SOMETIMES HOT, SOMETIMES COLD: WHAT IS THE FUTURE OF MPT & HF ANALYSIS AND PLANNING IN DoD ACQUISITION

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ABSTRACT

For many years the subjects of Manpower, Personnel, Training, and Human Factors planning oscillated between hot topics to espouse as essential for improved acquisition planning and execution in the Department of Defense, and out-of-favor subjects that caused the eyes of acquisition managers to glaze over. This paper explores how these topics have been treated in the past and how advanced technology and high-level administrative support may lead to improved human-system synergistic performance in the future.

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BACKGROUND

The development of computer and other advanced system analysis support equipment, tools, and methods has increasingly made policy decision-making more scientific and cost effective. The purpose of this paper is to assess the trends in Human Systems Integration (HSI) planning and policy making in system acquisition, and to forecast possible changes or advances that may occur over the next decade as a result of improvements in these tools. Specifically, past trends and issues involving Manpower (the number of spaces), Personnel (the number of faces), Training (particular skills and knowledge) and Human Factors (design of system to accommodate the human) in system acquisition will be discussed, along with new tools for Manpower, Personnel, and Training (MPT) analysis, and prospects for integrating MPT and Human Factors (HF) into future system design and analysis.

Past Practices

As far back as 1960 the Services were concerned about the lack of tools and processes for addressing human issues in system acquisition. Many military systems were being developed that did not adequately integrate the person into the design, or consider the people cost to support a system. Weapon systems were being delivered without preplanning for needed personnel or training required for successful utilization. Therefore, many systems were unnecessarily difficult and costly to operate and maintain.

Often, and periodically, MPT elements have been addressed separately in what is referred to as "stove pipe" planning. That is, the organizations and people tasked with planning each separate element did not work closely together to integrate their efforts. This resulted in less than ideal planning for the human elements for many systems. As systems were developed, the design was "thrown over the wall" to the logistician for consideration of MPT issues. This process resulted in many MPT factors being "late to need" and not the optimum solution for the system design.

System designs of the past were primarily hardware system design. They were concerned with how fast a system would go, how high it would fly, what bomb load it would carry, what armament it possessed, or how much it weighed, etc. These were truly not "system" designs, in that they gave very little consideration to the number of people, or the training and maintenance required for a system. When the engineers threw their designs over the wall for other System Program Office (SPO) specialists to consider, there was no one on the other side with the expertise to adequately consider the MPT.

SPOs generally didn't have personnel on their staffs with manpower or personnel experience. They frequently relied on their logistics personnel (maintenance NCOs or officers) to address manpower, personnel, or organizational issues, and often these individuals deferred decisions to the using commands. MPT issues were considered "Not my job."

The using command was also not staffed or organized to address MPT issues in a unified and integrated way. The acquisition community at the commands was usually made up of operators, with a few maintainers. Command manpower analysis functions were usually not assigned to work acquisition questions, or asked to participate in analyzing front-end MPT issues for new acquisitions.

Current Situation

The acceptance of Total Quality Management (TQM) and Concurrent Engineering (also known as Integrated Product Development in the Air Force) by the services, cleared the way for manpower, personnel, training, and human factors to become important considerations in system design, rather than step-children. Since Concurrent Engineering relies heavily on the use of empowered teams (composed of a variety of skills: engineering, logistics, manufacturing, etc.) to concurrently and collectively design a system to optimize system performance, supportability, and life cycle cost; it only makes good sense that people with MPT experience should be part of the team. It is now up to management to populate command acquisition teams with the expertise to consider the entire system. The services cannot afford, in this time of reduced budgets, to continue to consider only the operational aspects of a system. They must consider the total cost of a system in dollars and manpower requirements. In this era of increased competition and cost awareness, it is imperative that "people planning" play a larger part in acquisition process teams and early system design planning.

