DECISION MODEL FOR SELECTING THE BEST AIR START UNIT FOR NAVAL AVIATION

The George Washington University
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Executive Decision Making
Bob Krekel

ABSTRACT

Air start units are an invaluable piece of aviation common support equipment (CSE) which provide primary, secondary, and ground maintenance start capability for Navy and Marine Corps aircraft. In those weapon platforms without auxiliary power units (APUs), air start units are the only source of starting the aircraft's powerful turbine engines. If the air start unit fails, there will be no chance of the getting the aircraft airborne to perform its intended mission. Today the Huffer and its GTCP100-82 engine, which is housed in both a shore based and carrier configuration, is the Navy and Marine Corps' primary air start unit. Current operational Huffers range from 10 to 30 years old, and must be overhauled every 3 years at the depot level. Cost for overhaul has dramatically increased over the past 5 years, with repair parts being the primary price driver. With the end of the cold war and the nation's focus on a balanced budget, Naval Aviation must find ways to shed high priced operation and support costs that take up 60% of its total budget, while still providing equipment that meet its operational and performance requirements. In an attempt to reduce total life cycle cost and meet existing requirements, the support equipment resource sponsor wants to compare two alternatives to the Huffer. These alternatives are the UNIJASU (T53UJ), which is the Navy's next generation start unit, and the Air Force's existing start unit, the LASS (GTC 85-180). The goal of this paper is to assist the resource sponsor in selecting the best air start unit for Naval Aviation. Objectives in meeting this goal will be cost, performance, requirements, and training.

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BACKGROUND

Environment Overview

The resource sponsor for Navy and Marine Corps CSE is the Chief of Naval Operations, Air Warfare Division N881 (a Navy Captain). N881 and his principle advisors, the aircraft maintenance working group N881C, establish the planning, policy, and fleet support for all aviation maintenance issues for the Navy and the Marine Corps. The working group primarily focuses on monitoring and defending scarce resource dollars, which buy aircraft depot maintenance, engine improvements, weapons maintenance, supply support, and CSE. Funding of such requirements, through use of the Department of Defense's (DODs) Planning, Programming, and Budgeting System (PPBS), are submitted by respective resource sponsors into the Program Objectives Memorandum (POM). During the development of the POM, allocations are based upon competing requirements for the resources available in the Future Years Defense Plan (FYDP). The POM contains force and resource recommendations, and must conform to the fiscal guidance of the Secretary of Defense. The Department of the Navy's POM is the recommendation to the Secretary of the Defense for the detailed application of resources. Upon completion of analyses and adjustments, the Secretary of Defense submits the DOD budget (as part of the President's budget) to Congress for approval.

Problem Scenario

With the declining DOD budget, Naval Aviation must now acquire all requirements within its existing budget. Gone are the days of the Cold War and Reagan Era where new requirements meant additional money to a resource sponsor's budget line. In attempt to procure new aircraft such as the F/A-18 E/F Hornet and the V-22 Osprey, Naval Aviation is continually striving to reduce its operation and support costs, which currently takes up 60% of its budget. Requirements are scrutinized for total cost and their ability to provide favorable Return On Investment (ROI). Only those requirements that make good business sense survive the competition for scarce resource dollars. Although today's budget realities has the decision maker focus mostly on cost, what about other important criteria such as performance, operational requirements, and training? By adding additional criteria, the ability to choose the best alternative can become very complex. However, if the most optimal alternative can be chosen, the decision maker will have increased his ability to successfully justify and defend his program throughout the POM process.

Decision Identification

The primary focus of the resource sponsor will be to select the best air start unit for Naval Aviation.

Significance of Decision

This decision can have significant impact to Naval Aviation, both in aircraft readiness and in costs. Choosing the wrong alternative could have a negative impact to the start capability of forward deployed aircraft on board an aircraft carrier or shore station. Also, the wrong selection may lead to lost opportunities in program cost savings and avoidance, which could mean fewer dollars for the resource sponsor to invest.

