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ISSUES IN USING A DIS FACILITY IN ANALYSIS

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ABSTRACT

This paper analyzes the future prospects for the use of the Theater Battle Arena (TBA) specifically, and Distributed Interactive Simulation (DIS) facilities in general, in conducting analysis for senior Air Force leadership. The desire is to broaden the use of the TBA in the arena of combat analysis. We believe that such a study would benefit other participants in the Advanced Distributed Simulation (ADS) environment as they plan, develop, construct, and upgrade facilities that take advantage of the still emerging ADS technology.

1 INTRODUCTION

The DIS Steering Committee (1994) published *The DIS Vision* and declared the primary mission of DIS was to define an infrastructure for linking live, virtual, and constructive simulations, at various locations, for the simulation of highly interactive activities (e.g., combat). The document also states that the infrastructure should provide an architecture and protocols for a seamless environment that supports:

- training and education
- design and prototyping
- planning and rehearsal of Operations missions (Warfighting)
- developing new concepts of operations readiness

testing new systems early in the research and development cycle

Though there was no specific mention of analysis, the missions of development of new concepts of operations, testing new systems, and design and prototyping imply a tie with analysis which thus far is not well specified.

The Pentagon is currently home to a single DIS facility, the Theater Battle Arena (TBA). The TBA, in addition to its access to the DIS environment, has developed a superb visual, graphic, and virtual capability that can be linked to the exercises in which the TBA participates. Several models, simulations, and simulators have also been included in this facility. BGEN Campbell, the Director of Modeling, Simulation and Analysis for the Deputy Chief of Staff of the Air Force (Plans and Operations), outlined the TBA's current mission. *"The purpose of the TBA is to highlight capabilities within the Air Force to support its warfighters through modeling and simulation."* Again the idea of analysis is implied, but the role of DIS within the TBA with respect to analysis is not specifically stated.

Dewars et al. (1994) outline the concerns that many in the analysis community have expressed about the role of DIS in analysis. The authors present a view of what the future of analysis might look like within the DIS architecture and proceed to outline a number of problems that must be overcome prior to using DIS to perform acceptable analysis. Many analysts from the Air Force Studies and Analysis Agency (AFSAA), as well as from other services, are struggling to find an appropriate use of the DIS architecture and environment for analysis. Most admit the analysis attempts have fallen short of classic analytical standards. This paper documents the attempts of 9 officers to identify the current options available to the AFSAA analysts in using the TBA and its DIS environment.

The purpose of AFSAA is to provide the Chief of Staff of the Air Force with whatever analytical support he requires. Often, this means direct support of his initiatives. Less frequently, AFSAA is tasked to support other Air Staff agencies, and occasionally asked to support Major Commands such as Air Combat Command (ACC), Air Mobility Command (AMC), or the Air Force Materiel Command (AFMC). Specific programs such as the B-1 bomber or the F-22 Fighter may also be directly supported with analysis. Currently, the AFSAA provides analytical support to the Air staff and the Air Force operations, acquisition, training, logistics, and research and development communities.

The agency's motto, "Shed Light" accurately identifies the purpose and contribution within the Air Force.

With the shift from the Cold War world to a New World Order, heralded by the fall of the Berlin Wall, the demand for quality analysis has not diminished. With the DIS environment allowing many of the models and simulations to be tied to virtual and live worlds, more questions are being asked as to the fidelity, credibility, and validity of the results and more analysis of these results is required. Although much of the technology and applications of technology is still emerging, AFSAA analysts want to know how to use the TBA for analysis, now.

The current focus of the TBA includes providing a graphical display as a visualization tool for presenting information to key decision-makers as they view an entire campaign or selected pieces of the battle. "A picture is worth a thousand words" is especially true when demonstrating the effects of a new weapon system or a new concept of operations. Such graphical and visualization capabilities are a major step forward, especially in communicating analytical results to high-level decision makers. The current TBA vision also includes being able to run distributed simulations across a network in *REAL TIME* with ultimately thousands of entities participating. The proof of the concept of a large-scale exercise has occurred but there are still many obstacles in the way of making such exercises commonplace; see DIS Steering Committee (1994). The users of TBA want to move forward and implement AFSAA's current suite of models within DIS exercises and utilizing DIS protocols. A number of difficulties have already arisen. The first problems are those that are common to most DIS exercises:

- Adjudication issues over who shot whom, Battle Damage Assessment (BDA), and conflicts over differences in fidelity between models. (The highest fidelity model is not always used to adjudicate combat results.)
- Synchronization issues of addressing time step vs. event step.
- Compatibility of models that differ in resolution, treatment of units, databases, and the information included in Packet Data Units (PDUs).