The consideration of a system's total Life Cycle Cost (LCC) is especially critical as our total military infrastructure is down sized. Also, the importance of adequately considering MPT issues is highlighted since it has been well established that MPT factors account for between 50 and 65 % of most aircraft systems Operations and Support (O&S) cost. Figure 1 (extracted from the Air Force Cost Center) reflects a typical F-16 24 aircraft squadron O&S cost for one year (Dahn, 1992). One year's O&S costs are 53.9M (FY92 dollars). As can be seen, a major portion, 58% or $31.3 million, is dedicated to MPT related cost. These MPT costs are distributed as shown in the stacked bar chart with 77%, or $24.1 million, to train, pay, and provide other direct support to aircraft maintenance personnel every year. As is obvious, there is a great potential for significant dollar savings if more effective ways can be identified, and integrated tools developed, for addressing these MPT issues early in the systems acquisition process.

The importance of making these MPT decisions early in the system acquisition process cannot be overemphasized. As has been demonstrated on numerous acquisitions, approximately 70% of a system's cumulative life cycle cost is set by the time the system reaches Milestone I (the point in the acquisition cycle where a new system is

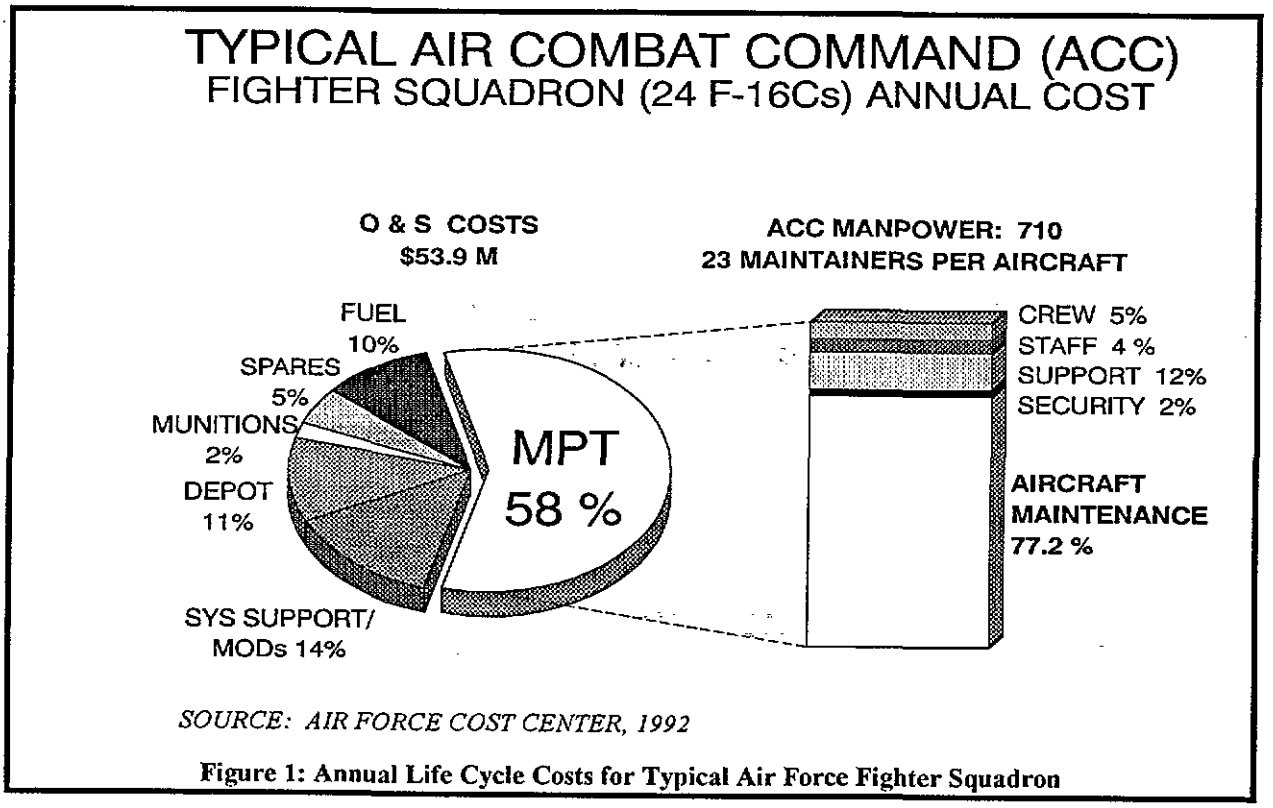

Figure 1: Annual Life Cycle Costs for Typical Air Force Fighter Squadron

