ASSESSMENT OF COMPUTER AIDS

IN SHIPYARDS

A Project of

The National Shipbuilding Research Program

for

The Society of Naval Architects and Marine Engineers
Ship Production Committee
Design/Production Integration Panel SP-4

April, 1993

COASTAL GROUP TECHNOLOGY

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Contents

SUMMARY

Background and History

The shipbuilding industry in the United States stands at the crossroads of major changes in the global marketplace. Panel SP4 is trying to launch a major project to examine the best computer technology to assist yards to enter this new marketplace. This study records progress to date and especially the initiating national conference held in May 1992.

The idea for the SNAME Panel SP4 initiative on computer aids came horn Panel discussions regarding a series of projects to assess the status and scope ofcomputeraids in shipyards worldwide with potential application to United States and Canadian shipyards. A five year program was discussed and the first year project was awarded to Coastal Group Technology in late 1991. CGT in turn prepared for and held an initiating national workshop conference in May 1992 with representatives of the shipbuilding, ship design, supplier, and government communities.

The May conference built a foundation and rationale for encouraging the industry to share sensitive information about their computer systems among the competing companies. In this first phase the original intent was to provide a methodology and vehicle under which to initiate a progressive process of disclosure and technology refinement intended to up-grade the industry as a whole over a five year period.

The workshop on computer aids was formed to create a vision of the best trends in computer aids through the next decade while at the same time providing a future business vision for the U.S. shipbuilding industry and sharing views on how U.S. shipbuilding might best provide products and services to fulfill the recommended vision.

The second part of this first phase was to describe and model a process for inventorying and assessing the actual multiplicity of computer aids independently adopted across the forty major companies of the Anerican shipbuilding industry. The full scale inventory and assessment was anticipated in year two after the industry as a whole was prepared to recognize the benefits of technological collaboration. Owing to the unanticipated lack offunding for the second year of this research, the Production Design/Integration Panel requested that an abbreviated inventory be conducted toward the end of the first year.

The value of this first year's work resides less in the inventory of computer aids at yards than in identification of the barriers to the introduction of new hardware and software to upgrade the industry. The response to the premature inventory was predictably weak with only six of forty companies responding. However, the six respondents do represent over 70% of the industry's capacity.

Participants at the May 1992 conference were startled to find that the collective

consensus clearly shows that no progress with better computer aids is possible without a very significant breakthrough in the extent to which yards, suppliers, designers, and customers cooperate. Twelve objectives with 83 initiatives resulted from the conference. Fullfillment of most of these depend upon both short term and long term actions as well as continuous support from NSRP over the next few years.

Results of Surveys

Analysis of the data is detailed later in this document. A summary of observations and conclusions horn this analysis are as follows:

- Yards assign the highest importance to teamwork and collaboration to make computer system efforts work
- The greatest number of applications are supporting shop and material planning
- The use of mainframe systems has shrunk to 27% of the total number of applications
- Historically there was a surge of new applications in the early 1970's and a second surge of new uses in the mid 1980's
- Applications planned for upgrade exhibit no clear pattern of functions nor of user size; in fact, there seems to be considerable differences between yards in their plans for upgrades of their computer systems
- If this small sample of data is indicative of the whole industry there is strong need for collaborative direction, if this sample is insufficient as evidence of significant trends, more research is needed in the near future.

Results of Meetings

The workplan for this first phase study counted on the integral participation of the Design/Production Integration (SP-4) Panel. Indeed the major May conference was critiqued by the July Panel meeting and led to adding the special questionnaire on computer systems reported here in. The value of the participation of such an ongoing and knowledgeable panel in a forum of collaboration and professional exchange for the good of the future of the industry can not be overstressed.

The rewarding results of these meetings, while generating some unexpected surprises, provide a valid channel to the realities of our North American shipbuilding industry. Unfortunately the results did not gain expression soon enough for continued finding next year. The meetings, however, resulted in a well considered action plan along with analysis methods to position the industry in the markets of the world.

Recommendations

With appropriate resources backing this action plan, it leads us to take both short term and long term steps toward industry liability. Ultimately we cannot control what we cannot produce; sustaining our economy so that we provide our children and grandchildren with options requires that we produce many kinds of products. Although

shipbuilding represents a small part of the United States economy, it is a bellweather for complex, heavy and high technology industry. Shipbuilding combines both factory line production and outdoor construction. Consequently and potentially our industry can combine the best practices of flexible computer integrated manufacturing with the best practices of complex outdoor projects.

We are not talking here about top managers alone. Middle management represents both a barrier to success as well as an essential ingredient for successful application of new approaches and technologies to this very old industry. All levels of management must participate in the process of keeping the ball rolling!

The participants in this initial study presented the problem in a most realistic manner. The message stands out clearly from the knowledge bases assembled at the workshop: change our thinking and change it fat! Some participants gave the industry as little as two years to do so.

It is not enough to have sounded this alarm and to have proposed 83 concrete steps toward improvement. The Council and the Panel must keep the momentum of this project going. Several U.S. Navy programs partly support continued action. Without such support the follow up to the action items would be weak or lacking altogether. With timely support the action plan can lead to a viable transformation of our' industry.

TASK 1
Identification of potential and relevant organizations or programs

Participants in the major workshop conference were chosen for their ability to represent and articulate the needs and values of U.S. and Canadian ship construction endeavors. Of the twenty-one participants the great majority were leading engineering or system executives. Several were consultants in the field and others represented major suppliers to the industry.

The participants selected represent a suitable cross-section of high technology in the best of American industries. Not only shipbuilding experts but also heavy manufacturing experts participated. Each party was judged to be well connected laterally and vertically in their industry and capable of implementing improvements in computer aids. The collective experience of this group represents 500 man years with the application and development of computer systems.

Participants were selected through Dan Thompson and James VanderSchaaf together with recommendations horn NSRP panel and council members. They were recruited by mail and by phone through initial discussion of the concept and the objectives of the project. Further details were provided by the facilitator, Dr. Michael Kelly. Background material was supplied by Dan Thompson.

The following people participated

Robert C. Badgett,
Computer aided Acquisition and Logistic Systems consultant

Dan Billingsley
U.S. Navy, Director of CAD, NAVSEA Code 507

Carl F. Bryant III,
computer consultant and former propeller manufacturer

Dan Cada,
AEGIS CALS Coordinator, U.S. Navy

Neil Cambridge, Coastal Group Technology and
Eclipse Business Systems Consulting,
computer programer to banks, manufactures, and distributors

Mike Connery
General Electric Corporation, GE Electronics Park
Seamless systems for ships, submarines, sonars, and radars

James Crocker, consultant and
installer of manufacturing resource planning (MRP II) systems for GE and shipyards

Lorna Estep,
Director FCIM (flexible computer Integrated manufacturing), Department of Defense and the U.S. Navy, Trident Research Center

Paul Friedman,
Director of Engineering Technology
Bath Iron Works Corporation
Jim Hutto, Intergraph
CAD II Program Manger

Michael T. Kelly, Ph.D.
Coastal Group Technology
FACILITATOR and management psychologist

Douglas J. Martin,
NASSCO shipyard, San Diego
Technical Information Systems

Jon Matthews,
JJH *InC.*
Design Manager JJH and NIDDESC Representative

Richard C. Moore,
Jonathan Corporation and member of Panel SP-4

Marion Nichols, Shipyard MRPII and
industry TQM experience
Digital Equipment Corporation

Robert Schaffran, Program Manager
Head, Design & Management Systems Division
U.S.N David Taylor Research Center, Code 125

James R.VanderSchaaf, Director of New Systems
Bath Iron Works Corporation

Daniel H. Thompson
Coastal Group Technology
PRINCIPAL INVESTIGATOR and management consultant

James R. Wilkins Jr.D.Eng.
Coastal Group Technology and
Wilkins Enterprise Inc.
ship program management and consultant to NAVSEA

Dan Wooley, Supervisor for Seawolf CAD VIVID system
Newport News Shipyard

Joe Wudyka, Corporate Manufacturing
Digital Equipment Corporation

TASK 2
Formulation of questionnaires about computer aids
Solicitations of interest and support

In addition to the many questions raised for the May workshop and in response to suggestions made at the July 1992 SP-4 Panel meeting, a questionnaire was sent to several shipyards and other organizations. The questions ranged from judgement of the importance of various computer systems to historical facts about systems in use. The questions were posed with the understanding that the answers would be reported in such a way that the responding organizations would not be identified with their response.

The text of the questions are included in Appendix B. The first part asks for information on functions, installations, and number of users. The second part asks for judgement of me relative importance of 27 areas of shipyard computer system interest. These questions are based upon knowledgeable shipyard sources and were developed with the intent that answers would be helpful in the overall assessment of the computer aids to shipyards in the United States and Canada.

Forty questionnaires were sent out on the 27th of July 1992. By 21 October 1992 only 6 were returned. However, those that were returned were from major shipyards. The data horn the returned questionnaires provide information on over two hundred computer programs in use in shipyards in addition to judgement on the 27 areas addressed in the second part of the questionnaire.

In an industry in which every participating company views itself as competing for a percentage of a rapidly shrinking market, computer-aids can represent a strategic competitive edge. This perception leads companies to regard collecting an inventory of computer tools as a potentially threatening exercise. Should a company's automation strategy leak out, it would be like a boxer telegraphing his punches. Given the lack of time and resources for making the serious effort necessary to overcome this negative perception, the response was better than expected. With the level offunding originally anticipated, one could develop enthusiasm for a thorough inventory across the industry.

Many solicitations for interest and support preceeded this study. Most of these occurred in preparation for the conference in May. Many persons wanted to attend but were unable to for various reasons. Virtually all were supportive. The few who were not felt that the study didn't directly support their interests in the highly competitive and specialized field of computer aided design for shipyards. In the absence of funds from NSRP others propose to help with the finding to continue with the next years' scope of work.

Most of all, the SP-4 Panel members themselves contributed to the study and helped move toward an industry collaboration in one of the only forums of its kind in the United States, the NSRP. In addition to the overall congressional support through the Defense Advanced Research Projects Agency (DARPA) for revitalizing American shipbuilding, NAVSEA is supporting this project by integrating the 83 initiatives with the current Design, Acquisition, and Construction (DAC) projects being conducted by NAVSEA. The Navy in general is sensitive to the need for the nation to nurture its ship building and maintenance capability. The Navy is also sensitive to the need to convert from military building to commercial and globally competitive construction.

This subject will be revisited in the discussion of Task 6 and its recommended action plan.

TASK 3
Development of common computer-aid system evaluation models for testing in the yard organizations
Report of major meeting in Brunswick [Appendix A]

After due consideration of the options and upon the advice of shipyard persomel, Coastal Group Technology chose the strategy verification model for collaborative decision making, described in the Summary below, as the evaluation model for testing

decision making, described in the Summary below, as the evaluation model for testing computer aids in shipyards. The decade of experience with this method led to its choice. As a ready test of its viability, this model then formed the centerpiece for research and culminated in the major meeting conducted in May 1992 in Brunswick, Maine. A summary of the meeting follows and Appendix A contains the full report.

The SP4 workshop on computer aids was convened for three days, Thursday, Friday, Saturday, May 14-16,1992, atthe Captain Daniel Stone Inn, a Canadian Hotel in Brunswick, Maine. Thursday started with a demanding, non-stop brainstorming session, shining lunches and work into the evening. Friday was equally intense but focused on how to reach and realize the vision through actual actions to be taken now and in the Mure. Saturday each of the participants was privately interviewed for one hour to expand on the meaning of each of the action initiatives as well as on general observations.

Well ahead of the actual workshop, prospective participants were sent material on the facilitation process selected. This insured that all were familiar with the agenda and methodology when they arrived for the meeting.