The second list consists of problems specific to TBA or any DIS facility trying to participate in the DIS exercises while also performing analysis on the results of the exercise:

- Data capture issues of what information should be kept and in what format
- Which measures of effectiveness (MOEs) should be developed, captured, and used
- How to use the battle-trace feature
- How to filter and use the massive quantities of data.

All of these issues remain open at this time and provide some idea of the scope of the problem.

Because of the U.S. Army's greater experience in the DIS arena, the Air Force should be able to draw on this experience to gain insight into the use of DIS. Within the Army analytic community there has been a practice of maintaining a division between models and simulations which are used for training and those used for analysis. We believe that most models built to accomplish *everything* well (i.e., accurately, quickly, consistently) usually result in models that are not very good at anything. One of the most widely used high resolution land combat models is JANUS. Up until 1994, JANUS actually had a separate model accredited for training (JANUS-T) and one for analysis (JANUS-A); see Joint Staff (1989). The Army analysts look upon hardware and software as tools for analysis, not as the drivers of the goals of the analysis. DIS/ADS are also viewed as a new tool set which has potential use for analysis. Finally, a key ARMY leader in the OR field recently offered the opinion that the future of analysis and DIS facilities, like the TBA, may be at the theater or campaign level helping key leaders make decisions without a tie to real time. He observed:

"The future of the DIS technology and the value of ADS will probably be its use by Warfighters to evaluate the joint concept of operations prior to execution. Except for the rare simulation of an anti-terrorist operation, I don't see a four-star watching A Company for 12 hours while it maneuvers into position for battle."

With the introduction of the DIS/ADS technologies we may be witnessing a shift in the modeling paradigm. Hughes (1989) provides a visual depiction of an ordinal ranking of military models based on four characteristics. The characteristics are:

- the level of human interaction and operational realism
- the degree of abstraction
- the reproducibility of the outcomes
- the convenience and flexibility of the models.

We have amended the Hughes diagram (see Figure 1) to include virtual models and to show the scope of simulations capable of being connected within the DIS environment. In general, there is now a capability to provide feedback during an exercise and the capability to include a number of different types of models in a single scenario. This advantage comes with some problems (which at this point are unresolved). Major among these problems is the issue of connecting a number of models which have different levels of fidelity within them. An example of this problem would be an Air Force model of a close air support mission dropping a guided bomb unit onto an enemy tank. The tank unit, being played by a different simulation (and probably in a different location), only knows of one type of bomb and adjudicates the battle damage based upon its own model which may be of questionable fidelity with respect to the bomb.

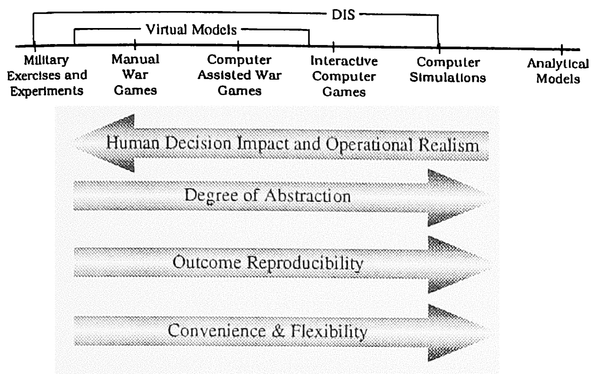

Figure 1: Traditional Characteristics of Models have Changed

The introduction of the ability to play more Human-in-the-Loop (HITL) simulations translates into more fidelity given a specific person on a specific day. Including HITL does not mean we are any closer to the expected or average performance. However, there is now an opportunity to examine a number of human factors issues which have in the past been ignored in military modeling due to the inability to effectively include them in large exercises or in key decision making roles. A recent example of human factors inclusion was a study accomplished by AFSAA where F-15 simulators were used at the MacAir facility to examine pilot response times and decision sequences. The results of this study were then used within the BRAWLER (a high resolution, air-to-air simulation) analysis to evaluate the effectiveness of the proposed F-22 fighter.