moved from concept exploration and definition to demonstration and validation). Figure 2 illustrates the gains possible by addressing acquisition issues early. (Potempa, Gentner, 1990) Along with the previous fact that MPT is responsible for 50 to 65% of a system's cost, the ability to address MPT early is doubly critical. In trying to reduce a system's overall cost (as shown in Figure 1) an obvious place to start is with manpower, especially since maintenance manpower (as can be seen in the above F-16 example 77% of all F-16 manpower is maintenance manpower) accounts for a significantly large portion of the overall system cost.

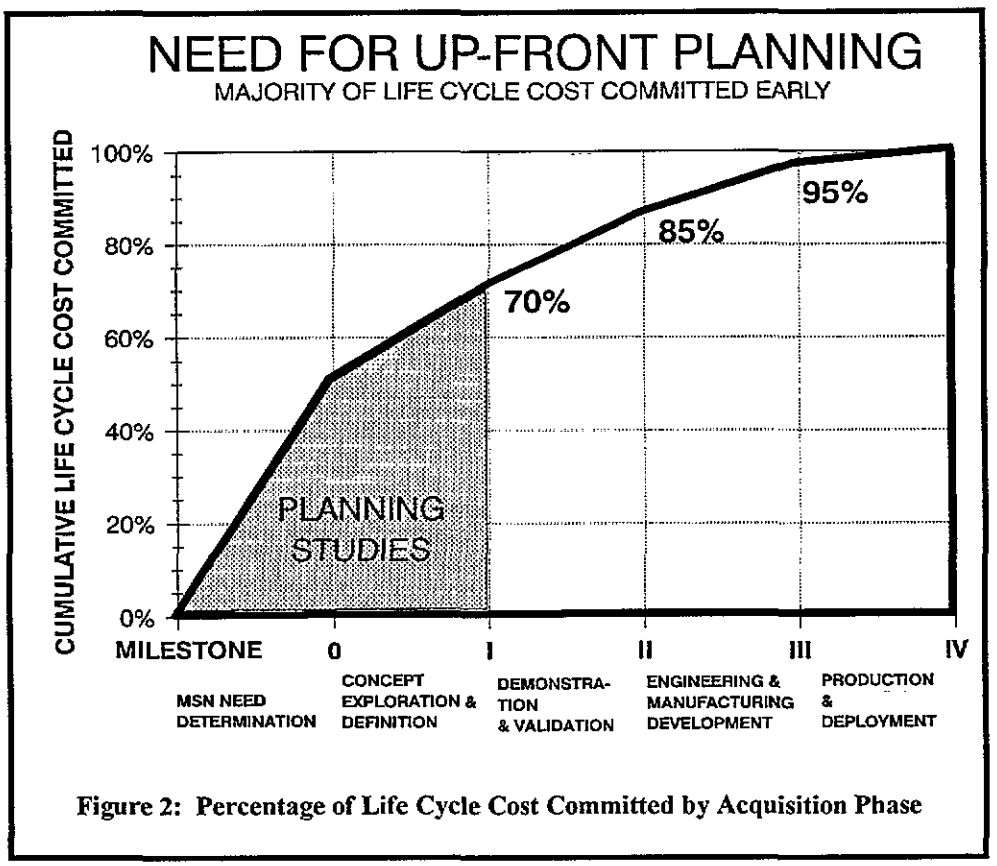

Figure 2: Percentage of Life Cycle Cost Committed by Acquisition Phase

Even though manpower is the obvious area in which to concentrate to lower cost, reducing manpower must be done carefully and with considerable thought and planning, since maintenance manpower requirements are generally driven by a variety of factors. In the above aircraft example, the number of aircraft, sortie rate, organizational structure, reliability, and number of specialties required, are a few of the major factors. The number of specialists a system requires, along with the organizational structure under which they work, are the key areas driving manpower requirements in the above F-16 example. (Cunningham, 1991) The reliability of new and proposed weapon systems (even though it is not the key driver) is such that it is possible to reduce the number of these specialties. Many specialists find themselves idle much of the time because the systems they work, are so reliable they very rarely break (the lonesome Maytag repairman syndrome).