The facilitator, Dr. Kelly, set the stage for the first session by asking each participant to take the role of a member of the Board of Directors of The U.S. shipbuilding industry. Each panelist was instructed to assume responsibility for setting the strategic direction for a major industry whose corporate and product identity commands world-wide recognition. It was left to each participant to bring his own set of values and perspectives that might be evoked by such association. The stage was further defined by stating that the group was now engaged in a three day session to determine the most profitable and productive future direction of the industry by providing the most appropriate computer technologies available or becoming available.

The results of the conference are reported in Appendix A. Appendix A recounts in detail the experiences of those at the conference. The same results are also reported in the literature as SNAME paper by Daniel H. Thompson entitled "The SP-4 Workshop on Computer Aids for Shipyards," paper No. 2B-3 before the NSRP Ship Production Symposium, New Orleans, 2-4 September 1992.

SUMMARY
of the
STRATEGY VERIFICATION PROCESS

Successful Action

Successful action requires total knowledge, cooperation, and capacity. The strategy verification method used to facilitate the SP-4 workshop follows a process designed to continually increase the quality of action toward such perfection.

Research at Boeing Company using a similar, though less integrated system, has shown that the calendar time for projects which require team meetings can be reduced typically 91 percent. Overall meeting time can be reduced as much as 71 percent (6).

So many ideas are created by so many people during an advanced management catalyst workshop (AMCat) that using marker pens and flip charts is prohibitively cumbersome and time-consuming. With a skilled operator handling a system consisting of a personal computer, printer, and projector however, three major benefits can be derived

- The facilitator is able to concentrate on eliciting the maximum participation from each member of the group
- All contributions are recorded and analyzed with great precision "
- Statements, lists, and matrices are clearly and quickly displayed and changed, leading to more rapid audience understanding and reaction.

What happens is that the technology, combined with the advanced management workshop process, actually begins to create knowledge, unlike simple data processing which can only create information It then makes that knowledge immediately available so that a bridge is built between the formulation of strategy and its implementation. It becomes catalytic. Figure 1 illustrates the principle which makes this possible.

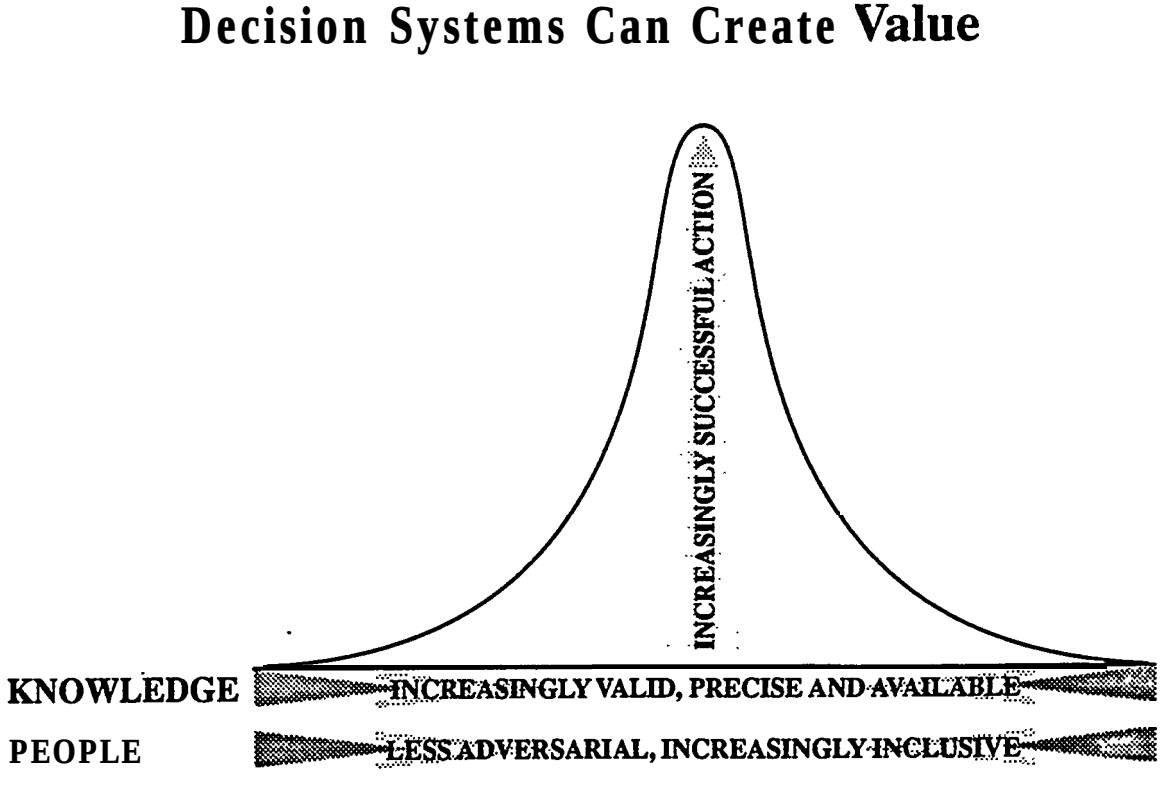

Fig. 1 Increase value to society by developing decision systems which use valid knowledge to complete appropriate action.

This figure illustrates the inter-relationship between knowledge, society, and

actions which create net positive value. As knowledge increases in validity, precision and availability, it gains leverage. Knowledge is valid when it is understood in a common context (3). It is precise when it is relevant and sufficient to describe the subject. It is available when it is at hand "just in time."

Knowledge, cooperation, and capacity are terms meaningful in a systems context, but they are inoperative without people. People supply knowledge and capacity. The success of action depends on the extent to which people cooperate to provide knowledge and capacity to their endeavors. Adversaries do not contribute to each other, but instead limit knowledge and the capacity of the system.

All in the shipbuilding industry are in the same boat. The total American shipbuilding system includes all knowledge and all concerned with this knowledge. Once this fact is realized by all,they becomeless adversarial and more willing to include new ideas from others. With valid knowledge the industry can become not only increasingly successful but also can increase its value to our whole society.

Understanding the potential of group decision systems, we were ready to work toward our first goal of assessing computer aids for shipyards. The process was carefully planned and then tied out in an intense period of time: the workshop itself.

A STRATEGIC VISION FOR THE U.S. SHIPBUILDING INDUSTRY

The participants brainstorming was launched by asking each participant to read the following statement of purpose (A) and a common, agreed upon definition of "Strategic Vision" (B):

(A) Why We've Been Brought Together

For the purpose of determining the direction of effort the shipbuilding industry will take over the course of the next decade, we invite you to assume the persona of a member of the board of directors of The shipbuilding industry. Please regard this position as an opportunity to create the future as much as it is an opportunity to respond to it.

Toward achieving this end, first task will be to describe what the shipbuilding industry's world of customers, technology, and organizational strategy will be over the course of the next (ten) years. We will call this the shipbuilding industry's strategic vision.

At the conclusion of the two day process we are now undataking together, we will have created a strategic vision; brainstormed every option, resource, and step we can imagine to fulfil our (The shipbuilding industry's) vision; refined those options and resources into a set of policy objectives; and mapped a general course for their implementation. We will use a procedure called the Advanced Management Catalyst (advanced management workshop) to orchestrate this process.

(B) What is Strategic Vision?

- A statement of purpose that is bread enough to involve people at every level within the industry and inspiring enough to encourage the emotional involvement of all participants

- An announcement to internal and external customers of what can be expected from the group

- A challenge to all ship builders based on where technology is headed

- The projection of future accomplishment that promises to extend the U.S. ship building industry's domain of influence in terms of both strategy and tactics

- The written description of this group's dream for the future.

Using this definition of strategic vision, the participants created the following strategic vision for The U.S. shipbuilding industry to be implemented over the next decade.

The Particpants Strategic Vision for the U.S. Shipbuilding Industry

We market, design, produce and support ships and other products that utilize similar processes, profitably, with greater value to our customers and in less time than anybody else in the world.

The industry has achieved a significant share of the global market and hence is recognized as a key sector of the U.S. national economy.

This industry recognizes that in order to ensure long term growth it must build better and better products at lower and lower prices and create opportunities for customers, owners, employees and suppliers.

We are:
A world leader in innovation and implementation of information, process and people management. We consistently achieve cycle times at least 10% better than the best in the international market place.

We are:
An industry which prudently reinvests in itself to support continuous improvement in process and capability.

We are:
Enterprises and business units where management and operating teams continually reconcile their processes and products within this vision.

We are:
An industry that creates an environment which supports cooperation among customers,

owners, employees, suppliers, and within itself.

We are:
Proactive in applying technology to improve our products and processes.

We are:
A self sustaining, non-subsidized industrial base.

We are:
An industry which attracts, retains and motivates talented people.

We are:
An industry which delivers what it promises.

We are:
Constantly sharing knowledge with other industries to our mutual benefit.

We are:
Committed to constructing a single ship as cost effectwely as multiples.

We are:
An industry that competitively services ships regardless of where they were built.

We are:
An industry which is continually re-inspired by its heritage.

Creation of a Strategic Vision for the U.S. shipbuilding industry was the most ambitious, debated, analyzed, and creative portion of the participants' activity. Under the non-interventionary guidance of the facilitators, the panel members covered every conceivable aspect of the future direction of marine production, management, and competition debated every possible strategic scenario that might catapult the industry into a position of leadership in providing customer solutions in the future weighed multiple approaches that might ensure capturing the majority of the participants' predictions of where customer values, technologies, economics, and marketing requirements and opportunities are leading. On almost every point, there was a minority view but rarely an unresolved conflict. Thus, the Strategic Vision was adopted and "bought into" by the participants.

The next step in the project brought the participants from visionary definition to specific recommendations. After creating their strategic vision for the shipbuilding industry, the participants identified well over 200 specific options including options for yard aids which could be pursued to fulfill it. After culling, 83 specific initiatives to be undertaken were recommended. These were organized into 12 policy objectives and then put in priority order.

This process forced a "bottoms up approach" on the participants in arriving at these policy objectives. Through vigorous use of brainstorming, the participants offered every conceivable action that they could think of that might be essential to implement

these policy objectives. Through vigorous use of brainstorming, the participants offered every conceivable action that they could think of that might be essential to implement the strategic vision and every possible support action that might be useful in implementing that vision. As evidenced in the final output, these recommended actions are sound, pragmatic, hard-hitting activities, actions, organizational adjustments, and strategic changes that, if implemented, ensure that the U.S. shipbuilding industry will "win" by fulfilling the strategic vision.

Once the participants had exhausted every possible required action for vision implementation, these actions were then grouped into objectives. The objectives were not labeled until a common thread was found whereby several recommended initiatives suggested an objective. By clustering to derive objectives rather than determining objectives and then assigning actions, the workshop's thinking was not constrained by form. Any possible action that a particiipant thought essential for American shipbuilders to claim and fulfill the strategic vision came out on the table and was woven into the policy objectives. The grouping of these initiatives into objectives then helped to integrate the initiatives around common mission style goals. The participants then weighed the various views of their strategic importance based on priority/urgency and feasibility in order to produce a "feasibility matrix." Then they assessed the stage of accomplishment of each objective industry-wide in order to produce a "diagnostic matrix." Both matrices are presented later.

The objectives and initiatives are first presented here as the workshop weighted them. The labels given to the objectives are purposefully brief and self explanatory. The initiatives following each objective are specific and able to be acted on — these actions are each considered necessary to fulfilling the stated objective but may not be all inclusive. See Table I for a brief characterization of objectives and initiatives:

Table I. Numbers of Initiatives per Objective

I Process Definition 15
II Integration 8
III Product Model Exchange 5
IV Product/Process Model 5
V ComputerAided Acquisition and Logistic SUPPORT (CALLS) Implementation 11
VI Human Resources Innovation 7
VII Follow Up 5
VIII Industry Cooperation 9
IX Expert Systems 5
x Configuration Management 3
XI Generic Modular Ship 5
XII Service Life Support 5

Total Initiatives: 83

OBJECTIVES IN PRIORITY ORDER

I. Process Definition

Our objective is to identify the best processes, tools and measurements which support our vision. We define processes as combinations of people, equipment, raw materials, methods, and environment our industry is striving to bring together to produce our products or services.