Areas of Opportunity: Figure 2 shows a view of the current modeling and simulation environment within the Air Force. This graphic indicates at least three options for examining the use of a DIS facility for analytical purposes. At AFSAA, as at most combat analysis agencies, there exist both high resolution (detailed, engineering-level, one vs. one models) and low resolution (aggregated, campaign/theater level, many vs. many) models. At all levels within this structure the impact of the HITL could be a key factor in determining the combat effects of operations, new weapon systems, and new tactics. Hence, human factors analysis can and should be part of the entire spectrum of simulations until the analysis resolution drops down so far on the engineering scale that we are modeling packets and electrons rather than systems controlled by a human.

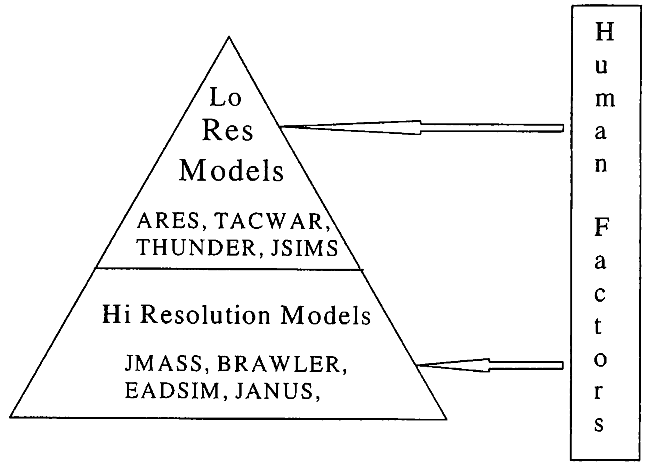

Figure 2: Hi-Res, Lo-Res, and Human Factors Analysis

2 HUMAN FACTORS ANALYSIS

As an area of great opportunity for a DIS facility, human factors analysis may be able to overcome a major military modeling shortfall: a lack of sensitivity of combat results to human capabilities. At the tactical level, a study of specific mission tasks (high resolution) may prove very useful. There are labs throughout the country equipped to do such studies - Wright Labs, Armstrong Labs, Brooks Labs - but most are not able to include simulations from various services or of various weapon systems. For ergonomic HITL studies, a DIS facility such as TBA is capable of easy adaptation, thus lowering the expense of individual studies and the time needed to conduct it. A HITL simulation exercise could be analyzed to indicate what type of reaction would occur in actual combat. Human factor analysis could include inputs from live instrumented ranges and could address how a human link affects/enhances the execution of new operational C^4I^2EW concepts. Consider the command and control of Close Air Support aircraft. Do the command and control models that are currently available, such as those in EADSIM; see Joint Staff (1994), accurately portray the decision processes with respect to time delay, quality, and consistency of decisions made? The ability to validate/calibrate human responses in constructive models may provide a larger measure of validity to analytical results. AFSAA (1993) recently used the F-22/F-15 simulators at MacAir to do this for their BRAWLER air-to-air analysis.

Thus far, the DIS technology and the TBA have been exploited mainly for training purposes, not for analysis. Hartman (1985b) explains:

> *"Human interactive models have the obvious advantage of simplicity--the hard decisions are handed off to the human player. Having a human decision maker introduces problems in the analysis of the model output, however, since it is generally impossible to reconstruct the audit trail of cause and effect to explain why a particular decision was made."*

What TBA can contribute to this problem is the ability to maintain the audit trail for the decisions made by players within a combat simulation. This audit trail can be analyzed both for training purposes (how combat tasks affect decision making) and for analysis of how different human decisions affect the outcome of combat. A number of issues need to be resolved before human factors analysis within DIS facilities is widely applied and accepted:

1. What is the availability of human participants, decision makers?
2. How appropriate is modeling this phenomenon?
3. How to "rerun" an HITL simulation to get valid replications -
   a. Is the same operator needed? If so, how will learning affect the results?
   b. How many trials?
   c. Is the same environment possible?
   d. What statistical level of significance is necessary or possible?
4. How to control the HITL simulation -
   a. Can the data be displayed to the participant(s) properly?
   b. Is the flow of data and information correct?
5. How to perform sensitivity analysis?
6. Has the model of the real world been improved with respect to the purpose of the model?