Decision Making Approach

Currently, the resource sponsor and working group do not rely on a single methodological process for decision making. Decisions derived, vary from using analytical problem solving approaches, (i.e. cost analysis) to solely relying on "gut feeling" or past experience. Because of the current budget environment, decisions presently made have a far greater impact to the overall organization. This has caused senior leadership to be more critical of decisions, not only for their ability to enhance operational capability of the warfighter, but also their contribution to reducing the cost of supporting Naval Aviation. This environment has created far more complex and unstructured (non-routine) decision problems for the decision maker than in past years. In these complex and unstructured environments, numerous hard data is mixed with the intuition of the decision maker, often surpassing the human brain's cognitive abilities.

In this scenario of selecting an air start unit, the Analytical Hierarchy Process (AHP) and Expert Choice (a software application based on the AHP) will be used. The AHP gives the decision maker the framework needed to model a complex decision scenario, therefore allowing for a better understanding of the problem, its criteria, and possible choices. The hierarchical structure consists of an overarching goal, objectives (criteria), sub-objectives, and alternatives (see figure 1).

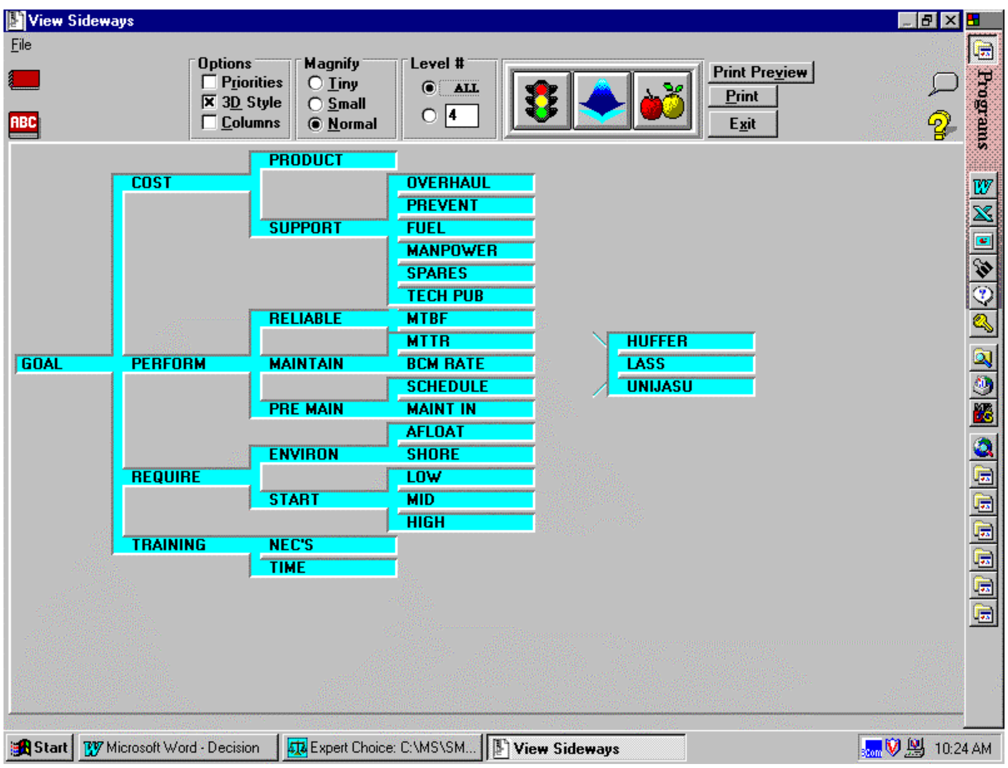


Figure 1. Hierarchical Structure

Using the AHP, a seven step process is followed to enable the decision maker to make the best choice among the three alternatives. The process includes:

1. Problem definition and research- Problem identification (statement of goal), identification of objectives and alternatives, and research of alternatives.
2. Discarding of infeasible alternatives.
3. Building the decision model in the form of a hierarchy (goal, objectives, sub-objectives, and alternatives).
4. Evaluating and prioritizing objectives and sub-objectives through use of pairwise relative comparison, using both factual data when available and intuition when not.
5. Measuring the alternative's contribution to each of the lowest sub-objectives.
6. Reviewing and verification of decision by performing sensitivity analyses and measuring it against the user's own intuition.
7. Documenting the decision for justification and control.