It is pointless for us to automate existing processes which perpetuate the current inadequate state of our industry in world competition. Instead, we need to document and analyze current practices to define new processes which will lead to our vision.

For example, money should be invested first in systems that improve the competitive position of shipbuilding in the United States. Benchmarking our competitors overseas represents such a system. Then priorities need to be set based on which processes are on the critical path toward that end.

II. Integration

We can and must bringthe improved processes together in a very connected way. This integrated approach will flow from design to implementation through a computer simulation of our ship as a product. The approach treats process and product as system elements and management tools. This computer simulation model must be accessible to all concerned. The complete picture of our processes must include:

- concurrent engineering
- business operations
- overall planning
- yard personnel
- all relevant databases
- proposal and detailed estimates
- work accomplished and reported.

III Product Model Exchange

For integration to work, information must flow freely throughout our industry. Suppliers to shipyards must have access to project data promoted by good interchange standards and organizations dedicated to maintaining them.

IV Product/Process Model

Standardized definitions and information shared by the industry must be captured to document the information required to manage.

V. CALS Implementation

Such integration and clarity of definition lead to the replacement of conventional drawings with digital product models, which provide customers with on-line access to product data and encourages vendors to supply product data with their products. Thus customers, suppliers, and life cycle needs are brought together effectively and efficiently.

Note: Concurrent with this workshop, a relevant systems analysis of U.S. commercial shipbuilding practices was published (7).

VI. Human Resource Innovation

Best processes and product models cannot effect the continuous improvement needed to realize our vision. All of us in the system must be empowered by a new philosophy and understanding of computer aids, concurrent engineering, and team building.

Per his statements on public radio, research by Lester C. Thurow, Dean of M.I.T's Sloan School, indicates that by the end of this century people and their skills will be the *only significant source of competitive advantage in global competition.*

VII Follow Up

We must conduct additional workshops like this one with senior management to build in follow up to this action plan. Also we must develop critical experiments and an industry wide project for reaching our goals.

VIII. Industry Cooperation

In spite of the self destructive intensity of competition between and among our organizations forced by the narrow pursuit of a single and "impoverished" customer, we must create:

- a national consortium for software
- databases of valid knowledge
- customer/producer councils
- leadership forums
- mechanisms for sharing information
- centers of excellence
- assessment and communications nets.

IX Expert Systems

Computer systems which capture the experience of ship designers and shipyard managers can and should be developed. Parametric ship design concepts and management decision modeling tools can greatly facilitate our planning and manufacturing.

X. Configuration Management

We must apply the methods of configuration management to our industry. We must both understand and design computer systems which clearly document and maintain valid knowledge of our processes.

XI. Generic Modular Ship

We need to build a national library of reusable design modules to the parts level of detail. This may require consortiums of Navy and private shipbuilders for commercial ship production with modular designs for both military and commercial ships possibly being produced in the same facility.

XII. Service Life Support

We must develop a new ship repair strategy using advanced technology. New construction methods must be extrapolated to fulfill lifetime support applications including automated crew training aids and shipboard computer aids for at sea operations.

FEASIBILITIES

The Feasibility Matrix was one of the most revealing products of the advanced management workshop process at the workshop. Participants were asked to rate the feasibility of each objective according to the following scale:

0	Conceivable	6	Unfamiliar process
1	Theoretically possible	7	Early Adopters
2	Technically achievable	8	Organizationally viable
3	Innovative	9	Widespread acceptance
4	Producible	10	Routine.
5	Risk Worthy		

The feasibility rating is displayed on the horizontal axis and the priority/urgency is displayed vertically.

The matrix below(figure 2) startled the participants as it gave a shocking picture of the condition of our industry. The information captured from the participants indicates that there is a major barrier to moving critical objectives from implementation to production. The industry has little difficulty developing and demonstrating new methods and technologies; it just can not incorporate them readily! This "wall" represents a management mind set reluctant to embrace emerging team building strategies. This barrier is holding back not only applications of better computer systems to the industry but also the whole industry's effectiveness and efficiency as a whole.

Half of the objective critical to the advancement of our industry are blocked by this wall:

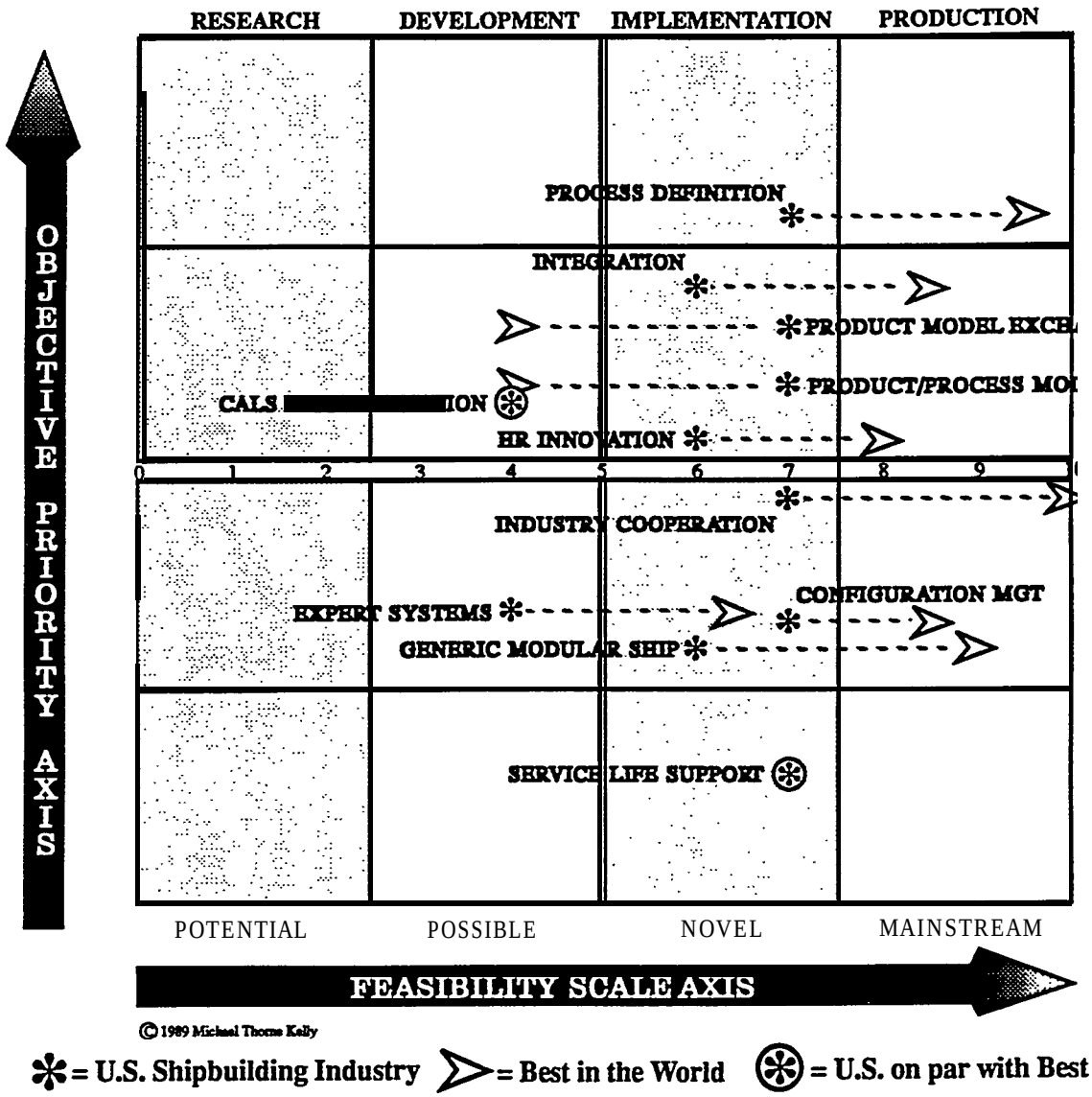

Figure 2 Feasibility Matrix

- Process Definition
- Product Model Exchange
- Product/Process Model
- Industry Cooperation
- Conjuration Management
- Service Life Support.

The first three of these are of the top four in priority!

All 12 objectives are portrayed on Figure 2. Behind each of the objectives are detailed initiative action items. When this conferences reported in final form, the first year of research will be published in the standard report format for NSRP. At that time each of the 83 initiatives will be detailed together with all of the pertinent interviews of participants.

DIAGNOSTIC

The workshop participants were asked to focus on the current stage of peformance of the objectives within the whole industry using the performance stage scale illustrated below. The priority axis is the same as for the feasibility matrix.

The diagnostic matrix illustrates the optimum path for accomplishment. It shows the relationships between objectives as they contribute to fulfilling the vision and how well these priorities are managed.

Figure 3 below shows the priority order of action necessary to move the U.S. shipbuilding industry into viable global competition through computer technology and changes in management practices. It graphically illustrates the fit between priorities and actual use.

The meaning of the performance stages is described below as presented to the participants.

Performance Stages

0—YOU HADN'T THOUGHT OF IT UNTIL NOW.
1—You ARE THINKING ABOUT IT, WONDERING IF IT WILL ACCOMPLISH WHAT YOU INTEND.
2—YOU ARE THINKING SERIOUSLY ABOUT IT; EXAMINING IMPLICATIONS AND FEASIBILITY.
3—YOU HAVE BEGUN PLANNING. IF THIS WERE A BUILDING IT WOULD BE LIKE HAVING THE ARCHITECT BEGIN THE DESIGN.
4—YOU ARE OPERATIONALIZING IT. AGAIN USING THE BUILDING ANALOGY, YOU NOW HAVE YOUR PLANS, SO YOU ARE CALLING THE CONTRACTOR THE CEMENT COMPANY, AND ETC. AND ARRANGING TO HAVE THEM CARRY OUT THEIR TASKS AS REQUIRED BY THE PLAN.
5—YOU ARE READY TO INITIATE IMPLEMENTATION.
6—THE PLAN IS BEING IMPLEMENTED BUT AS YET YOU HAVE NO FEEDBACK ABOUT WHETHER OR NOT IT JS PROGRESSING SUCCESSFULLY.
7—THE PLAN IS BEING IMPLEMENTED AND YOU ARE GETTING POSITIVE RESULTS BUT AS YET YOU ARE STILL INVESTING MORE THAN YOU ARE GETTING.
8—IMPLEMENTATION HAS ACHIEVED INDEPENDENT MOMENTUM. YOU HAVE PASSED THE BREAK-EVEN POINT.
9—YOU ARE MANAGING IMPLEMENTATION. YOU HAVE CREATED AN EFFECTIVE, EFFICIENT SYSTEM THAT REQUIRES THAT YOU DO NOTHING MORE THAN OVERSEE ITS OPERATION.
10—PRODUCTION PROCEEDS EFFORTLESSLY. ALL OF THE IMPLEMENTATION IS DELEGATED LEAVING YOU READY TO UNDERTAKE YOUR NEXT PROJECT.

The lighter area on the matrix is the path of optimum accomplishment. When activity and resources are properly aligned with priorities, objectives fall on this path. According to the consensus of all participants in this advanced management workshop, the U.S. shipbuilding industry has fully 75% of its activity off the path for achieving the strategic vision.