For example, studies in the Air Force suggest that a reduction in the number of specialties, from 14 to 4 or 5, could be made for new systems on the drawing board. Even though this could result in considerable savings in maintenance manpower, it could also create other problems. If one specialist is now responsible for what used to take two specialists, will the one specialist be *capable of absorbing* and maintaining currency on the information necessary to do the two jobs? Under such conditions, the technician may need to be provided with some type of job aid (either on or off the system, electronic or manual) or additional job training, up-grade training, or refresher training to keep current.

Because of the large amount of training required for maintenance specialist to stay current, the complexity of the training, and the use of computers in training and on the job, Human Computer Interface has become a current area of extreme interest. Technical skills required to operate and maintain systems are becoming less dependent on mechanical aptitude and more dependent on computer skills and abilities. The human factors of designing complete workstations *is vitally important to ensure productivity of the* human machine interface. Much is left to be done in what remains a key area for future research development.

DoD MPT PROGRAMS

As outlined in the above background discussion Manpower, Personnel, Training, and Human Factors issues are at the heart of reducing manpower requirements and cost for current and future weapon systems. With this understanding DoD established the Human System Integration (HSI) program. At the Department of Defense level the program is referred to as HSI, but the individual services programs supporting the DoD initiative have individual names. The Air Force program is the Integrated Manpower, Personnel, And Comprehensive Training and Safety (IMPACTS) program; the Army calls theirs the Manpower and Personnel Integration (MANPRINT) program; and the Navy prefers Navy Human Systems Integration. Even though the services' programs had similar goals, they have followed very different development and management courses. The Army MANPRINT program was supported and directed from high in the Army chain of command and received "top down" direction and funding, whereas the Air Force effort was a grass-roots program, designed to establish working relationships with SPOs and determine "from the bottom up" what was required in the way of MPT.

Even though the service MPT organizations have achieved a margin of success, they have experienced considerable difficulty in a number of areas. One of the most difficult problems the services' experienced, and the one that has been impossible for the Air Force to overcome, has been the lack of consistent support, both financial and policy. The OPR for the model Air Force organization, at its establishment, was SAF/AQ (Acquisition) but, within the next few years the responsibility shifted from AQ to DP (Personnel), to MO (Manpower) and back to AQ. At the same time, and at a much more rapid pace than the office symbol changes, the general officers responsible for providing high-level guidance and support came and went with lightning speed. The rapid leadership changes and failure to achieve a firm leadership stand caused delays in program development. Each time a general officer OPR would make a commitment to HSI, he would be moved to another assignment and his replacement would have a new agenda, and would not necessarily follow up on commitments made by his predecessor. This constant turnover in leadership resulted in years of fluctuating support. Following a period of increased emphasis in HSI planning in the late 80s and very early 90s, the past two years have again seen a falling off of interest by leadership (Howell, 1989) as a result of recent force down sizing. This lack of concern for HSI has produced the usual result. The July 26-August 1, 1993 issue of the Defense News identified that the last AIM-129A Advanced Cruise Missile is expected to be delivered to the Air Force in August 1993, but no one will be trained to work on it for another two years.