The user-friendly design of Expert Choice will enable the user to easily build the AHP model and perform pairwise comparisons. Judgments that are both hard data and intuition may be inputted. The software will synthesize the decision maker's priorities in order to obtain overall priorities and ranking of the alternatives. The alternative with the highest priority is the best choice. Sensitivity and what-if analysis may be performed by changing previously inputted assumptions, allowing the decision maker to see how sensitive the rankings of the alternatives are to changes in the importance of the stated objectives.

ALTERNATIVES

The alternatives chosen for this decision model are the Huffer, the LASS, and the UNIJASU.

<u>Huffer</u>

The Huffer (GTCP100-82) is powered by a gas turbine compressor and is the primary air start unit for Naval Aviation. The unit is housed in both a shore based and carrier configuration, making it versatile in any environment. Because of its low to high flow start capability, it has the ability to support every aircraft in the Navy and Marine Corps inventory. Current operational Huffers range from 10 to 30 years old, and must be overhauled every three years at the depot level. Cost for overhaul has dramatically increased over the past five years due to price increases in repair parts that are no longer in the supply system. It is unknown how much further overhaul prices will increase in the coming years. Of the three alternatives, it has the highest failure rate.

<u>LASS</u>

The LASS (GTC 85-180) uses a gas turbine compressor powerplant and is the one of two air start units currently used by the Air Force. Designed for traditional land air bases, the large size of the LASS makes it incompatible with the crowded deck of an aircraft carrier. In addition, the unit only produces *low pressure and flow rates, allowing it to only support half of Naval Aviation aircraft. Because of the Air Force's reluctance to overhaul most of their start units, the LASS is still in production today. Cost of production is 40% more than the overhaul price of the Huffer, with the overhaul cost being 50% less. Spare parts for scheduled and unscheduled maintenance are readily available in the supply system. Of the three alternatives, it has the lowest failure rate.

**For the Navy and Marine Corps, the NATOPS manual dictates the pressure and flow requirements for starting aircraft as recommended by the aircraft manufacturer. However, the LASS has demonstrated its ability to start Naval Aviation aircraft with mid and high flow requirements. The long term effect of starting aircraft with less than designed pressure and flow is not known, therefore it will only be classified to support low flow aircraft in this analysis.*

UNIJASU

The UNIJASU is powered by a gas turbine compressor and is the Navy's next generation start unit. The unit was designed for both shipboard and land based operations. The production cost will be approximately three times higher than the LASS. Currently undergoing operation testing and evaluation, the actually reliability and overhaul costs are unknown. However, manufacturer estimates state the UNIJASU will be seven times more reliable than the Huffer, with overhaul costs to be approximately 50% less. Spare parts are forecasted to be readily available within the supply system. Significant research dollars have been invested in the development of the UNIJASU. The prime manufacturer has several subcontractors, some of which are staying afloat through the UNIJASU contract. If the contract is canceled, congressional inquiries are sure to follow.

DECISION MODEL

Goal

The goal of this decision model is to select the best air start unit for Naval Aviation.

Primary Objectives

The following primary objectives were identified to be the most relevant in regards to the decision goal (see figure 2)

- Cost — Total production and support costs of air start unit.
- Performance — Relative measures of reliability, maintainability, and preventative maintenance.
- Requirements — Ability of air start unit to operate in a shore and afloat environment; and to start various Naval Aviation aircraft.
- Training — Number of Navy Enlisted Classifications (NECs) needed to support the air start unit; and total time to train personnel.