When objectives are behind the path, like Process Definition and five others, it means that there has been insufficient assessment of the risks, rewards and demands involved relative to achieving the strategic vision. When things are ahead

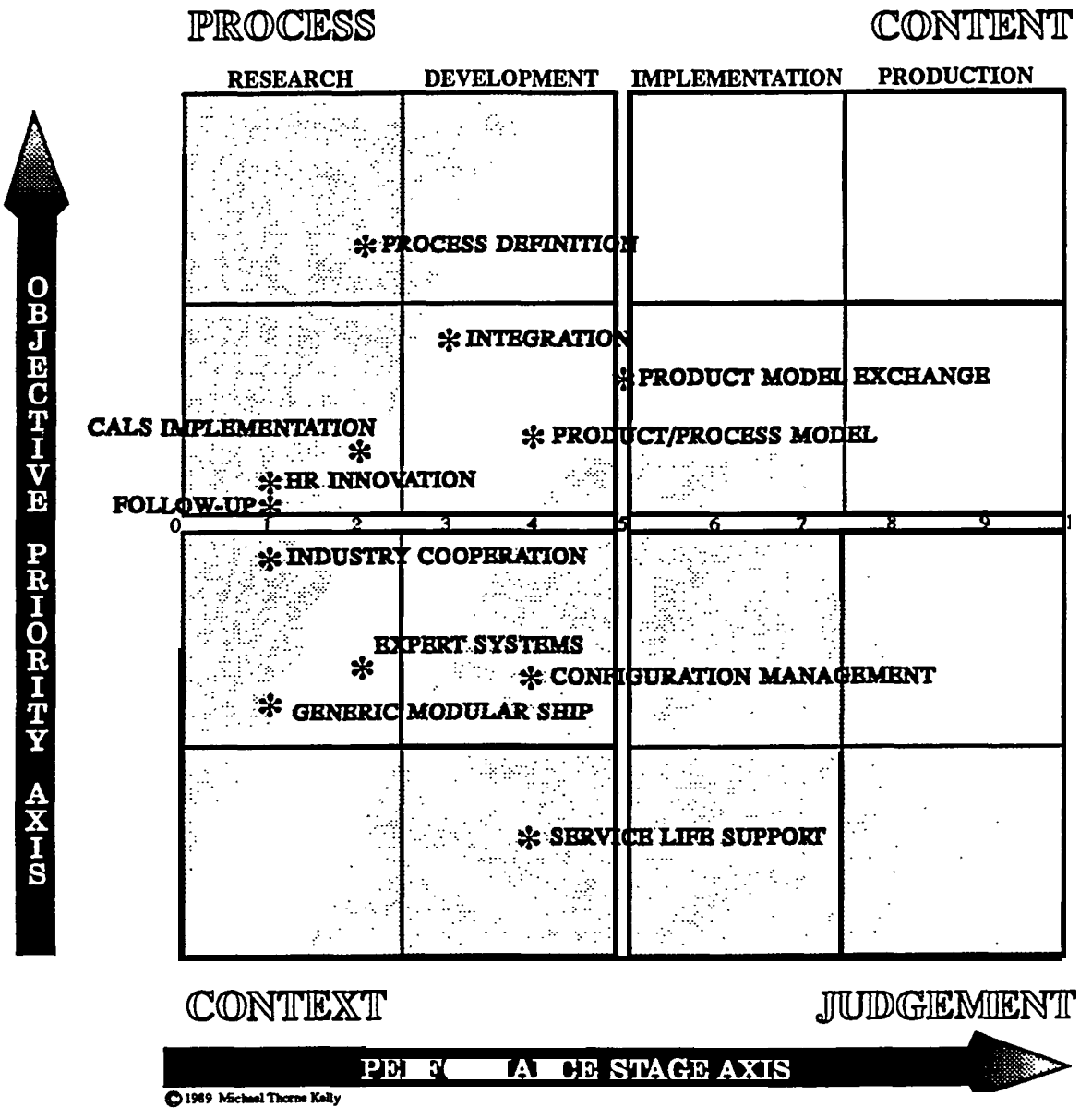

Figure 3 Diagnostic Matrix

of the path, Service Life Support and ConfigurationManagementinthis case, resources have been prematurely allocated.

According to the facilitator, this is the graph of an industry which will be repeatedly blindsided in its attempts to fulfil the strategic vision unless crisis measures are taken to thoroughly assess the effectiveness of the objectives that are behind the path and clear the way for developing them. It will also waste resources on efforts that, though perhaps successful in themselves, will hit a glass ceiling and fail to contribute to accomplishing the vision.

His comment was that 'This is a catastrophe in the making. This is the graph of a start-up industry where no one really knows what they are doing or why. The fact

that the shipbuilding industry in this country is two hundred years old and encumbered with all the unforgiven sins of the past foreshadows a repeat of the U.S. steel industry's staggered pattern of collapse."

COMMENTARY FROM PARTICIPANTS

As indicated in the discussion of the feasibility matrix, all participant comments on initiatives have been recorded. A synopsis of their comments follow.

1. What is your assessment of the vision relative to where we are today?

Everyone agreed that the vision represents a worthy goal for the industry and is based on a relatively accurate overall assessment of the industry.

Repair and ship overhaul is the near term future of the industry, not new construction.

Unless there is general cooperation to support this vision as a Computer-Aided Acquisition and Logistic Support effort the industry is doomed.

It is a great vision but culturally the industry is not prepared to understand it much less implement it. Moreover there are concrete structural impediments to realizing it.

Perhaps the industry can make progress in its thinking if the industry is considered now to be simply one of many defense contracting industries tailor making ships for the Navy.

The vision is an affirmative vision, an aggressive one without question, but when you recognize that there are people in the industry capable of supporting steps toward it right now, it is not impossible at all, more a question of will than substance.

2. How can our strategic plan strengthen the Computer-Aided Acquisition and Logistic Support (CALS) initiatives?

The CALS initiatives could use a lot of strengthening. After six years we do not even have a plan.

"It appears tome that what is planned and will be planned as a result of this workshop will feed right into that [CALS]."

Some questioned the relevance of CALS to commercial shipbuilding; however most agreed that it is relevant to government regulation. It is certainly relevant to the computer tools because it makes the data exchange and makes sure the government does not ask for stuff they really do not need or will not use, as they have a tendency to do.

Implementation of CALS is a means to achieve some strategic notions that we discussed. In addition I think the strategic plan probably would be a help to implementing CALS because it tends to address the issues that CALS does not deal with. It establishes a context for CALS.

The strategic plan could function like abridge between CALS as technology and shipbuilding as business. "There might be some commercial experience that might trim some stuff out of CALS. The proof of that pudding is interest in buying CALS."

3. What constraints need to be eliminated to strengthen the industry?

'The main thing that I think is holding us back is slack of understanding of what the potential is that is at hand right now. The potential is to eliminate the false work, the retrieval effort, the transformation effort that occupies so much of our everyday working efforts."

We are constrained by lack of training, lack of enthusiasm among a gutted user community and by lack of management support.

There is a concern that unless progress is made on a broad front one area will advance at the expense of other areas.

The industry is locked into a drawing with pencil and paper mind set which dictates that you haven't finished the design process until you have a drawing to use as the essential basis for activity. We have to break out of that mold and accept a digital mode for product models. We need to see the drawing as something that needs to exist only in the computer.

The functional similarities across companies are much greater than our differences, but our perceptions of self interest drives us to block the progress possible through collective agreement. The government is maintaining segments of our industry but not supporting the industry as a whole to make substantial leaps forward.

It is difficult for us to relate to each other because we lack a common terminology.

The industry thinks that the Navy is the only game in town and consequently is starving in the midst of global abundance. We need an Apollo style program to build commercial ships for the world.

4: What management attitudes need to be changed?

"Everyone must realize that information technology is no longer the domain of specialists. It is having a pervasive effect on all aspects of NAVSEA's business. Because of the current fiscal environment, the rate of change is becoming revolutionary. Everyone is involved!" (8).

"The old 'theoryx' management style where a manager manages by intimidation is still prevalent."

We have too many layers of management."

"I'm pretty optimistic about the way our unit is transforming itself- I just hope we can do it in time."

"I would focus on changing the attitudes of middle management rather than senior. Many of our middle managers, especially the ones who are real good at their job, because that is what they have been doing for a long time, are hung up on the notion that that is the way God intended it to be done. I see that as our shipyard's biggest impediment. I would focus on middle management attitudes and there is no specific attitude that needs to be changed other than a willingness to change."

The industry is caught up in the attitude that all workers need a crisis to promote productivity. This palpable lie is worn out.

Management has to take the attitude of 'What does it take to be profitable in the commercial business?" The question then is, 'What are the appropriate computer tools for profitable commercial shipbuilding?"

5. What management methods hold the greatest promise for implementing this plan?

Total Quality Management provides an opportunity to create solutions as long as it is not presumed to be the solution itself. me operating philosophy should be one of continuous improvement."

We need employee empowerment including trust in the knowledge of the worker to accomplish positive changes in the processes they know well.

Self directed teamwork leads to the kind of employee empowerment (at the process level) and motivation necessary to global competitiveness.

We need to identify and implement management methods which support faster cycle times, continuous improvement and more efficient use of resources.

Leadership needs to be taught at all levels of our business. Senior management does not understand the nature of leadership confusing it with authority. People on the shop floor are not training in leadership because they are expected to be followers.

6. What is the best approach to standards development for the industry?

"I have been involved with the data exchange standards and they sure have been painful. There has to be a better way."

Were the industry participants to collaborate on and finance standards the outcome would be positive.

'I think our strategic plan has to get the vision right fit, we have to know where we are going. I think we have the foundation in the vision. Then we complete the analysis of best practice for a world class competitive commercial yard including identifying what tools are in that yard, informational, structural or physical tools. After that we decide which of those tools would be used across the industry. Then we standardize the tools that are in this new commercial/military shipyard. These are the tools, especially those tools that help, which are capable of migrating and communicating across shipyards."

Electronic Data Interchange is a viable approach to promoting standards in the industry.

CONCLUSIONS

This action plan should be implemented because it leads us to take both short term and long term steps toward industry viability. Ultimately you cannot control what you cannot produce; therefore, production of many kinds of products is needed to not only sustain our economy but also to provide our children and grandchildren with options. Although shipbuilding represents a small part of the United States economy, it is a bellwether for complex heavy and high technology industry. Shipbuilding combines both factory line production and outdoor construction. Consequently and potentially our industry can combine the best practices of flexible computer integrated manufacturing with the best practices of complex outdoor projects.

We are not talking hereabout tip managers alone. Middle management can be either a barrier to success or a powerful support in attitude and successful application of new approaches and technologies to this very old industry. Let us involve all levels of management in the process of keeping the ball rolling!

We can conclude that the participants in this initial study represent the problem in a most realistic manner. The message that stands out clearly from the knowledge bases assembled at the workshop: change the thinking of the shipbuilding industry and change it fast.

RECOMMENDATIONS

The participants in the workshop sounded this alarm and proposed 83 concrete steps toward improvement, but this is only a beginning. The Executive Control Board and the SPA Panel must keep the momentum of this project going. Without such support the follow up to the action items will be weak or lacking altogether. With support the action plan will lead to more persons committing to more effective actions to save American shipbuilding.

REFERENCES

1. Ernest G.Frankel, "The Path to U.S. Shipbuilding Excellence -- Remaking the U.S. into a World-Class Competitive Shipbuilding Nation," Journal of Ship

Production SNAME, volume 8, number 1, February 1992.

2. Thomas Lamb, "Organizational Theory and Shipbuilding A Brief Overview," Marine Technology, volume 29, number 2, April 1992.