Point 6 is crucial -- simulations are often criticized by operators for their lack of realism, i.e. no Gs, no sweat, no death. Combat models are often judged based on fidelity or closeness to reality. Including a HITL within a DIS environment should prove to be a major leap forward in fidelity if we can answer the questions given above. Dewars et al. (1994) discuss many of these basic human factors analysis problems. While some of the questions can be answered using classic techniques; see McCormick (1976), USAMC (1981), questions 1, 2, 4, and 5 are relatively unanswered and must be addressed. Whatever we have done in the past, the closeness to reality afforded by the HITL should improve within a DIS environment. It is likely that intensive use of a DIS facility like the TBA or Warbreaker; see Case (1995), in combination with human factors analysis could significantly improve the state of the art of HITL simulations and the value of such analysis.

Reference point 5, sensitivity analysis can be performed on a small number of levels of a human factor/characteristic to see if realism is warranted. If the results are not significantly affected (determined by the purpose of the test) then more realism may not be worth the cost in terms of dollars, time, safety, and effort.

Although human factors analysis, assumed to include analysis of human decision making, may imply real-time analysis, this is not always the case. For many of the C^3I experiments, real-time has less importance than the quality of the decision. In other words, the decision making ability of the human involved is often much more important than how quickly the decision is made. The decisions may depend upon the amount of information available, the quality of the information, and the idiosyncrasies of the decision maker. This may affect the execution of an exercise by running either faster or slower than real-time when the other simulations are assuming real-time. Simulations that are implemented entirely in-house, without a link to remote players, are more flexible, more controllable, and can still be run using DIS protocols. In-house simulations can usually run much faster than DIS (i.e., external) simulations, allowing jumps to critical decision points and possibly *more analysis per hour*. This is currently hardware, bandwidth, and facility dependent and will be so for the next few years; see DIS Steering Committee (1994).

3 HIGH RESOLUTION MODELING

The opportunities for high resolution analysis in the short term focus on the acquisition analysis of system level prototypes in a virtual "fly before you buy" arena. The concept of virtual prototyping will be a valuable one as systems become even more complex, expensive, and difficult to produce particularly as budgets continue to contract. The systems, or at least the important characteristics of the systems, can be modeled and experimented with in a DIS environment. Analysis of the modeled characteristics will be easily controlled and much less expensive and dangerous to accomplish. The TBA advantage of visualizing both the experiments and the results of the analysis leads to rapid identification of deficiencies in a system and appropriate adjustments to the system requirements.

Much of the more aggregated analysis is based on parameters estimated after a high resolution modeling effort. A good example is the aggregate air model THUNDER; see Joint Staff (1994), basing its attrition coefficients on the Hi-Res simulation BRAWLER; see Joint Staff (1989). The link to human factors is now obvious since BRAWLER parameters have been updated based upon recent human factors analysis in the DIS environment ; see DIS Steering Committee (1993).

The Warbreaker facility (a DIS facility maintained by ARPA) has proven that Hi-Res analysis can be done within a DIS facility, at least at a local level; see Case (1995). ARPA has assessed system capabilities of the virtual system High Altitude Endurance Unmanned Aeronautical Vehicle (HAE UAV) within their facility and plan several more tests in 1995. Some of the tests involve linkage to other assets which can only be elsewhere in the DIS environment.

The type of analysis that may be applicable to the TBA would be an evaluation of similar systems that have been offered as solutions to previously identified operational problems. Similar to the Warbreaker facility, different systems could be rated on their effects upon the execution and success of a campaign plan. For example, a UAV and a SR-71 (reconnaissance plane) could each be utilized in attempting to intercept an enemy missile during the early portion of its flight (called the boost phase intercept scenario). The systems, one of which is a virtual system, would be rated on their ability to assist in the overall goal of destroying the enemy missiles.