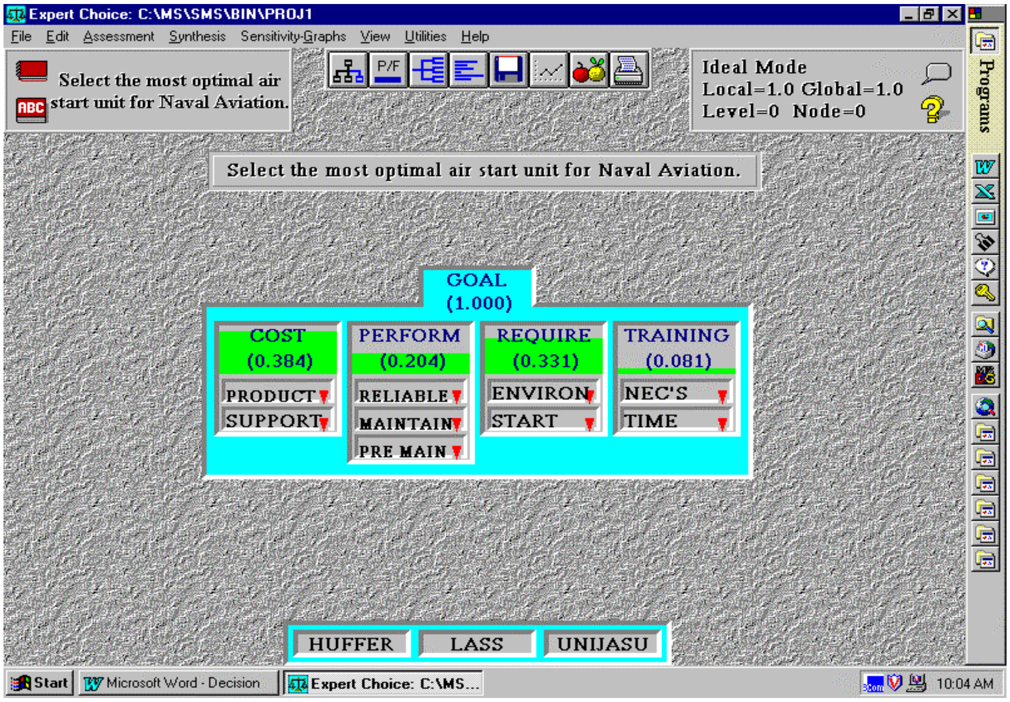


Figure 2. Decision Model

Sub-objectives

The following sub-objectives fall under their respective primary objective (see figure 1 for full breakdown).

COST

- Production- Total cost of acquiring a new air start unit from the manufacturer.

- Support- Total support costs associated with the air start unit.

  Overhaul- Cost of overhauling a start unit at the depot level.

  Preventative Maintenance- Annual total hours expected to be spent in preventative maintenance.

  Fuel- Annual fuel cost of operating start unit.

  Manpower- Annual manpower support cost.

  Spares- Annual spare parts forecasted to be required to maintain start unit.

  Technical Publications- Total cost of supplying technical publications to all units.

PERFORMANCE

- Reliability- Reliability of air start unit between failures.

  MTBF (Mean Time Between Failures)- Average operating hours of the start unit before failure occurs.

- Maintainability- Ability and time to maintain and repair a start unit.

  MTTR (Mean Time To Repair)- Average time needed to repair a start unit.

  BCM (Beyond Capability Maintenance) Rate- Inability of organizational or intermediate maintenance activity to conduct needed unscheduled maintenance.

- Preventative Maintenance- Scheduled maintenance actions that help prevent unscheduled maintenance failures.
  - Schedule- Average scheduled maintenance per week.
  - Maintenance Interval- Maintenance interval of conducting scheduled preventative maintenance.

