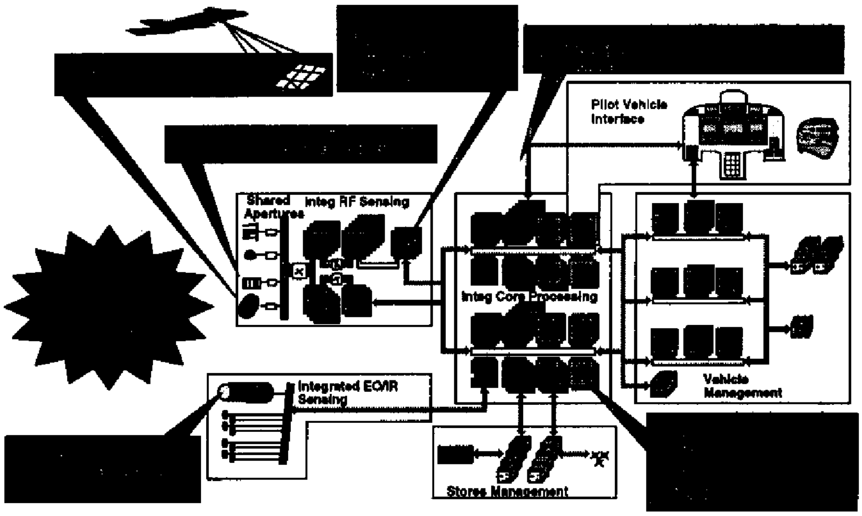

Figure 5 Mission Systems Integrated Technology Demonstrations

Propulsion Technology

The propulsion technology maturation program is focused on technologies which improve single engine safety, reliability and maintainability, survivability and affordability. Multi-service application is also a significant technology driver. An aggressive Prognostics and Health Management program is being explored for the propulsion system to maximize single engine safety and significant reduce its operations and support costs. Alternate component material solutions and manufacturing initiatives are under study to reduce procurement costs. Increases to reliability and maintainability are being pursued to reduce the propulsion system's logistics footprint and increase the sortie generation rate for the aircraft. Both ground and flying demonstrations are being performed to mature such critical technologies as: Advanced diagnostics, turbine supercooling, advanced composite materials, subsystem integration and affordable low observable applications.

Prognostics and Health Management

The prognostics and health management (P&HM) focus on the Joint Strike Fighter Program is to develop a set of fully integrated sensors and predictors, utilizing both on-board and off-board systems, which estimate life usage and can forecast potential critical failures (figure 6). This is extremely important for a single engine aircraft and can significantly reduce the number of unnecessary inspections and equipment removals. In addition, a robust P&HM architecture will support an "autonomic" logistics approach. Through autonomic logistics, the aircraft P&HM system can stimulate the aircraft systems prior to return to base and data link all anomalies to the support organizations. A reliable P&HM system can allow for prepositioning of tools and equipment and maintenance rehearsal thereby improving the sortie generation capability.

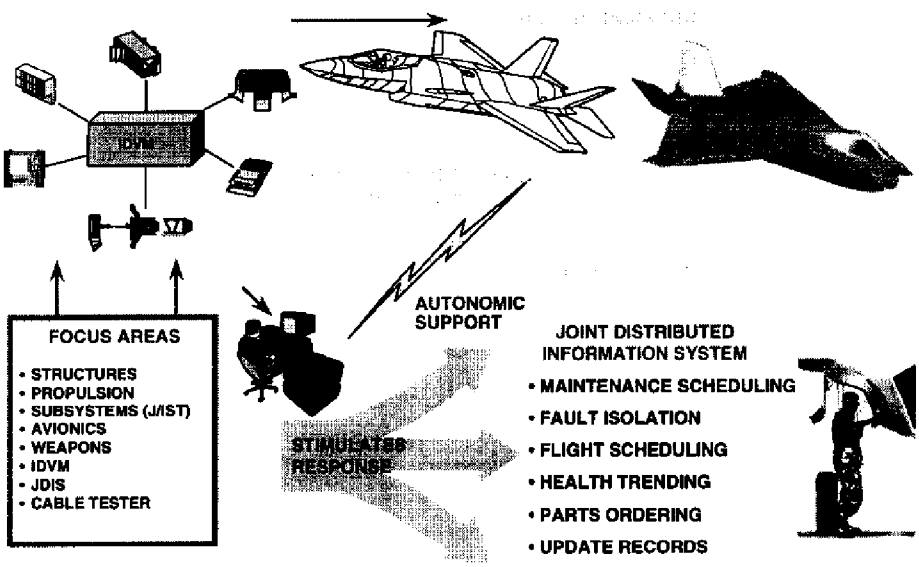

Figure 6 Prognostics and Health Management Approach

JSF Technology Impact to Affordability

Both government and industry studies have identified leveraging technology efforts, which could significantly lower the production cost (30% savings) of the Joint Strike Fighter as well as the cost of ownership (28%-32% savings). The Joint Strike Fighter Program office has focused its scarce resources in pursuing those technologies, which significantly impact the affordability of the weapon system, and provides best value to the warfighters. By knowing which of the weapon system attributes drive cost of ownership, you can get the most leverage from your investments. The Joint Strike Fighter Program is the model for affordable weapon systems of the future!