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"Defense Acquisition and Virtual Prototyping"

Luncheon Address of
The Under Secretary of Defense for Acquisition and Technology
Dr. Paul G. Kaminski
to the
NSIA Collaborative Virtual Prototyping (CVP) Symposium
Crystal Gateway Marriott Hotel, Arlington VA

April 23, 1996

It is a great pleasure to be with you at this important and timely conference. It is important because industry and DoD must cooperate to identify and resolve common issues preventing more effective use of virtual prototyping and advanced modeling and simulation capabilities.

The conference is timely because the Department of Defense, through the establishment of the Defense Modeling and Simulation Office and adoption of DoD Modeling and Simulation Master Plan in October 1995, has begun to move forward on a more coherent strategy for improving oversight and coordination of DoD modeling and simulation activities.

DEFENSE INVESTMENT FORECAST

Let me start with a brief look at the defense budget and a forecast of the Department's investment accounts. During this post-Cold War adjustment phase, we have brought the total defense budget down about a third from the peak levels reached in 1985. We have also maintained a high state of readiness to support increased operational tempos—our deployments in this period are up by a third.

We have done this by reducing our procurement at a pace that is twice the rate of the overall downturn in total obligation authority. This response is consistent with historical norms. . . procurement has traditionally been the most volatile component of the budget in a draw down because it is not necessary to purchase new equipment for a smaller force structure.

But this approach also defers future readiness. I view this as a temporary condition as we complete our draw down, which is just about over. Our current level of investment--it was about $39 billion in procurement and $34 billion in RDT&E in the FY97 budget request--will not sustain the Bottom Up Review (BUR) force over the long term. The draw down is nearly complete, and so, we will have to increase our investment spending to sustain the force.

But if I take a realistic look at the overall Federal budget picture, there will be continued pressure to limit increases in defense investment spending. In this climate, we must think in terms of a modernization strategy, rather than a re-capitalization strategy, for equipping our forces. To me, re-capitalization of our current inventories implies a one-for-one replacement of existing platforms with new ones with similar capabilities. On the other hand, a modernization strategy means developing and fielding fewer, more capable systems. Over the foreseeable future, it is plainly apparent that we cannot afford one-for-one replacement of our tanks, ships and planes.

AN ALTERNATE PATH

The key issue is managing the cost of more advanced, more complex systems. Norm Augustine, the CEO of Lockheed Martin, pointed out some years ago that the cost of each successive generation of fighter aircraft was increasing geometrically. As a result, although fighter aircraft were becoming more and more capable, the United States could afford fewer and fewer of them.

Augustine's projection—an extrapolation of aircraft unit cost as a function of deployment date--was that by some time in the middle of the next century the United States would only be able to afford one fearsomely sophisticated aircraft and the military services would each take turns flying it!

The key point to remember is that Augustine's prediction is empirical. It is based upon *our past experience and processes* for handling the interplay of increasingly complex technologies. We in the Department and American industry clearly need to share responsibility for finding an alternate path to field affordable, modern systems.

INDUSTRY ROLE

I believe industry must continue to make a cultural change—already under way today—by shifting from serial to integrated processes for product development and support. Integrated Product and Process Development (IPPD), also known as concurrent engineering, stresses cross-functional evaluations and a shared vision of the system.

The key to reducing costs associated with integrating complex systems will be for the functional members of an Integrated Product Team (IPT)—design, engineering, manufacturing, logistics, product support—to understand the concerns of their counterparts and identify the technical challenges on the program as early as possible.

Use of standard, relatively inexpensive computer equipment, virtual prototypes and simulations helps to bring together a shared vision of the system and provides a means for understanding the complex interactions among the configuration items in the system design. Some studies indicate that the use of computer aided design/manufacturing (CAD/CAM) tools and common databases can result in significant manufacturing cost avoidance, including:

- 20-60% reductions in set up time
- 15-25% reductions in planned labor and tooling
- 15-75% reductions in rework and scrap
- 20-50% reductions in work-in-progress carrying cost

The real power of a computer based modeling and simulation system lies in the connection and coordination between the tools and functional users. Systems that provide a seamless environment for geographically distributed teams and a diverse set of functional users will tend to lead to cost avoidance on the higher end of the ranges I shared with you earlier. In addition to increasing the effectiveness of the design and manufacturing functional specialists, the product support members of the team will benefit as well—testers, logisticians and maintainers.