REQUIREMENTS

- Environment- The operating environment in which the start unit will be starting aircraft.
  - Afloat- Capability of start unit to operate aboard an aircraft carrier.
  - Shore- Capability of start unit to operate in a land based environment.

- Start- Pressure and flow range needed to start Naval Aviation aircraft.
  - Low- Low range pressure and flow, has the ability to start the following aircraft: EA6B, AV8B, C130, C9, F5, F14A, H60, P3, S3, and T38.
  - Mid- Middle range pressure and flow, has the ability to start the following aircraft: F18ABCD, F18EF, C2, E2, and E6.
  - High- High range pressure and flow, has the ability to start the following aircraft: F14BD.

TRAINING

- NECs (Navy Enlisted Classification)- Total number of designated billets needed to support the start unit.

- Time- Total time of initial training per student in hours.

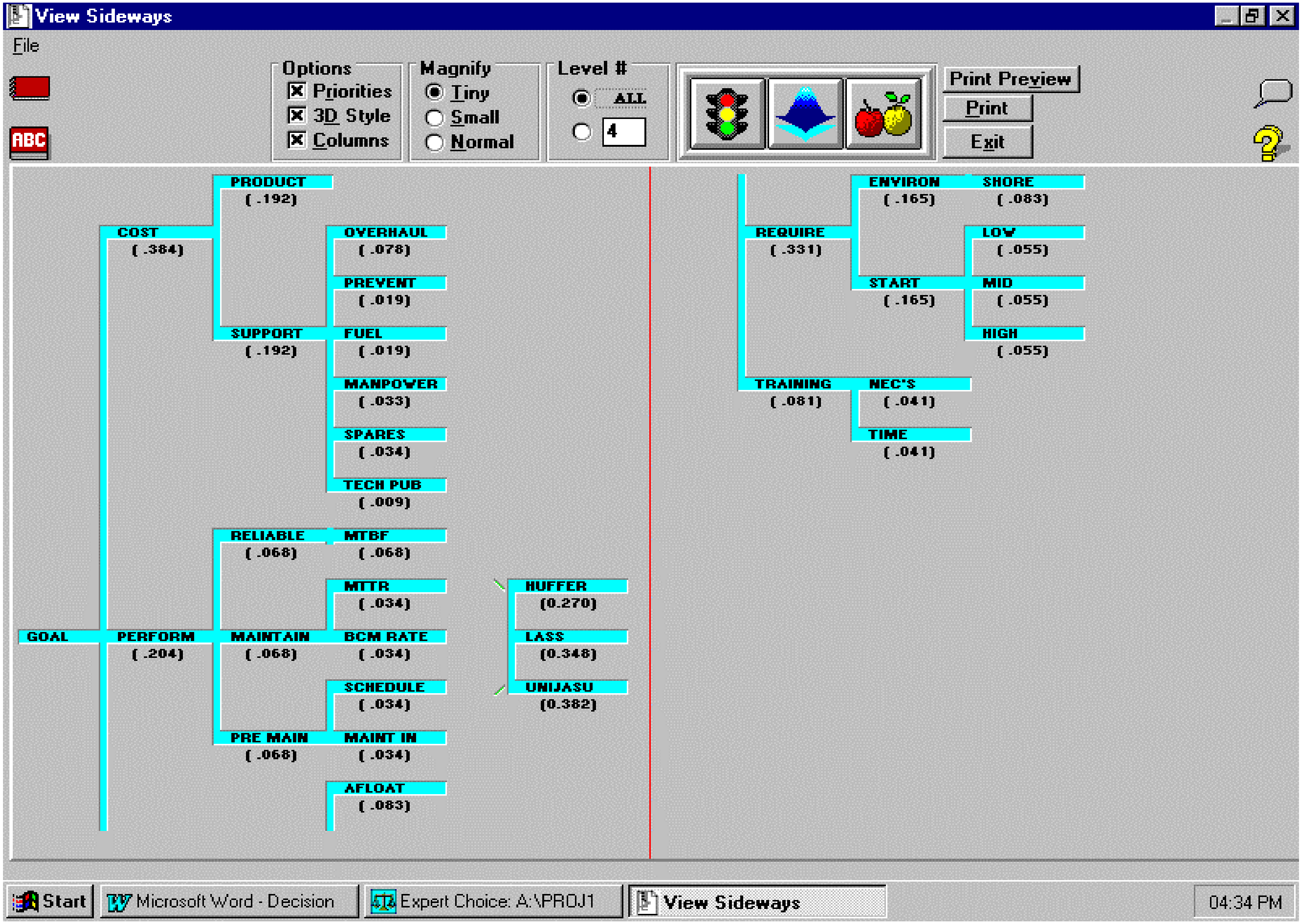
RESULTS AND ANALYSIS

Weighting of Objectives and Sub-objectives

Through the use of the graphical pairwise comparison function in Expert Choice, weights were derived for the four primary objectives of cost, performance, requirements, and training; giving the decision maker priorities for the stated criteria.

- Cost- .384
- Performance- .204
- Requirements- .331
- Training- .081

* See figure 3 below for derived weights for primary objectives and sub-objectives.



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PRODUCT (.192)
SUPPORT (.192)
OVERHAUL (.078)
PREVENT (.019)
FUEL (.019)
MANPOWER (.033)
SPARES (.034)
TECH PUB (.009)
PERFORM (.204)
RELIABLE (.068)
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SCHEDULE (.034)
MAINT IN (.034)
AFLOAT (.083)
HUFFER (0.270)
LASS (0.348)
UNIJASU (0.382)