The overriding concern with force down sizing (especially without having the time to plan and execute an optimal approach to force changes, given changing missions, new systems, and new organizational structures) has again caused leadership at nearly all levels to reduce concern for HSI issues. This is ironic since HSI, and the tools being developed for HSI analysis, have as one of their major features the ability to analyze and optimize the manpower requirements for a system, or force structure, as a result of change. It appears the breakneck speed of the draw down and reorganization has allowed only time for "meat cleaver" analysis. This is rather appalling, considering that if management had provided the timely leadership needed, analysis organizations could have provided well thought-out assessments of manpower requirements based on mission and system requirements. These studies could have detailed ways of savings manpower instead of deleting squadrons of aircraft, ships, and tanks (and people) to satisfy manpower draw downs. Although the current frenzy of force draw downs and funding reductions has resulted in reduced support for the active HSI programs, these same factors are likely to bring increased high-level management interest once the short-term reaction to force structure changes has passed. This will likely come about as high-level management is made aware of the manpower and cost savings that can result from the integrated use of newly available analysis tools, along with systems efficiency improvements that follow operator and maintainer workload reductions. In the face of decreased funding, it will become essential to reduce manpower requirements to the absolute minimum to support both new and modified systems.

The services have never been thrilled with the idea of reducing manning. To overcome their resistance, the services will have to be convinced the savings can be made without harming their ability to accomplish their missions. If the services don't accept this idea, then further reductions probably won't take place. This is not to say that the services wouldn't prefer systems that could be

supported with less manpower, it's just that they don't want to give up the manpower they currently have. Manpower means flexibility. Flexibility in war could mean the difference between success and defeat. Therefore, it should not be too surprising that the services have shown little inclination to make manpower reductions. From the users' point of view, if projected reliability in systems, or stability of the world environment doesn't work out, as has happened in the past, they will have to live with reduced manpower, and the resulting problems, for years. (Cunningham, 1991)

The lag between need and procurement is not just a condition confined to obtaining manpower. The time it has taken to develop HSI policy, procedures, and tools has also been a major problem for HSI practitioners. In the late 80s when interest in MPT was at a peak, the services were instructed to establish MPT organizations and to develop policies, procedures, and tools to be able to perform appropriate MPT analysis. All the services struck out smartly to comply with these requirements, but were soon to learn that change is slow in coming.

Regulations, policies, handbooks, training, and tools required to do effective MPT analysis have lagged considerably behind management interest. (See Figure 3) When interest was extremely high the MPT community had no tools, guidance, training, or money. As these items have been developed and MPT analysts trained, management interest has moved on to other things. Now that HSI policy is law, and tools are coming on line, management interest is again starting to ramp up, but now without funding. Maybe someday we will get it all together.