The bottom line is that integrated product and process development, backed up by a strong commitment to computer based modeling and simulation tools, provides a dominant competitive edge in the commercial marketplace and a clear warfighting edge on the battlefield. It provides an alternate path for getting to market first and at a lower cost. In the process, quality is improved. Products are customized.

Let's look at two commercial examples. The first is Boeing's use of Computer Aided Three Dimensional Interactive Applications—IBM's CATIA software—for the development of the 777 aircraft. Boeing's management made the decision to change the culture of the company and invest $100 million in a computer aided development capability.

As a result, there is no physical mock up for an aircraft with 85,000 components and over four million parts. The goal is to achieve the same number of manufacturing hours as the 767--for an aircraft with 57% greater empty weight. To date, Boeing is reporting a 93% reduction in design changes compared with earlier aircraft at the same stage of development.

My second example illustrates the point that computer assisted integrated product development is not just for large corporations. In this case, Kohler's Engine Division is a producer of small 5-25 horsepower 4-cycle lawn mower engines. This company is a small player in a big field. The business strategy is fairly straightforward--sell engines by offering superior performance and high reliability at a lower cost.

Kohler has been using state-of-the-art CAD/CAM tools to introduce new designs that are radically different from earlier versions—quite a departure from the evolutionary change approach traditionally practiced by this industry. At Kohler, manufacturing cycle times have been cut by two years. Physical prototypes are no longer necessary. Kohler offers a 2-year warranty—the longest in the industry.

As a result, John Deere selected Kohler for its line of lawn mowers instead of the previous supplier—Kawasaki. Kohler's market share has continued to grow significantly over the past several years. My point is that the technologies for integrated product development, virtual prototypes and modeling and simulation are widespread and available to smaller corporations. If correctly managed, transition costs should not present an insurmountable entry barrier to smaller, moderate sized corporations.

Another conclusion I draw from these two examples is that world class producers across both ends of the manufacturing spectrum—from 777 aircraft to 20 horsepower lawn mower engines—are being driven by market forces and are finding a way to chart a new path off of Augustine's cost forecast for fielding increasingly complex systems.

If the underlying technology is widespread and market forces are driving industry towards an integrated product development approach, what is DoD's role in charting a new course for making weapon systems more affordable?

DEPARTMENT OF DEFENSE ROLE

Simply stated, the Department needs to become a smarter buyer in both what and how we buy defense equipment. To me, the "what to buy" question is far more important than "how to buy."

What to buy

To determine what we will buy, the Department is placing considerable emphasis on a systems-of-systems decision making approach or construct. Our goal is to select the most cost-effective mix of type and number of individual systems for development and fielding. In pursuing this approach, we are typically making trades between on-board and off-board capabilities with regard to individual systems. Alternative systems are evaluated in simulated combat conditions.

Just within this past year, the 1995 Heavy Bomber Study looked at adequacy of the planned bomber force within the context of a two major regional contingency scenario, supporting tactical air forces and a mix of on-board weapons with varying capabilities against the simulated threats. The Strategic Airlift Force Mix Analysis and Tactical Utility Analysis were used to evaluate the cost-effectiveness of various mixes of C-17 aircraft and non-developmental airlift aircraft (NDAA) to perform airlift missions in support of various contingency operations. This year a similar study is underway to evaluate the mix of accurate guided weapons being procured by the Department.

As these examples illustrate, a hierarchy of models and simulations are used to help the Department make the "what to buy" decisions. At the engagement or system-on-system level, system effectiveness against an adversary system is evaluated. At the mission/battle or force-on-force level, the ability of a multiple platform force package to perform a specific mission is evaluated. And finally, in theater/campaign level simulations, the outcomes of a conflict are determined for a total package of joint and combined forces.

At the current time, I envision extensive use of constructive models and simulations for these system-of-system evaluations. Eventually, I see greater use of virtual simulations in which virtual prototypes are operated on synthetic battlefields.

Without question, the Department will move to make greater use of simulation based evaluations of systems. As we do so, the Department must ensure that these assessments are made in a controlled and repeatable environment. For example, the Department is taking steps to establish such an environment, known as the C4ISR Decision Support Center for evaluating systems in a combined C4I (Command, Control, Communications, Computers and Intelligence) and ISR (Intelligence, Surveillance and Reconnaissance) environment.

The Department's "what to buy" decisions are also being driven by life cycle cost-performance trades where cost is an independent variable (CAIV).