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As mentioned earlier, the current budget environment has forced decision makers to weigh heavily on the costs to a program. It is not surprising that cost (.384) was rated as the objective with the highest priority. Digging deeper into the sub-objectives for cost, it was found that the cost of overhauling a start unit had the biggest impact to support costs (at .078 it was weighted twice as high as the next sub-objective, manpower .033). Following cost was the objective requirements (.331). By being weighted just below cost, this should alarm the decision maker that the focus of the decision should not be solely on production and support costs. With DOD becoming so cost conscious, it has become a common pitfall for decision makers to fixate on cost, while ignoring other key objectives that could have an impact to the decision being made. Following requirements was the objective performance. Reliability (.063) was the top sub-objective for performance, followed by an even distribution of the remaining objectives MTTR, BCM rate, schedule, and maintenance interval (.034). The lowest weighted priority was training at .081.

Selection of the Best Alternative

The three alternatives, the Huffer, LASS, and UNIJASU were measured against all sub-objectives, followed by the four primary objectives. Focusing on one example, it is easy to see the effects that the prioritized objectives and sub-objectives have on the alternatives. The Expert Choice graph below in figure 4 shows the LASS unit is weighted higher because of its cheaper overhaul cost at the depot ($38,663), compared to the higher prices of the UNIJASU ($45,000) and the Huffer ($87,000).