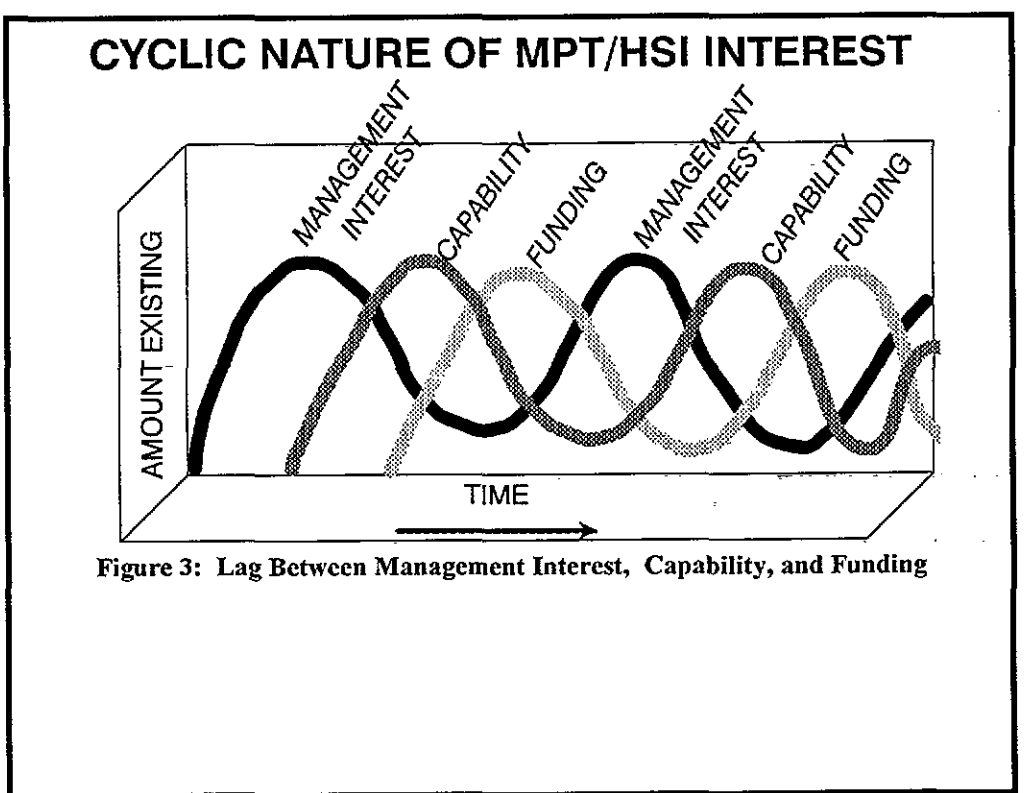

Figure 3: Lag Between Management Interest, Capability, and Funding

REGULATORY GUIDANCE

When briefed on HSI, generally everyone considers the idea of increased emphasis on Manpower, Personnel, Training, and Human Factors "motherhood and apple pie," but they also concede they need lots of help in how to do MPT analysis. In recognition of this need, the Department of Defense (DoD) mandated a series of system acquisition directives, DoDD 5000.1, instructions DoDI 5000.2, and manuals DoD 5000.2M which require HSI analyses during the acquisition process. *Defense Acquisition Management Policies and Procedures,* "...requires the effective integration of human considerations in system design in order to improve total system performance." Design objectives for human components of a system are to be established at Milestone I, then subsequently addressed and refined at each phase of the acquisition process. Further, the Director of Defense Research and Engineering (1992). lists "human-systems interface, design automation, and environmental effects" as three of the eleven key DoD technologies in system design. (Gentner, Crissey, 1993)

TOOLS

With the DoD mandate to perform Human Systems Integration analysis on acquisition systems, government and contractors have produced (or are producing) an impressive array of tools to meet the analysis needs. With this wealth of HSI technologies, it is often difficult to identify which tool is available and appropriate. Under the sponsorship of the Office of the Assistant Secretary of Defense and the North Atlantic Treaty Organization (NATO) Research Study Group 21, the term "Liveware" was coined and a survey conducted to collect and catalog the human-related Manpower, Personnel, Training, Safety, Health Hazard Prevention, and Human Factors Engineering tools. A total of over 500 tools were identified and analyzed. (Gentner, Crissey, 1993) The greatest number of technologies were in the training area, and the fewest in Health Hazards. Over half of the technologies were developed by the military, the remaining by industry and academia. Two of the most impressive MPT tools cataloged belonged to the Air Force and the Army.

The Air Force is developing a Manpower, Personnel, and Training in Acquisition Decision Support System (MPT DSS). The MPT DSS is an integrated set of analysis tools to help inject design influences in the acquisition and modification of Air Force weapon systems in support of the Air Force's IMPACTS program. These tools consist of a Specialty Structuring tool to structure jobs from the ground up, at the task level, or restructure a specialty starting from an existing definition; a Personnel Aptitude and Characteristics model to ensure that the collection of job tasks does not require unreasonably high aptitude levels or physical profile characteristics that can't be supported by the Air Force population; a Training Resources Requirements tool to project an estimate of resources needed to establish and maintain the training pipeline; a Manpower estimating tool to determine the number of people required to operate, maintain, support, and train a single unit or squadron; a Force Structuring tool to aggregate the manpower estimates into wings, groups, MAJCOMS, and force level projections using appropriate overhead and support ratios; an Inventory Projection/Civilian Availability model to determine whether the civilian populace can support the level of aptitude in the numbers identified from the Force Projection model; a Trade-off model to balance between Manpower, Personnel, and Training as they each affect the other. Finally, all decisions will be run through a Life-Cycle Costing model to determine a bottom line dollar figure for the MPT element of the equation.