3. Richard Moore, "Point Paper: Which Business Model to Follow for Computer Aids in Shipbuilding? OK Does Operations Management Really Matter?" an unpublished paper forwarded privately to the author in April 1992 to prepare for the workshop on computer aids for shipyards.

4. James Rogness, "Breaking the Chains of Tradition and Fantasy -- A Revolutionary Approach to the Constraints on Productivity", Journal of Ship Production volume 8, number 2, May 1992.

5. Ernest G. Frankel, "Management of Technological Change and Quality in Ship Production,"Journal Of Ship Production, volume 8, number 2, May 1992.

6. "'Computerizing' Dull Meetings is Touted As an Antidote to the Mouth That Bored The Wall Street Journal,, Tuesday, January 28,1992, page B1.

7. Michael Wade and Zbigniew J. Karaszewski, "Infrastructure Study in Shipbuilding A Systems Analysis of U.S. Commercial Shipbuilding Practices", Journal of Ship Production volume 8, number 2, May 1992.

8. Daniel W.Billingsley, Jeffrey D.Arthurs, Karlu Rambhala, and William R.Schmidt, "Revolution at NAVSEA, Managing Design and Engineering Information", paper #14, SNAM/ASE Naval Ship Design Symposium, 25 February 1992.

TASK 4
Conducting cross-organizational workshops to assess and share system evaluation methods
Report of panel meetings
Report of presentation to NSRP
Report of tested model in Virginia Beach [Intergraph Report]

The major cross organizational workshops were the one in May and the July Panel meeting in St.John, New Brunswick, Canada. In addition to the above results of the conference in May, benefits of continuing the efforts next year included the following.

- Radical decrease in total cases of each shipyard developing their own "suboptimized" assessments of computer aids. The method produced will develop a network of people ready to help the industry improve as a whole.

- It is expected that there will be an annual decrease in each shipyard indepen-

dently developing measures and assessments of computer aids at a savings of up to 3 man years per yard. Three man years represents the magnitude of major NSRP projects done in the past. If the methodology is developed collaboratively and only once, this will represent a savings to the industry, conservatively estimated, of 27 man years.

- The network of people ready to help the industry could increase the beneficial interactions ten-fold. Sharing comparative data and assessments of computer aids will ratchet up overall industry competitiveness in the global economy. The NSRP goal of a 3% share of the international shipbuilding market can be achieved.

- Extensive discussion confirmed the importance of the effort and added the need for further benchmarking of the shipyard computer systems by means of a questionnaire specifically designed for the purpose.

Further, it was suggested that the results of the conference in Maybe presented before the National Shipbuilding Research Program annual meeting in New Orleans. Such a report *was* delivered (SNAME paper No. 2B-3 before the NSRP Ship Production Symposium, New Orleans, 2-4 September 1992).

Meanwhile Intergraph Corporation and NAVSEA decided to use the methodology of the May evaluation to bring together requirements for service life support of Navy ships from the P1anning Yard perspective under the CAD II program. Basically the same methods were used in a major conference for that purpose in Virginia Beach, VA, in September 1992. This conference has the further effect of validating the approach taken in this study. That is, most of the barriers to effecting progressive improvements in the application of advanced computer systems to the industry are policy and communications restraints.

TASK 5
Synthesize commonalities and suggested directions for new interchanges of research data
Analysis of questionnairæs [Appendix B]

Afterthe May conference and in preparation for the July SP-4Panel meeting, the thrust of the research was analyzed and presented to the Panel as a Phase II of the overall study. The heart of the next phase would be to implement the 83 initiatives of the May 1992 Phase I workshop to improve the computer aids in shipyards and the concord of the whole industry.

This Phase I (Project N4-91-5) for the assessment of computer aids in shipyards led to the May 1992 workshop participants' recommendations for the shipbuilding industry. The definitive nature of the findings inspire two or three alternative paths for implementation. One path supports the existing competitive structure of the industry.

The second supports a transformation in the relationships among American shipbuilders.

The participants identified 83 initiatives which must be implemented in the near term to support the vision of a world class shipbuilding industry in this country. These initiatives will not be sufficient by themselves, only necessary. All of them require some degree of activity in 1993. Some of them will require major dedication of resources in 1993 and succeeding years. The requisite level of support can come only from individual companies and the federal government. No one else has the necessary people or money.

The first path leads to working with the industry company by company. The workshop facilitates, having fired their shot across the bow of each American shipbuilder, can board and launch a process to implement the 83 initiatives in each company independently. Once integrated in the strategic and operating plans of the individual shipyards, the yards can continue to compete with each other as in the past but toward a goal which has a future. While this would require relatively little imagination or deviation born contemporary industrial processes for incremental change in this country, it risks being too little too late in the final charge to gain world market share in shipbuilding for the coming build cycle with the consequence that there will not be a U.S. shipbuilding industry for succeeding cycles.

If this were the chosen path, the facilitators would hold a workshop at each of the companies which sponsors the panel. Each workshop would bring all of the key corporate decision makers and key technical support people together to develop a corporate strategic plan and operating agenda for the corporation which integrates the 83 initiatives. Since this would be, in part, a reprise of the original workshop tailored to the circumstances of each shipbuilder, it would require significant support from the SP4 panel or born each corporation for 1993.

The second path requires creative imagination. It requires shipbuilders and the federal government to undertake a crash pilot program in full cooperation with each other to fundamentally upgrade major American shipbuilders equivalently and simultaneously and in such a way that the 83 initiatives are implemented atleast in beta test. Designing and building ships by simulating them and their construction in computers and using those simulations to manage activity will soon become standard operating procedure across shipbuilders worldwide because of its effectiveness and efficiency. If it works for ships why not for shipyards?

We suggest that American shipbuilders undertake as a pilot project, the creation of a virtual shipyard which incorporates the 83 initiatives. Fully simulating a shipyard with the intention of discovering by test what works and what does not work will provide objective goals for shipbuilders to pursue to gain competitive advantages in ship construction. No shipbuilder in the world would consider building a ship from a design which had never been tested in a towing tank. The same need for an objective basis stands for construction processes. The computer provides an electronic medium which is equivalent to the water in a towing tank. The virtual yard will serve a role for the industry equivalent to that of the *USS Timmerman* test bed for future destroyer

design at the end of World War II. It will necessarily involve implementation of almost all of the 83 initiatives. The techniques developed and tested in the pilot can then migrate directly into standard operating procedure in the yards. Since the project will bean independent corporation owned and supported equally by the shipyards what is discovered will be available to all and can be incorporated at the discretion of each.

The synergy inherent in this path will open the way for the overall upgrade of the industry to a world class level of competitiveness without giving any single participating company an unfair advantage. Moreover it will not disrupt those aspects of shipbuilding which already work in each company as the Navy initiatives in the sixties and seventies would have. Each company will be able to pick and choose those aspects from the virtual model that meet its needs. Once the model is complete and available to be installed on site, it can be extended to serve as a training and project management tool.

In the case of the second path, the workshop facilitators will spend 1993 gaining commitment, arranging funding, organizing the project and staffing it from among the panel sponsors. The first step will be to hold a meeting of the senior executives of the yards who think they might want to participate. The outcome of this meeting will be an overall goal for the project and a plan of action for implementing it. Cost estimates can be developed from this and then each organization can commit to participate or drop out. Those who commit to go forward will do so in the context of the vision developed in May of 1992. To do this will require the resources indicated in the sections below.

A third alternative for those who like hedging their bets requires pursuing both paths simultaneously. The advantage is that as the virtual shipyard begins to produce information and new processes the yards will be ready to take full advantage of them. This will also support enrichment of the virtual project by allowing the yards to focusing its activities on their own areas of highest priority.

A Recommended Plan for Five Years

- 1992: Complete the 1991 project
- 1993: Coordinate the development of computer aids with the overall national plan to revitalize merchant shipbuilding.

  Conduct an advanced management workshop for the Executive Control Board and representative senior management of the major shipbuilders to breakdown the barriers identified by this study.
- 1994 Effect pilot projects such as the virtual shipyard testing and demonstrating cooperative use of high technology computer systems

- 1995: Create best practice guidelines and industry wide organizations

- 1996: Rebenchmark the global competition and adjust the vision

ŽReconduct the national assessment.

Questionnaires:

Questionnaires were formulated after the July Panel meeting. Results were collected and analyzed in October. The analysis is reported in Appendix B.

TASK 6
Recommended new evaluation and information exchange methods Proposed action plan.

After the May conference, the July Panel meeting, and the presentation before NSRP in New Orleans, several courses of action seemed apparent. These courses were described in part in the recommendations made in July for a Phase II to this study especially see the discussion of Task5, above. Without funding, however, many of the objectives can not be achieved.

At the New Orleans NSRP conference it was suggested that the objectives are too important to lose momentum. Therefore, portions of these objectives and initiatives could be supported from other programs and in other ways. On 18 September 1992 a meeting on this subject was held in Bob Keane's office (Code 05DB) in NAVSEA to explore alternatives including the possibility of the NAVSEA sponsorship of the next two years of the NSRP Panel SP-4'S project on computer aids for shipyards. Attendees at the meeting were;

Bob Keane
Tom Beyer
Dan Billingsley
Craig Carlson (standing in for Cliff Geiger)
Dr. James Wilkins
Dan Thompson.

Dan Thompson led off the discussion by indicating the background above with the desire for this meeting to point in a practical direction to continue the efforts for at least the next two years. It is now clear that the funding from NSRP and DTRC will not be possible because of the funding cycles; Bob Shaffran has tried to apply discretionary funding but with no avail. Dan Thompson and Tom Beyer had discussed the possibility for the Design, Acquisition, and Construction effort taking over the functions of the project until such time as the NSRP can provide sponsorship.

Dan Billingsley agrees with the impetus of this idea to continue the work but notes that many of the activities are in place and it just requires the will of all concerned and especially the shipyards. Dan Thompson draws upon analogous community development experience, which indicates that people tend to rally around a well thought out plan.

Bob Keane discussed how the priorities would work and (after that was explained by the diagrams in Appendix A) suggested that the goal is indeed to focus on process and especially the process between design and production. Later he suggested that the currently formulating DDG-51 upgrade (2B) would be a very good time to develop a generic build strategy, perhaps from the superset of NAVSEA data on building practices as well as from the yards.

After the first meeting, Tom Beyer, Jim Wilkins, and Dan Thompson met to discuss the intersecting possibilities between DAC and the SP-4 project with 12 objectives and especially those in objective I, Process Definition. We see at least four of the 15 initiatives that are high on both agendae: generic build strategy, process analysis, cost analysis, and benchmarking competition. It was agreed that Tom would look at both sets of action items and that Dan Thompson would write up that meeting to get started.

Jim Wilkins asked what the next steps would be beyond the current project which completes this year. Dan answered that the next step is to translate the 83 initiatives and 12 objectives into a structured planning process with dependencies and resource analysis. This could be a network plan to be melded with the DAC network plan. Then detailed plans of actions and milestonesforthe top priority objectives would be developed.

As a result of this meeting, it is clear that one of the most promising ways to continue this research is as part of the DAC program of NAVSEA . This program can carry on many of the objectives as part of its own charter. Specifically, here below is an annotated list of the 12 objectives and their 83 initiatives indicating where DAC can or cannot continue the momentum of the study. [Based in part on a FAX from Tom Beyer, NAVSEA 05R4 of 15 October 1992.] DAC is working on 38 of the 83 initiatives or 46%. Importantly, the very high priority items find DAC work in 67% of the initiatives. Also, where other activities are working the action items, they are noted below.

I Process Definition [Considerable work has been accomplished in the process definition area from an unique Navy perspective.]

1 Make sure processes are necessary and good before automating them [DAC needs to investigate in more detail.]
2 Analyze process improvement [This has been accomplished in selected areas; DAC is finding more detailed work is needed with a stronger focus on quantifying process improvement.]
3 Develop simulation tools for the complex problems of shipbuilding [Not being investigated by DAC.]