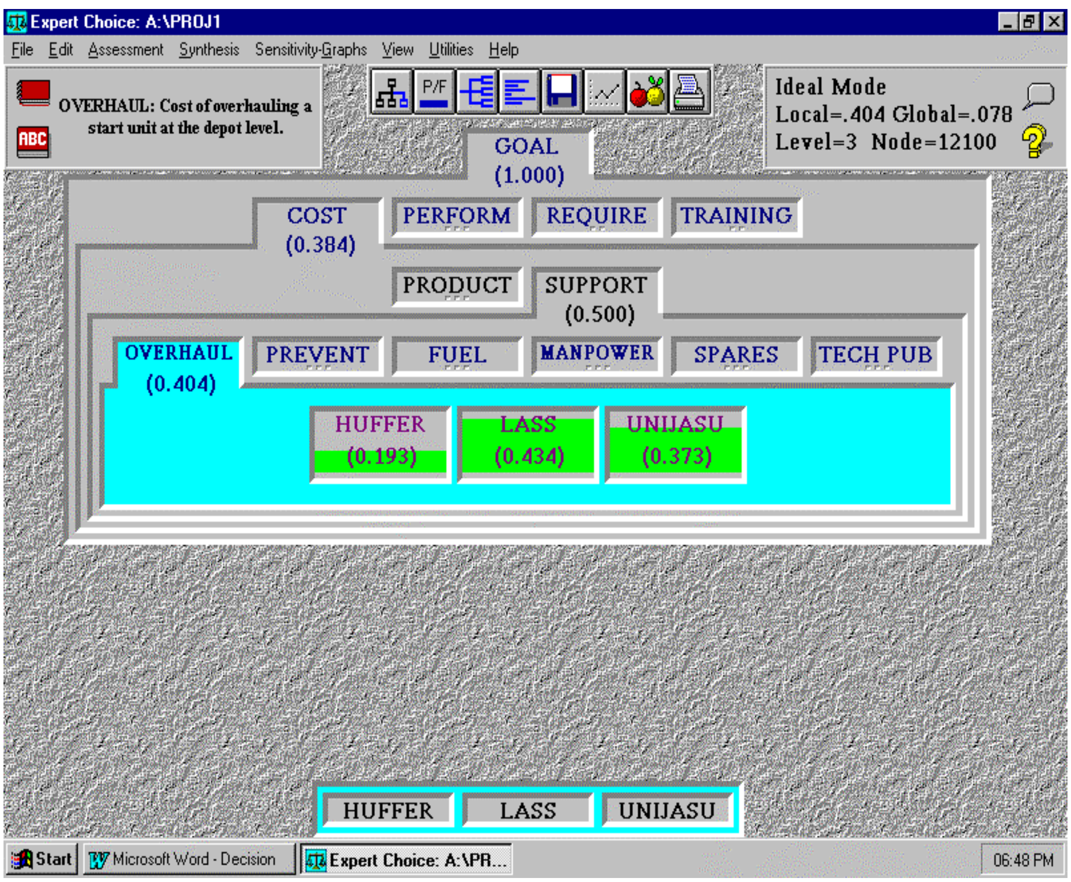

Figure 4. Weighted Alternatives

By viewing the sensitivity analysis graph (see figure 5), it becomes obvious the impact the weighted objectives and sub-objectives have to the alternatives. Figure 5 clearly shows that in relation to cost, the Air Force's LASS takes top billing. However, as the LASS is weighted against performance and requirements, it quickly loses its appeal. In the end, the Navy's next generation air start unit, the UNIJASU, becomes the best selection for Navy and the Marine Corps. Had the decision maker solely focused on cost, the LASS would have been the most likely alternative chosen. However, because of the weighting of performance and requirements by the decision model, the final outcome has the UNIJASU as the overall best selection. Through the use of the sensitivity analysis function, the user can alter the individual weights to the stated objectives and visualize how their changes can impact the overall result. Because the UNIJASU is still in development, the performance data provided is from engineering predictions, and not actual reliability run times of the unit. Using Expert Choices sensitivity and "what-if" analysis, the user will find that if performance drops dramatically after operational testing this year, UNIJASU will no longer be the best choice. As in this case, as the scenario changes overtime, Expert Choice gives the decision maker a well documented decision tool that can be readily refined as data and intuition changes.