The Army in support of it's HSI effort has produced a suite of six software programs called HARDMAN III. The six HARDMAN III tools are illustrated in Figure 4. The first module, the System Performance and RAM (Reliability, Availability, and Maintainability) Criteria Estimation Aid (SPARC), is used to set realistic system and mission performance criteria through the use of task network modeling. The Manpower Constraints Estimation Aid (M-CON), Personnel Constraints Estimation Aid (P-CON), and the Training Constraints Aid (T-CON) are used to identify the number of soldiers, and their skills and abilities, and the training resources likely to be available. The last two models, Manpower-based System Evaluation Aid (MAN-SEVAL) and Personnel-based System Evaluation Aid (PER-SEVAL), are used to evaluate system design with respect to the manpower crew size and personnel characteristics required. (Alender, McAnulty, 1992)

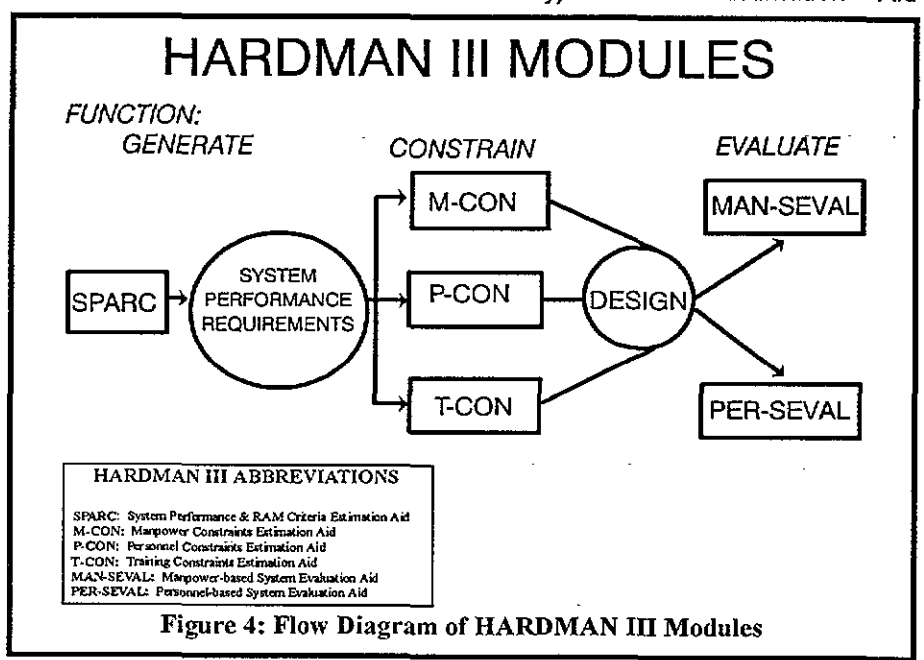

Figure 4: Flow Diagram of HARDMAN III Modules

RECOMMENDATIONS

To recommend change, or advocate change, is generally not a very popular thing to do. Many people don't like advocates, or advocacy programs. They feel that if something's value isn't self evident, then it isn't worth doing. It would be extremely simple to get things done if everyone immediately understood the value of an action, and would independently do whatever was required to accomplish the action. But this isn't the way people behave. Too many times we act like sheep waiting for someone to show us the way to the barn. President John Kennedy was the advocate for putting a man on the moon. Through his vision, we as a nation were able to see.

The following recommendations on how to improve the consideration of HSI issues within the DoD are solely the opinions of the authors and do not reflect the thoughts or recommendations of any other person, service, or organization. The recommendations are based on the authors' fifty two years of combined Department of Defense experience in the areas of manpower, personnel, training, human factors, logistics, operations, acquisition, maintenance, operations research, computer simulation, and requirements policy.