How to buy

The Department is changing it's approach for "how to buy" systems. We are institutionalizing our "how to buy" initiatives, including the use of virtual prototypes and modeling and simulation, in a new version of the Department's 5000 series acquisition regulations. The new regulation will strongly encourage the use of models and simulations to improve quality and to reduce acquisition time, resources, and risks.

It will also encourage embedding virtual prototypes in synthetic environments to support requirements definition, concept exploration, manufacturing and testing of new systems. The recent LPD-17 Early Operational Assessment, for example, used a CAD/CAM representation as its basis. I expect that more such EOAs based on Virtual Prototyping to be planned and documented in TEMPs and acquisition strategies.

We have found that decision cycle times are improved when program managers and functional staffs have assess to modeling and simulation results. General Dynamics Electric Boat Division has implemented a Production Automated Design Process

(PADP) with the goal of making the information available to reduce cycle time and cost, and improve product quality by integrating the engineering design process and manufacturing considerations early in the life cycle of the New Attack Submarine.

On the Joint Strike Fighter Program—extensive use is made of modeling and simulation to perform:

- Mission area analyses
- Operational analyses
- Requirements trade-offs
- Conceptual design studies
- Systems engineering trade-offs
- Cost and operational effectiveness analyses; and
- Logistics analyses

As a result, significant commonality and life cycle cost reductions have been achieved among some seemingly disparate Air Force, Marine Corps, U.S. Navy and Royal Navy strike aircraft requirements.

Our experience with the New Attack Submarine and Joint Strike Fighter programs strongly supports the view that modeling and simulation is a tool to manage program risk—both technical and operational. In this regard, I see virtual prototypes in the role of facilitating increased user involvement and early visualization of the system. By operating virtual prototypes in a stand alone mode or connecting them to an electronic battlefield, the program manager can make an early estimate of operational effectiveness. This kind of assessment will identify system strengths and provide an opportunity to correct weaknesses at a time when the greatest amount of flexibility exists to make changes.

Models and simulations also allow the program manager to measure and track performance against milestone decision criteria. A virtual factory can be developed to evaluate the producibility of a design and initiate tooling design at an early stage of the program. By identifying the maintenance and supply requirements associated with a design, a program manager can exert positive front end control over the system's logistics "footprint" and life cycle cost.

The benefits to training are virtually unlimited. Special attention must be given to the development of training simulators that are developed in parallel with embedded training and maintenance concepts.

Since simulations could eventually be part of source selection, cost and operational effectiveness analysis and test planning and evaluation, we may need to have RFPs include identification of those models and simulations the government plans to use in evaluation, and that the industry response to the RFP include a proposed modeling and simulation plan.

Our program managers and the contractors who support them should plan on developing a simulation support plan to identify the resources required for modeling and simulation activities and ensure the acquisition strategy leverages the modeling and simulation investment. A good simulation support plan, submited in response to the RFP, will ensure that analyses are repeatable, traceable and credible. It will further demonstrate that offerors understand and have integrated the use of modeling and simulation into a life-cycle view consistent with the vision I have outlined for you today.

It is absolutely essential to be able to reconstruct an analysis at a later date; produce an audit trail for analyzing causes and effects; and making documentation available to reduce the risk of misuse of the output. A strong configuration management plan as part of the simulation support plan will also help maintain interface control—something that is required to maintain simulation interoperability.

SUMMARY

In summary, our challenge is clear cut--break the trend of geometrically escalating costs in successive generations of defense equipment. Limiting the sophistication, and therefore, the capability of future systems is not a realistic option. Our task is to field increasingly complex technologies at a more affordable cost on shortened acquisition cycle times.

It is clear to me that this task is well understood in the commercial sector. Market driven competition from world class producers are forcing a renaissance in approaches to development of commercial products—from 777 aircraft to lawn mower engines. We are now seeing the emergence of close knit teams, working together, and employing an integrated product and process development approach that fully integrates the use of virtual prototypes and simulation into the design, manufacturing, test and logistics support of products.

It is going to take a team effort by industry and the DoD to field a superior capability, affordably and in less time than our potential adversaries. Industry needs to continuously upgrade their integrated product development capabilities using the latest information technologies. The DoD needs to become a smarter buyer. Together, we must evolve our acquisition management culture to take advantage of integrated product development approaches by stressing the need for a *shared vision* and *continuous insight* -- to ensure that quality is built into programs from the start.

Thank you.