Feasibility testing of future operational concepts has been discussed as a valuable use of the TBA. To visually watch a perhaps eccentric tactic be explored during a DIS exercise helps the decision maker verify the exact actions he (she) intended, watch the effects of such tactics, and essentially analyze for himself the value of the operational concept. As always, there is danger in such experiments that one or two initial results will be accepted as `truth'. The need for the ability to conduct analysis within a designed experiment is evident.

Of the uses discussed, the most promising Hi-Res analysis application in the TBA would be system requirements analysis. The advantages of the TBA allow integration of the inputs of live/HITL results to the generally constructive modeling effort. Instances of this type of analysis are already being planned and accomplished at Warbreaker, the Tactical Air Command and Control Simulation Facility (TACCSF), and TBA.

There are drawbacks and limitations of Hi-Res analysis using DIS, including:

1. Establishment of a standard resolution level -- Hi-Res may connote engineering level of resolution, one entity per weapon system, or one entity per small unit or group of weapon systems.
2. Adjudication of combat -- Controlling the killer-victim scoreboard and selecting the "right" fidelity model to determine the outcome of a firing event.
3. Actual data collected would be Hi-Res model dependent -- Since the data comes from every model involved in the exercise, the results would have mixed levels of fidelity, even if the models have the same level of resolution.
4. Common, large scale exercises using remote DIS sites are still a hope of the future-- only a proof of concept has occurred (e.g., the STOW-E exercise). There are bandwidth problems and coordination problems.

The TBA has some specific limitations that are not necessarily DIS limitations:

1. Data collection limitations. Sufficient manpower, hardware, and software are necessary for capturing, filtering, and analyzing large amounts of raw data. A smart data collection capability, e.g. one that could identify the appropriate data needed for a specified purpose, is needed. A graphical user interface (GUI) would be desirable for this task. Filters are a necessity since the number of PDUs generated during a relatively small exercise is too large to store completely. A database capable of easy manipulation by an analyst is also a necessity.
2. Space requirements limit the number of individual models, simulations, and simulators that can be housed in the facility.
3. Expertise for each model being maintained and operated in the facility is required. Most simulations are not one-person, one-machine systems.
4. A lack of DIS capable combat models, possibly because of the two previous limitations, is currently the case. If a facility is limited to a single model, then the role a given DIS facility can play in an exercise is also limited, as is the type of analysis that can be accomplished. The future may be a new generation of models which are DIS compliant. EADSIM is currently being successfully used while BRAWLER is being assessed for use. Other model architectures, such as the ARES framework or JMASS, are promising joint models for the future.
5. Slowdown of the simulation from real time or crash of the entire exercise because of overloads on the network are real problems. Reliability of a DIS exercise through DSI nodes or T-1 lines also depend upon all of the exercises running. Graceful degradation is very important characteristic that is not yet a reality.
6. Lack of sufficiently realistic simulators limits the type of human factors analysis and the fidelity of results. Again the degree of resolution and degree of fidelity must agree with the objectives of the exercise.

Hi-Res analysis, indeed, Hi-Res modeling should be well-defined. To some Hi-Res means item level weapons, simulators, one-on-one fighting, individual missiles. Hi-Res to others means every soldier in the ground combat battle throughout the theater. Still, to others, Hi-Res connotes engineering level or even molecular level simulation. For instance, EADSIM assigns an entity to every weapon system being played. To some this is a Hi-Res simulation model. However, EADSIM does not simulate the flight of a missile down to the molecular or engineering level. Therefore, many consider the model to be a Low-Res model with respect to missile fly-out. In addition, Hi-Res does NOT go hand-in-hand with low-level since missile defense and theater level time-critical targets (TCTs) are simulated in relatively high resolution but are not low-level threats. They are analyzed and controlled at the Corps, Theater, or Campaign level.