In order for HSI to have the maximum impact on acquisition and cost, there must be a strong advocate, high in the chain of command, who will demand that HSI be given attention. The Secretary of Defense's focal point for Human Systems Integration, Personnel and Readiness (formerly called Force Manpower and Personnel (FM&P)), should be augmented with representatives from all the services, and experts from the HSI domains (Manpower, Personnel, Training, Human Factors, Safety, and Environmental) and empowered as the joint services HSI office for developing policy and procedures. Too often the services have, in their rush to respond to the needs of a rapidly changing environment, unknowingly duplicated research being carried out by one or more of the other services. Establishing Personnel and Readiness as the joint OPR for HSI would be a first step in developing cooperation in the HSI domain. By providing such an organization the possibility for duplication is reduced, and the development on inner service synergy possible.

The development of joint inter service plans and policy without the teeth to back it up, would only be a paper tiger. To give teeth to the tiger, the HSI plan should be made an exit criteria for the Defense Acquisition Board (DAB). No program would be allowed to transition to the next phase until the plan had been approved.

Not only is policy needed, but the proper tools and techniques must also be available. To ensure adequate HSI analysis tools are available, money must be made available for research and analysis, and training. To accomplish this, a Program Element (PE) should be established for HSI, funded, and the money used to develop training, and the tools and techniques necessary to evaluate and tradeoff HSI issues in system acquisition.

A joint service HSI office for research should be established. This would be an ideal way to avoid possible duplication, and develop inner service cooperation. This office would be tasked with developing new HSI tools and techniques, and integrating those the services currently have.

If the establishment of joint HSI policy and research offices are deemed unworkable, the establishment of a joint services working group and steering committee for HSI issues should be considered. The working group would be responsible for evaluating the services individual HSI programs; making recommendations as to how to take advantage of processes and products already developed; and recommending any new research that might be needed. The steering committee would consider the overall needs of the HSI program, the individual service's needs, and make recommendations on how to integrate the best of each.

CONCLUSION

The "integration" of domains and requirements, such as is accomplished in the Human Systems "Integration" program, is not a new concept, but one very difficult to achieve, or sometimes accept. We are so use to working in a narrow "stove pipe" world it is hard to see beyond our own set boundaries. If we are to succeed and prosper in this very competitive world we must be willing to work together and share ideas. The ideas presented in this paper are nothing more than the utilization of the principles of Concurrent Engineering and Total Quality Management. Multi-disciplined teams have been shown to be an excellent way to exchange and perfect ideas. By forming joint service teams to address HSI issues and research, we can produce the most cost effective, and integrated approach for addressing the human in acquisition.

In the classic tale *The Wizard of Oz*, the road to the magic city of Oz was a well marked yellow brick road. As Dorothy and her friends traveled the road it took heart, courage, and intelligence to reach their goal. The road to the consideration of human elements in acquisition is not so well marked as the yellow brick road, but just as hazardous. The services must also have the traits of Dorothy and her friends, as well as patience and perseverance, to obtain their goals. The road to consideration of Manpower, Personnel, Training, and Human Factors in acquisition has been eroded by lack of top-level guidance and support, lack of incentives to reduce manpower, lack of money, lack of experienced practitioners, and the lack of integrated analysis tools to perform tradeoff analysis. But times are changing! The drastic draw down in services' manpower and budgets has reemphasized the need to get the absolute most out of the services' most costly resource -- manpower. The lag between management emphasis, policy, and tools has now been narrowed, or in some cases, eliminated. The services now have (or shortly will have) the tools to respond to the call for increased MPT analysis.

As for the likely future of HSI--although current force draw downs and funding reductions have resulted in reduced support for active programs in HSI, these same factors are likely to bring increased high-level management interest once the short-term reaction to force structure change has passed. In the face of decreased funding, it will become essential to reduce manpower requirements to the absolute minimum to support both new and modified systems.

To overcome the long-term resistance to HSI life cycle planning, the major commands and high-level service leadership must be convinced that the savings are real, and that the benefits are the fielding of well planned usable systems. The upturn in HSI interest and support is just around the corner--hang on.

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