4 Identify the best processes, tools and metrics that support the vision **[Considerable work has been accomplished by DAC in this area forthe DAC Vision, which may differ from the vision of the May workshop. TheDAC Vision is reduced ship cost, construction time, and improved quality.]**

5 Create costing structures that adequately portray the specific unit **[Work is under investigation by a process action team (PAT) to improve the accuracy and document the assumptions associated with our budget estimates.]**

6 Identify the critical path processes for automation prioritization **[Not being investigated by DAC.]**

7 Spend money first on systems that improve competitive position **[Not being investigated by DAC.]**

8 Document current processes **[This is an on-going activity in DAC. Each proposed improvement area documents the process for which they are responsible.]**

9 Make sure that computer aid is essential not in addition to process **[Not being investigated by DAC.]**

10 Reestablish process engineering as a discipline **[DAC is not reestablishing process engineering, rather DAC is doing it for the first time.]**

11 Set priorities based on which processes are on the critical path **[DAC attempts to work on the most important work first.]**

12 Benchmark competitors **[DAC initiated a program to benchmark Japanese shipbuilding (i.e., DDG-51 and TAGOS). DAC plans have been delayed to sometime in the future.]**

13 Apply Theory of Constraints to the shipbuilding process **[Not being investigated by DAC.]**

14 Have management and operations groups co-determine products and processes **[DAC is working in this area, in selected areas, and will continue.]**

15 Improve process base lining technologies **[This standard operating procedure, the existing process is documented and used as the basis for future improvement.]**

II Integration

16 Implement seamless integration from design through implementation **[If this means concurrent, continuous engineering, DAC is working in this area.]**

17 Put all that is known about a ship in an integrated model **[This is not being worked by the DAC but may be occurring as a result of NAVSEA commitment to CAD design.]**

18 Make user interfaces more intuitive and simplify them for non-professionals **[Not being investigated by DAC.]**

19 Implement concurrent engineering in shipyards **[DAC is looking at this initiative from the viewpoint of concurrent engineering during the design phase, which includes bringing shipbuilders onboard early.]**

20 Integrate business operations with ship data models e.g planning and cost **[To the extent that top level operations requirements are considered by**

concurrent engineering for global marketshare, DAC helps; also, to the extent that uniform and detailed standards for cost information is produced, the better business operations are supported. See Appendix A pages 104 through 106.]

21 Get computer tools into the hands of yard personnel **[Not being investigated by DAC.]**

22 Implement distributed data bases **[DAC is working in this area, mainly in cost and budget development.]**

23 Integrate proposal estimates, detail definitions, work accomplishment, and contract reporting **[Not being investigated by DAC.]**

III Product Model Exchange

24 Set up a data exchange project for the shipbuilding supplier industry **[DAC is not directly working in this area; however, NAVSHIPSO in Philadelphia does have an extensive database of information on suppliers of marine equipment.]**

25 Make sure standards drive the architecture not the current winning technology **[Not being investigated by DAC.]**

26 Develop good interchange standards **[DAC is not working this, but there is activity via the NIDDESC efforts.]**

27 Fund prototype development of applications running on the NIDDESC information model **[DAC is not working this area; NAVSEA 05Q would be the proper organization to coordinate this initiative.]**

28 Implement PDES **[Not being investigated by DAC.]**

IV Product/Process Model

29 Establish a shipbuilding data dictionary **[Not being investigated by DAC.]**

30 Develop an information technology plan featuring data and function integration **[Not being investigated by DAC.]**

31 Specification for information independence **[It is not certain whether DAC will be working this area. Present QMB direction will result in establishing a specification improvement PAT.]**

32 Pin down shared conceptual schema for ship data modelling **[Not being investigated by DAC.]**

33 Document the information required to manage **[DAC is working in this area for those initiatives (in-house) which apply.]**

V CALS Implementation

34 Replace drawing with product modeling **[Not being investigated by DAC. However, the NAVSEA 05Q group is involved.]**

35 Provide customers with on-line access to product data **[Not being investigated by DAC. It is believed that that this is being considered and investigated on a case basis.]**

36 Require CDRL'S to be written to pass product model information **[Not being**

investigated by DAC. However, in the future, depending on the progress in initiative 35, this will have to be considered.]

37 Encourage vendors to supply product data with their products **[Not being investigated by DAC.]**

38 Provide contract awards only to reliable suppliers **[Not being investigated by DAC. However, private commercial industry should take this on, within the law, as good business practices.]**

39 Establish relationships that support the entire life cycle **[DAC is working on this via the organizational structure of the program DAC is establishing a "life cycle" relationship by involving all elements of the government involved in shipbuilding. Public law prohibits involvement of the commercial industry. DAC relies on the NSRP and the Shipbuilders' Council of America and similar organizations for the industry connection]**

40 Create systems that reduce the costs of gathetering cost data **[DAC is currently working in this area. DAC has a PAT which is dealing with the front end of the acquisition process. Future work will investigate other areas of management information systems specifically in the cost area]**

41 Involve the customer in review of configuration and reporting requirements as cost driver **[DAC is currently working in this area internally. DAC'S definition of customer in the current activity focuses on OPNAV; however, the industrial customer (i.e., the shipbuilder) must be considered in the future.]**

42 Establish customer capability to produce product models required by CDRL **[Not being investigated by DAC.]**

43 Make CALS a way of life **[Not being investigated by DAC directly. NAVSEA 05Q is involved in this area currently.]**

44 Substitute process reliability for granularity of data collection **[Not being investigated by DAC at present but expects to do so in the future.]**

VI Human Resource Innovation

45 Introduce employee empowerment philosophy to shipbuilding industry **[Not being investigated by DAC for private industry but is for the government.]**

46 Thoroughly expose management and workers to best processes for process improvement **[DAC is working in this area for the government side of the equation.]**

47 Management supervision understanding of computer aids **[DAC is working in this area for government management.]**

48 Implement concurrent engineering within the industry **[DAC is working in this area and much needs to be done in both industry and the government.]**

49 Invest to overcome organizational & cultural barriers to change **[This is what DAC is all about.]**

50 Identifi and document team building and team empowerment success stories **[DAC is working in this area. As the various PAT's report, their final**

report provides the documentation suggested above. The notion of success is something which can only be determined after measuring the improvements which are implemented.]

51 Provide university work study programs in maritime industries **[Not being investigated by DAC.]**

VII FollOW Up

52 Conduct additional workshops like this one with senior management [DAC is working in this area. **[DAC is planning a workshop early next year to obtain industry participation in the definition of product oriented design and construction (PODAC).]**

53 Build in follow-up to this action plan **[Not being investigated by DAC.]**

54 Connect everybody in this group to a common system in order to continue to discuss these issues **[Not being investigated by DAC.]**

55 Developa critical experiment to proveto management that this process will work **[DAC is working in this area because of DAC'S commitment to TQL. Continued high level commitientis, and willcontinue to be, a problem. For private industry, there are several examples of the successful use of these principles. Perhaps management must be convinced by the professionals currently marketing these tools.]**

56 Develop an industry wide project for reaching our goals **[DAC is currently working in this area within NAVSEA.]**

VIII Industry Cooperation

57 Establish a national consortium for shipbuilding software development **[Not being investigated by DAC.]**

58 Provide knowledge transfer to spread best processes across industry **[DAC is working in this area through the NSRP and SCA. DAC believes more can be done in this area and are interested in establishing more conduits to Private industry.]**

59 Form customer, innovator, producer councils to project the fiqure **[Not being investigated by DAC.]**

60 Create leadership forums for the industry **[Not being investigated by DAC; however, DAC would be interested in participating.]**

61 Establish a Shipbuilding America Network **[Not being investigated by DAC.]**

62 Implement shipbuilding shareware **[Not being investigated by DAC. Elements of this initiative result born the projects awarded through the NSRP.]**

63 Focus centers of excellence On shipbuilding industry (MANTECH) **[Not being investigated directly by DAC; however, the MANTECH program is the principal supporter of the NSRP (not as a center of excellence but ;as an element of industrial preparedness.)]**

64 Form joint technology assessment teams **[Not being investigated by DAC.]**

65 Establish electronic communications within the industry **[Not being directly investigated by DAC. Selected Program Managers have incorporated**

electronic communications with the principles of their program and other Program Managers will most likely continue to do so.]

IX Expert Systems

66 Use expert systems in designing ships **[Not being investigated by DAC.]**
67 Implement parametric design concepts in shipbuilding **[DAC is working this both directly and indirectly. However, the activity is focussed on early design DAC'S hope is that by involving shipbuilders early DAC will be able to tap into whatever efforts are underway at the shipyards.]**
68 Capture design decisions as part of the model **[DAC is working in this area from the view of early design and program initiation]**
69 Integrate Expert systems with CAD,planning and manufacturing systems **[Not being investigated by DAC directly.]**
70 Develop expert management shipyard software **[Not being investigated by DAC.]**

X Configuration Management

71 Apply the processes of configuration management to our processes **[Not being investigated by DAC directly.]**
72 Understand the discipline and training of configuration control **[Not being investigated by DAC currently but will be when internal process improvement warrants.].]**
73 Design a system that automatically documents the as-built product **[Not being investigated by DAC.]**

XI Generic Modular Ship

74 Build a national library of reusable design modules down to the part level **[DAC is working in this area as is the Affordability Through Commonality (ATC) program. This is a majorr part of DAC's work.]**
75 Create a consortium of navy shipbuilders to create a joint commercial endeavor **[Not being investigated by DAC directly; however, elements of the Fast Sealift maybe focused along these lines: Captain Dave Whiddon should be contacted about this.]**
76 Develop modular designs **[DAC is working in this area as is the Affordability Through Commonality (ATC) program. This is a major part of DAC'S work.]**
77 Find a way to build commercial and military ships in the same facility **[Not being investigated by DAC directly; however, it is a long range goal of the program Congressional language in a FY92/93 committee hearing required the DOD to develop a plan for integrating the commercial and defense sectors of the industrial base. NAVSEA 05 forwarded recommendations and comments to higher authority. DAC has received no feedback to date but continues to await a response.]**
78 Generalizing navy designs to generic shipbuilding designs **[DAC is working in**

feeback to date but continues to await a response.]

78 Generalizing navy designs to generic shipbuilding designs **[DAC is working in this area DAC plans an industry workshop later this year to agree on definitions and to enlist industry involvement.]**

XII Service Life Support

79 Develop a ship repair strategy using advanced technology **[Not being investigated by DAC.]**

80 Extrapolate new construction methods to lifetime support **[Not being investigated by DAC.]**

81 Develop automated crew training aids **[Not being investigated by DAC.]**

82 Use shipboard computer applications during a shipbuilding program **[Not being investigated by DAC.]**

83 Add value to ships by incorporating computer aids for operation **[Not being investigated by DAC.]**

APPENDIX A

Contents

THE SP4 WORKSHOP ON COMPUTERAIDS

ABSTRACT

The shipbuilding industry in the United States stands at the crossroads of landmark changes in the global marketplace (1). Panel SP4is launching a major project to examine the best computer technology to assist yards to enter this new marketplace. This paper reports on the progress to date and especially the initiating national conference held inMay 1992.

Participants at the conference were startled to find that the collective consensus clearly shows that no progress with better computar aids is possible without a very significant breakthrough in the extent to which yards, suppliers, designers, and customers cooperate (2). Twelve objectives with 83 initiatives resulted fromthe conference. Most of these depend upon both short term and long term actions as well as continuous support from NSRP over the next few years.