Many of the limitations listed above could be fixed with increased funding, staffing, and space. In an era of limited resources, innovative solutions to the limitations or adjustment of the types and scope of analysis desired are necessary. This is an area for further research by the simulation, analysis, and modeling communities.

4 LOW RESOLUTION MODELING

The current aims of low resolution (Lo-Res) modeling typically include supporting the Warfighters by identifying problems in the joint concept of operations execution, supporting planners and trainers with future campaign analyses which focus on doctrinal issues, and supporting force structure analysis. Force structure analysis will increase in importance as weapon system justification will be linked to its contribution to the joint combat effectiveness, e.g., Mobility, Space, C^3I^2EW.

Because Lo-Res simulations and models assume entities are aggregations of lower level entities (e.g., a battalion represents 700 soldiers), fewer entities, at a given scope, are required than in a Hi-Res simulation. However, in DIS a Lo-Res model is still tied to real-time because of its linkage to Hi-Res models also playing in the exercise and as the scope of the Lo-Res model increases, the number of Hi-Res simulation entities (and PDUs) drastically increase. Therefore the limitation of bandwidth is just as serious with Lo-Res modeling. If the simulation is contained totally within the facility, without using DIS protocols, then the advantages of Lo-Res simulations can be realized. These advantages are well-defined and discussed in Hartmann (1985).

Data collection in Lo-Res exercises has different problems. The objectives of a Lo-Res exercise are necessarily different and require more intelligent data gathering. There are more types of information that can be analyzed in a high-level, Lo-Res environment and require more flexible and easier to use databases and information analysis tools.

The staffing and limitations discussed in regards to the Hi-Res analysis are exacerbated in a Lo-Res environment. Example: THUNDER often requires several months for scenario development along with a large staff. The conflict itself may only be a 1 week, theater level war.

There is a valid concern that DIS and Lo-Res/high-level models are not compatible. DIS implies real time, while most aggregated models do not. DIS allows human interaction, most high-level models only allow human interaction at the highest levels (EAGLE is a model that does allow human interaction at intermediate levels). Aggregated models can be run as stand alone systems and do not need the coordination and overhead that the DIS system needs. The aggregation and disaggregation required to run Lo-Res models simultaneously with Hi-Res models currently used in DIS exercises has not been solved. The best project to-date to solve this aggregation problem has been the EAGLE-BDS-D project which has made some significant strides towards improving vertical compatibility. All of these concerns must be addressed before a capability discussed in the first section of this paper can be realized.

Aggregated, Lo-Res analysis should focus on interoperability of joint doctrine, the impact of new technology potential in the combat arena, and contingency planning at the theater/campaign level. The joint requirement is a reason to include DIS in Lo-Res analysis since many aggregated models are single-service oriented (Eagle, THUNDER, Corban, etc.), although there are several models that are actual multi-service models (JTLS, FTLM, and TACWAR). In the future, a new generation of DIS compatible models (JSIMS, JMASS, and ARES) will be available.

Similar to the Hi-Res analysis, performing Lo-Res analysis in a DIS facility such as the TBA has drawbacks and limitations including:

- Data collection capability
- Coordination of a large number of players
- Present suite of models is inadequate -- Need to add Lo-Res models such as TACWAR, JTLS, EAGLE, or AWSIM. Perhaps wait for the new ARES architecture (similar to JSIMS). Joint capability is a must.
- Lo-Res analysis requires more staffing for increased information analysis and scenario development
- Hardware currently installed is not geared towards low-Res modeling; the cost of conversion would be great (TBA specific).
- Air Force assets are generally modeled in a Hi-Res form, therefore, there is less experience in Lo-Res modeling (TBA specific)

A critical step forward might include a joint DIS environment located in the Pentagon and connected to the TBA. With a joint hub and all four services connected on a LAN, credible joint campaign analysis might be conducted. In this environment new configurations of forces might be tried, new concepts of operations might be exploited, new (futuristic) systems might prove their worth prior to development, production, and deployment. We would be able to identify holes in a battle plan prior to execution and consider drawbacks to our employment philosophies prior to an enemy exploiting them.