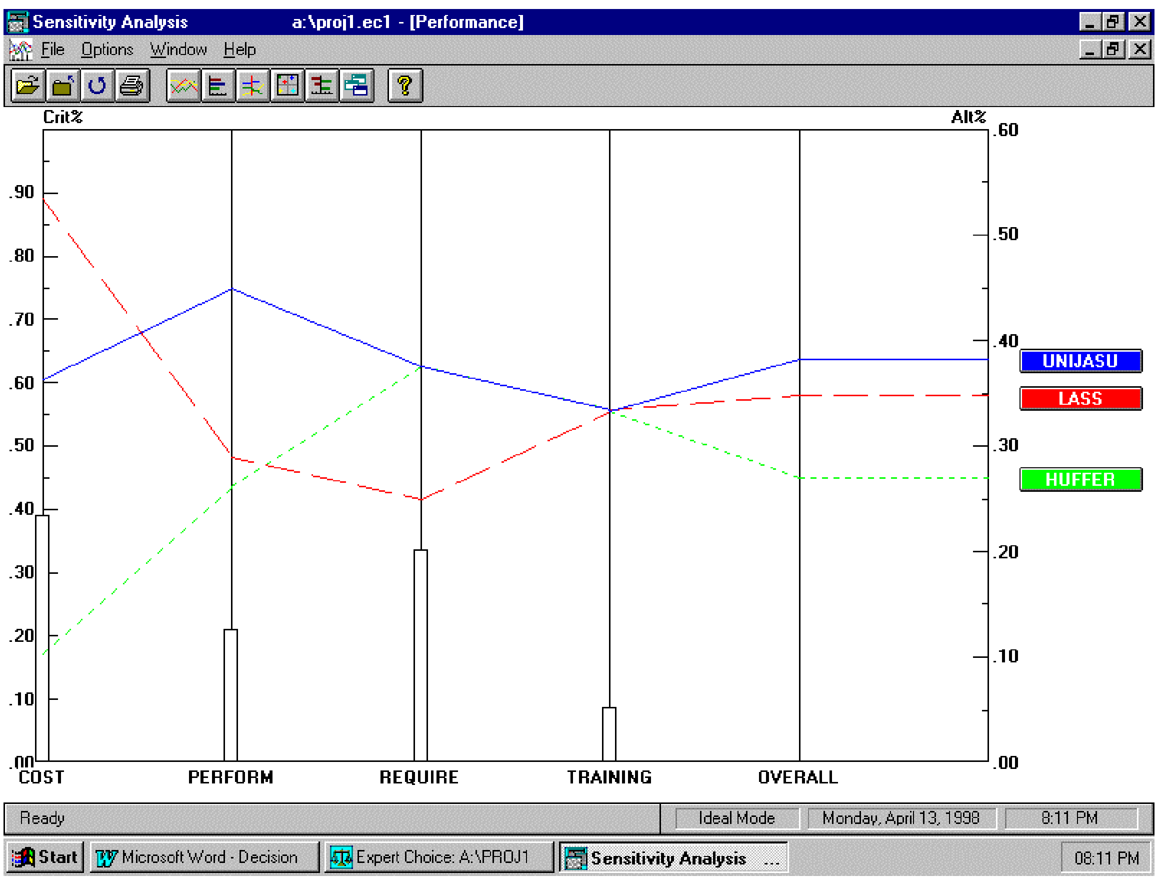

Figure 5. Sensitivity Analysis

CONCLUSION

The end of the Cold War and the Nation's desire to balance the national budget has had a tremendous impact to the decision process within the DOD's acquisition community. Long gone are the days of undisputed requirements and overflowing budget lines. Today's budget environment has made the acquisition decision process extremely complex and frustrating. Within Naval Aviation, resource sponsors are keenly fixated on the total cost of a program using quantitative analysis to measure tangible costs. However, as a decision problem becomes more complex and unstructured, objectives other than cost (including certain intangibles), have the potential to dramatically change the outcome of the decision. Use of the AHP and Expert Choice helps the decision maker to structure and analyze complex scenarios, allowing for a better understanding of objectives, sub-objectives, and alternatives in relation to the overall goal. The end result…improved decision making abilities for the user and a means of communicating and refining the decision model through the use of a simple hierarchy structure and graphical presentations.

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