BACKGROUND

The idea for the SNAME Panel SP4 initiative on computer aids came horn Panel discussions regarding a series of projects to assess the status and scope of computer aids in shipyards worldwide with potential application toUnited States and Canadian shipyards. A five year programsvas discussed and the first year project was awarded to Coastal Group Technology in late 1991. CGT in turn prepared for and held an initiating national workshop coderence in May 1992 with representatives of the shipbuilding, ship design, supplier, and government communities.

The workshop on computer aids was formed to create a vision of the best trends in computer aids through the next decade while at the same time providing a future business vision for the U.S. sbipbuilding industry and sharing views on how U.S. shipbuilding might best provide products and services to fulfill the recommended vision.

THE PARTICIPANTS

Participants were chosen for their ability to represent and articulate the needs and values of U.S. and Canadian ship construction endeavors. Of the twenty-one participants the great majority were leading engineering or system executives. Several were consultants in the field and others represented major suppliers to the industry. The following people participated

Robert C. Badgett,
Computer aided Acquisition and Logistic Systems consultant

Dan Billingsley
U.S. Navy, Director of CAD, NAVSEA Code 507

Carl F. Bryant III,
computer consultant and former propeller manufacturer

Dan Cada,
AEGIS CALS Coordinator, U.S. Navy

Neil Cambridge, Coastal Group Technology and Eclipse Business Systems Consulting,
Computer programmer to banks, manu-

factures, and distributors

Mike conney

General Electric Corporation, GE ElectrOniCS Park
Seamless systems worships, submarines, sonars, and radars

James Crocker, consultant and
installer of manufacturing resource planning (MRP II) systems for GE and shipyards

Lorna Estep,
Director FCIM (flexible computer integrated manufacturing), Department of Defense and the U.S. Navy, Trident Research Center

Paul Friedman,
Director of Engineering Technology
Bath Iron Works Corporation

Jim Hutto, Intergraph
CAD II Program Manger

MichaeI T. Kelly, Ph.D.
Coastal Group Technology
FACILITATOR and management psychologist .

Douglas J. Martin,
NASSCO shipyard, San Diego
Technical Information Systems

Jon Matthews,
JJH Inc.
Design Manager JJH and NIDDESC Representative

Richard C. Moore,
Jonathan Corporation and member of Panel SP-4

Marion Nichols, Shipyard MRPII and industry TQM experience
Digital Equipment Corporation

Robert Schaffran, Program Manager
Head, Design & Management Systems Division
U.S.N David Taylor Research Center, Code 125

James R. VanderSchaaf, Director of Corporate Information Projects
Bath Iron Works Corporation

Daniel H. Thompson
Coastal Group Technology
PRINCIPAL INVESTIGATOR and management consultant

James R. Wilkins Jr. D.Eng.
Coastal Group Technology and
Wilkins Enterprise Inc.
ship program management and consultant to NAVSEA

Dan Wooley, Supervisor for Seawolf CAD VIVID system
Newport News Shipyard

Joe Wudyka, Corporate Manufacturing
Digital Equipment Corporation

PRE-EVENT ACTIVITY

Participants were selected through Dan Thompson and Jim Vander Schaaf together with recommendations horn NSRP panel and council members. They were recruited by mail and by phone through initial discussion of the concept and the objectives of the project. Some correspondence modified the agenda (3). Further details were provided by the facilitator, Dr. Kelly. Background material was supplied by Dan Thompson. Of those invited several

deferred because of scheduling conflicts.

THE FACILITATOR:

Michael Kelly, Ph.D of Coastal Group Technology pioneered the procedure used to guide the participants to a focused statement of vision and policy objectives for the project. The creator of the Advanced Management Catalyst System (AMCat) at the heart of the strategy verification method, Dr. Kelly has worked with management in companies such as Xerox, Citibank, and Asea Brown Boveri to catalyze the development and implementation of corporate vision and new operating plans. This strategy verification procedure now has been computerized to elicit, record, process, and analyze collaborative group input. Strategy verification enables the participants to develop a road map to decision making, to integrate information in ways that are innovative and extremely powerful, and to establish a strategic vision down to the tactical steps for accomplishment and evaluation. The prerequisite impetus for this approach has been presented several times before NSRP (1), (4), (5).

THE STRATEGY VERIFICATION PROCESS

Because the results of this workshop are likely to be controversial. We include a detailed description of the methodology and process used. That method while well tested in private industry is relatively new in this arena and represents a significant departure from the typical work shop process.

sucessful Action

Perfect action requires total knowledge, cooperation, and capacity. The strategy verification method used to facilitate the SP4 workshop follows a process designed to continually increase the quality of action toward such perfection.

A great deal of the current press on group collaboration is focused on a wide range of cumputer-supported meetingtools, dubbedgroupware. While technology can be an aid, it is not the solution. 'We have to put the horse before the cart. Automating outmoded business processes won't work and neither will automating poor collaborative processes," according to Robert Fletcher, president of Computer Planning Consultants, Inc., "Kelly put the horse in the right place, creating a well structured, productive meetingprocess and sensitive techniques for facilitating collaboration."

Research atBoeingCompany on a similar, though less integrated system, showned that the calendar time for projects which require team meetings can be reduced typically 91%. Overall meeting time can be reduced as much as 71%.

So many ideas are created by so many people during an AMCat that using marker pens and flip charts is prohibitively cumbersome and time-consuming. With a skilled operator handling a system consisting of a personal computer, printer, and projector, three major benefits are derived

- The facilitator is able to concentrate on eliciting the maximum participation from each member of the group
- All contributions are recorded and analyzed with the greatest precision
- Statements, lists, and matrices are

clearly and quickly displayed and changed, leading to more rapid audience understanding and reaction.

Says Fletcher, "In different terms, what happens is that the technology, combined with the AMCat process, actually begins to create knowledge, unlike simple data processing which can only create information. It then makes that knowledge immediately available so that abridge is built between the formulation of strategy and its implementation. It becomes catalytic." Figure 1 illustrates the principle which makes this possible.

This figure illustrates the interrelationship between knowledge, society, and actions which create netpositive value. As knowledge increases in validity, precision and availability, it gains leverage. Knowledge is valid when it is understood in a common context(3). It is precise when it is relevant and sufficient to describe the subject. It is available when it is at hand "just in time."

knowledge, cooperation, and capacity only exist in a systems context. Moreover they only exist in reference to people. People supply knowledge and capacity. The success of action depends on the extent to which people provide knowledge and capacity to their endeavors. Adversaries don't contribute to each other, this impoverishes the knowledge and capacity of the system.

We are all in the same boat.. the total system includes all knowledge and all concerned with this knowledge. Once this fact is realized by all, they become less adversarial and more willing to include new ideas from others. With valid knowledge our industry canincrease not only our own success but also its value to

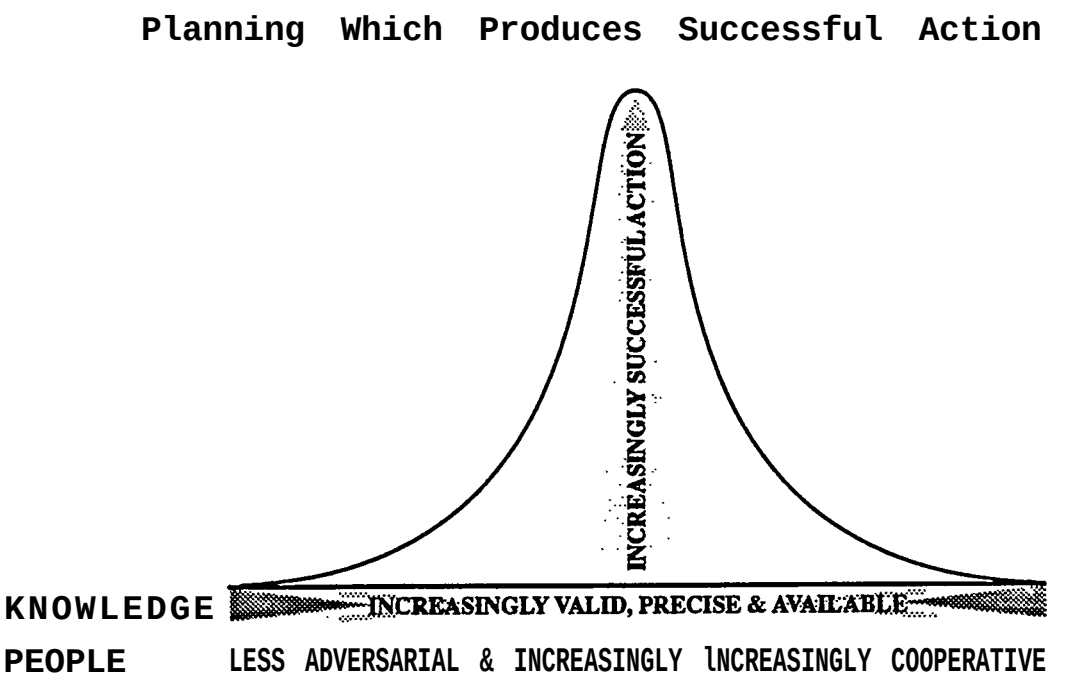

Fig. 1 Increase value by developing decision systems which acquire and use valid knowledge to complete appropriate action.

our whole society.

With such understanding of the potential of group decision systems, we were ready to achieve the immediate goal of assessing computer aids for shipyards. The process was carefully planned and then carried out in an intense period of time: the workshop itself.

The Event

The SP4 workshop on computer aids was convened for three days, Thursday, Friday and Saturday, May 14-16, 1992, at the Captain Daniel Stone Inn, a Canadian Hotel in Brunswick, Maine. Thursdaysbrtedwitha demanding, nonstop brainstorming session, sharing lunches and work into the evening. Friday was equally intense but focused on how to reach and realize the vision through actual actions to be taken now and in the future. Saturday each of the participants was privately interviewed for one hour to expand on the meaning of each of the action initiatives as well as on general observations relevant to the industry.

Well ahead of the actual workshop, prospective participants were sent matetial on the facilitation process selected. This process has been well tested and forms an integral part of the way Coastal GroupTechnology conducts such consultations.

Dr. Kelly set the stage for the first session by asking each participant to take the role of a member of the Board of Directors of The U.S. shipbuilding industry. Each panelist was instructed to assume responsibility for setting the strategic direction for a major company whose corporate andproductidentity commands world-wide recognition. It was left to each participant to bring his own set of values and perspectives that might be evoked by such association. The stage was further defied by stating that the group was now engaged in a three day session with management to determine the most profitable and productive future direction of the industry by providing the most appropriate computer technologies available or 0becoming available.

A STRATEGIC VISION FOR THE U.S. SHIPBUILDING INDUSTRY

The participants' brainstorming was launched by asking each Participant to read the following statement of purpose (A) and a common, agreed upon definition of 'Strategic Vision' (B):

(A) WHY We've Been Brought Together

For the purpose of determining the direction of effort the shipbuilding industry will take over the course of the next decade, we invite you to assume the *persona* of a member of the board of directors of The Shipbuilding Industry. Please regard this position as an opportunity to create the future as much as it is an opportunity to respond to it.

Toward achieving this end, our first task will be to describe what The Shipbuilding Industry world of customers,technology, and organizational strategy will be over the course of the next (ten) years. We will call this The ship buiilding industry strategic vision.

At the conclusion of the two day process we are undertaking together, we will have created a strategic vision brainstormed every option, resource, and step we can imagine to fulfil our (The shipbuilding industry's) vision;

refined those options and resources into a set of policy objectives; and mapped a general course for their implementation. We will use a procedure called theAdvanced Management Catalyst (AMCat) to orchestrate this process.

(B) what is Strategic Vision?