5 RECOMMENDATIONS

Given TBA's critical location in the Pentagon, superb visualization assets, and its link into the DIS environment, several recommendations are presented. We believe the most benefits will be achieved by adopting a crawl-walk-run philosophy. In other words, get good at one thing at a time, verify it works, validate it against real world data, then move on to the next area. Build confidence in the operation.

- Concentrate on Hi-Res, high-level analysis of critical, limited scope problems. There has been some success already in this area. Develop a comprehensive plan for each experiment to include very specific objectives that are achievable within the limitations of both the TBA and DIS. An executable and supportable experimental design is important.
- Improve the data collection, database management, and data analysis tools available to the data analyst. Ensure the design of experiment and the analysis plan have taken data limitations into account. Recommend development of a smart data collector that ties directly into the DIS PDU stream -- possibly with a user friendly GUI front-end.
- Concentrate on system requirements analysis. A function or problem that exists on the actual or virtual battlefield will be attacked using systems designed by requirements, utilizing the resources of the TBA (e.g. successful Theater Ballistic defense).
- Based upon staff and space limitations, limit the amount of analysis actually done in the TBA. Capitalize on the visualization tools in the TBA but perform majority of technical analysis with other than TBA analysis and at a different location.
- Also based upon equipment and space limitations, conduct small group or single person human factors experiments and analysis. Focus on decision maker(s) rather than operators.
- Use the DIS interface as a tool for educating analysts and decision makers about the elements and advantages of the DIS environment. Also recommend using the passive mode for monitoring exercises and ensuring Air Power is being played sufficiently well to properly indicate the effect of its presence in joint exercises.
- When the DIS community has solved several of its most difficult problems, become involved in Lo-Res analysis using the DIS interface. Until such time, Lo-Res analysis should be accomplished using the simulations and models that have been used before DIS was available.
- Develop a methodology for analyzing different concepts of operations. For instance, use the replay function to change a tactic and analyze the change in outcome. This could be used for developing doctrine or for building a guideline for choosing courses of action (COAs).

6 CONCLUSIONS

Similar to the experience of the Artificial Intelligence (AI) community in the 1980s, DIS/ADS has probably been oversold. AI was hailed as the savior of the OR community, capable of solving all problems and developing new paradigms for analysis. As AI failed to deliver on the more grandiose (and unachievable) claims, it lost credibility within much of the scientific community. However, within narrow realms AI has made a great impact, e.g. the use of rule-based expert systems for diagnostics in the medical community. To preclude DIS/ADS from experiencing a similar setback, we must address the limitations, and obstacles involved in pursuing the advancements that draw us closer to an ADS training and analysis environment.

The coordination of a DIS facility, like the TBA, would be constrained by resources, money, and time. The proper staffing would be in excess of current TBA manning levels and would probably require at least a Supervisor, 2 mid-level analysts, a hardware manager, and 3 to 5 additional junior analysts.

A final conclusion is that a DIS facility, like the TBA, should serve as a tool for analysts in AFSAA rather than a stand alone analysis cell. The TBA members should be technical experts in a given area such as data collection, DIS protocols, or design of experiments. The analysts (e.g. in AFSAA) would would consider the appropriateness of using the TBA in the analysis. If appropriate, the facility would be scheduled. The TBA staff would work with the analyst to design an experiment appropriate for the task.

Alternative Uses: Although this paper has presented a discussion of uses of DIS facilities in performing operational, system requirements, and human factors analysis from a purely military perspective, the DIS environment offers many potentially profitable opportunities to commercial, industrial, and political decision makers and analysts.

- Airport design, development, and operations. Designers and operators of airports could use DIS facilities to try out new concepts, train pilots and crew, and reveal potential logistics problems.

- Olympic Games operations. Distributed simulations of games' events could be as important as the now proven virtual Olympic city flyover.
- Design and improvement of large factories (automobile, heavy construction equipment, etc.). Human interaction in the section, department, and factory has its effect upon production and quality.
- Testing, retraining of remote company personnel on high-tech equipment. Trainees may be trainers, maintainers, or sales representatives use a local DIS facility to retrain, saving travel time and expenses.
- Crew, staff, and customer interaction/participation in new designs of commercial aircraft.
- Design and operation of vehicle-installed navigation systems and transportation flow effects..

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