•A statementofpurposethatisbroad enough to involve people at every level within the industry, and inspiring enough to encourage the emotional involvement of all participants

- **An announcement to external customers of what can be expected from this group**

- **A challenge to all shipbuilders based on where technology is headed**

- The projection of future eaccomplishment that promises to extend the U.S. shipbuilding indust#s domain of influence in terms of both strategy and tactics

- The written description of this group's dream for the future.

Using this definition of strategic vision, the participants created the following strategic vision for the U.S. shipbuilding industry to be implemented over the next decade:

The Participants' Strategic Vision for the U.S. Shipbuilding Industry

We market, design, produce and support ships and other products that utilize Similar processes, profitably, with greater value to our customers and in less time than anybody else in the world.

The industry has achieved a significant share of the global market and hence is recognized as a key sector of the U.S. mtional economy.

This industry recognizes that in order to ensure long term growth it must build better and better products at lower and lower prices and create opportunities for customers, owners, employees and suppliers.

We are:
A world leader in innovation and implementation of information, process and people management. We consistently achieve cycle times at least 10% better thsn the best in the international market place.

We are:
An industry which prudently reinvests in itself to support continuous improvement in process and capability.

We are:
Enterprises and business units where management and operating teams continually reconcile their processes and products within this vision.

We are:
An industry that creates an environment which supports cooperation among customers, owners, employees, suppliers and within itself.

We are:
Proactive in applying technology to improve our products and processes.

We are
A self sustaining, non-subsidized indus-

trial base.

We are:
An industry which attracts, retains and motivates talented people.

We are:
Anindustry which delivers whatitpromises.

We are:
Constantly sharing knowledge with other industies to our mutual benefit.

We are:
Committed to constructing a single ship as cost effectively as multiples.

We are:
An industry that competitively services ships regardless of where they were built.

We are:
An industery which is continually re-inspired by its heritage.

Creation of a Strategic Vision for the U.S. Shipbuilding Industry was the most ambitious, debated, analyzed, and creative portion of the participants' activity. Under the non-inderventionary guidance of the facilitators, the panel members covered every conceivable aspect of the fiture direction of marine production, management, and competition debated every possible strategicscenario that might catapult the industry into a position of leadership in providing customer solutions in the fiture weighed multiple approaches that might ensure capturing the majority of the panelists' predictions of where customer values, technologies, economics, and marketing requirements and opportunities are leading. On almost every point, there was a minority view but rarely an outright recalcitrant. Thus, the Strategic Vision was adopted and "bought into" by the panel.

The next step in the project brought the panel from visionary definition to specific recommendations. After creating their strategic vision for the shipbuilding industry, the panelists identified over 200 specific options including options for yard aids which could be pursued to fulfill it. After milling, 83 initiatives for action were recommended. These were organized into 12 policy objectives and then put in priority order.

The AMCat process forced a "bottoms up approach" on the participants in arriving at these policy objectives. Through vigorous use of brainstorming, the participants gathered every conceivable option that they could think of which might be essential to implement the strategic vision. These were culled to produce a list of initiatives for action. As evidenced in the final output, these recommended actions are sound, pragmatic, hard-hitting activities, organizational adjustments, and strategic changes that, if implemented, ensure that the U.S. shipbuilding industry will "win" by fulfilling the strategic vision.

Once the participants captured every essential action for vision implementation, these actions were grouped into objectives. The objectives were not labeled until a common thread was found whereby several recommendedinitiatives suggested an objective. By clustering to derive objectives rather than determining objectives and then assigning actions, the workshop's thinking was not constrained by form. Any possible action that a participant thought essential for American shipbuilders to claim and fulfill the strategic vision came out on the table and was woven into the policy ob-

jectives. Grouping the initiatives into objectives integrated them around common mission style goals. The participants then weighed the various views of their strategic importance based on priority/urgency and feasibility in order to produce a Feasibility Matrix. Then they assessed the stage of accomplishment of each objective across the industry in order to produce a Diagnostic Matrix. Both matrices are presented below.

The objectives and initiatives are first presented here as the workshop weighted them. The labels given to the objectives are purposefully brief and self explanatory. The initiatives following each objective are specific and actionable — these actions are each one considered necessary to fulfilling the stated objective but may not be all inclusive. See Table I for a brief characterization of objectives and initiatives:

Table 1. Numbers of Initiatives per Objective

I Process Definition	1s
II Integration	8
III Product Model Exchange	5
IV Product/Process Model	5
V CALS Implementation	11
VI Human Resources Innovation	7
VII Follow Up	5
VIII Industry Cooperation	9
IX Expert Systems	5
x Configuration Management	3
XI Generic Modular Ship	5
XII Service Life Support	6
Total	83

OBJECTIVES AND INITIATIVES IN PRIORITY ORDER

Lprocess Deifinition

Our objective is to identify the best processes, tools and measurements which support our vision. We define processes as the combinations of people, equipment, raw materials, methods, and environment our industry brings together to produce our products or services.

It is pointless for us to automate existing processes which perpetuate the current inadequate state of our industry in world competition. Instead, we need to document and analyze current practices in order to define new processes which will enable us to fulfill our vision.

For example, money should be invested first in systems that improve the competitive position of shipbuilding in the United States. Benchmarking our competitors overseas represents such a system. Then priorities need to be set based on which processes are on the critical path toward that end.

Initiatives:

1 Make sure processes are necessary and good before automating them
2 Analyze process improvement
3 Develop simulation tools for the complex problems of shipbuilding
4 Identify the best processes, tools and mettrics that support the vision
5 Create costing structures that adequately portray the specific unit
6 Identigy the critical path processes for automation prioritization
7 Spend money first on systems that improve competitive position
8 Document current processes
9 Make sure that computer aid is essential not in addition to

process
10 Reestablish process engineering as a discipline
11 Set priorities based on which processes are on the critical path
12 Benchmark competitors
13 Apply Theoqy of Constraints to the shipbuilding process
14 Have management and operations groups co-determine products and processes
15 Improve process baselining technologies

II Integration

We can and must bring the improved processes together in a very connected way. This integrated approach will flow from design to implementation through a computer simulation of our ship as a product. The approach treats process and product as system elements and management tools. This computer simulation model must be accessible to all concerned.

Initiatives:

16 Implement seamless integration from design through implementation
17 Put all that is known about a ship in an integrated model
18 Make user interfaces more intuitive and simplify them for non-professionals
19 Implement concurrent engineering in shipyards
20 Integrate business operations with ship data models e.g planning and cost
21 Get computer tools into the hands of yard personnel
22 Implement distributed data bases
23 Integrate proposal estimates, detail definitions, work accomplishment, and contract reporting

III Product Model Exchange

For integration to work, information must flow freely throughout our industry. Suppliers to shipyards must have access to project data promoted by good interchange standards and organizations dedicated to maintaining them.

Initiatives:

24 Set up a data exchange project for the shipbuilding supplier industry
25 Make sure standards drive the architecture not the current winning technology
26 Develop good interchange standards
27 Fund prototype development of applications running on the NIDDESC information model
28 Implement PDES

IV Product/Process Model

Standardized definitions and information shared by the industry must be captured in order to document the information required to manage well.

Initiatives:

29 Establish a shipbuilding data dictionary
30 Develop an information technology plan featuring data and function integration
31 Specification for information

independence
32 Pin down shared conceptual schema for ship data modelling
33 Document the information required to manage

V CALS Implementation

Such integration and clarity of definition lead to the replacement of conventional drawings with digital product models, which provide customers with on-line access to product data and encourages vendors to supply product data with their products. *Thus customers,* suppliers, and life cycle needs are brought together effectively and efficiently.

Note: Concurrent with this workshop conference, a relevant systems analysis of U.S. commercial shipbuilding practices was published (6).

Initiatives:

34 Replace drawing with product modeling
35 Provide customers with on-line access to product data
36 Require CDRL'S to be written to pass product model information
37 Encourage vendors to supply product data with their products
38 Provide contract awards only to reliable suppliers
39 Establish relationships that support the entire life cycle
40 Create systems that reduce the costs of gathering cost data
41 Involve the customer in review of configuration and reporting requirements as cost driver
42 Establish customer capability to produce product models required by CDRL
43 Make CALS a way of life
44 Substitute process reliability for granularity of data collection

VI Human Resource Innovation

Best processes and product models cannot effect the continuous improvement needed to realize our vision. All of us in the system must be empowered by anew philosophy and understanding of computer aids, concurrent engineering, and team building.

Research by Lester Thurow, Dean of M.I.T.'s Sloan School, indicates that by the end of this century people and their skills will be the only significant source of competitive advantage in global competition.

Initiatives:

45 Introduce employee empower*ment* philosophy to shipbuilding industry
46 Thoroughly expose management and workers to best processes for process improvement
47 Management supervision understanding of computer aids
48 Implement concurrent engineering withhin the industry
49 Invest to overcome organizational & cultural barriers to change
50 Identify and document team building and team empowerment success stories
51 Provide university work study programs in maritime industries

VII Follow Up

We must conduct additional workshops like this one with senior management to build in follow up to this action

plan. Also we must develop critical experiments and an industry wide project for reaching our goals.

Initiatives:

52 Conduct additional workshops like this one with senior management
53 Build in follow-up to this action plan
54 Connect everybody in this group to a common system in order to continue to discuss these issues
55 Develop a critical experiment to prove to management that this process will work
56 Develop an industry wide project for reaching our goals

VIII Industry Cooperation

In spite of the self destructive intensity of competition between and among our organizations as forced by the narrow pursuit of a single and "impoverished" customer, we must create a mutually supportive industry.

Initiatives:

57 Establish a national consortium for shipbuilding software development
58 Provide knowledge transfer to spread best processes across industry
59 Form customer, innovator, producer councils to project the future
60 Create leadership forums for the industry
61 Establish a Shipbuilding America Network
62 Implement shipbuilding shareware
63 Focus centers of excellence on shipbuilding industry (MANTECH)
64 Form joint technology assessment teams
65 Establish electronic communications within the industry

IX Expert Systems

Computer systems which capture the experience of ship designers and ship yard managers can and should be developed. Parametric ship design concepts and management decision modeling tools can greatly facilitate our planning and manufacturing.

Initiatives:

66 Use expert systems in designing ships
67 Implement parametric design concepts in shipbuilding
68 Capture design decisions as part of the model
69 Integrate Expert systems with CAD, planning and manufacturing systems
70 Develop expert management shipyard software

X Configuration Management

We must apply the methods of configuration management to ourindustry. We must both understand and design computer systems which clearly document and maintain valid knowledge of our processes.

Initiatives:

71 Apply the processes of configura-

tion management to our processes
72 Understand the discipline and training of configuration control
73 Design a system that automatically documents the as-built product

XI Generic Modular Ship

We need to build a national library of reusable design modules to the parts level of detail. This may require consortiums of Navy and private shipbuilders for commercial ship production with modular designs; perhaps even with both military and commercial ships being produced in the same facility.

Initiatives:

74 Build a national library of reusable design modules down to the part level
75 Create a consortium of navy shipbuilders to create a joint commercial endeavor
76 Develop modular designs
77 Find a way to build commercial and military ships in the same facility
78 Generalizing navy designs to generic shipbuilding designs

XII Service Life Support

We must develop a ship repair strategy using advanced technology. New construction methods must be extrapolated to fulfill lifetime support applications including automated crew training aids and shipboard computer aids for at-sea operations.

Initiatives:

79 Develop a ship repair strategy using advanced technology
80 Extrapolate new construction methods to lifetime support
81 Develop automated crew training aids
82 Use shipboard computer applications during a shipbuilding program
83 Add value to ships by incorporating computer aids for operation

FEASIBILITIES

The Feasibility Matrix is one of the most revealing products of the AM-Cat process at the workshop. Participants were asked torate the feasibility of each objective according to the following scale

o	Conceivable
1	Theoretically possible
2	Technically achievable
3	Innovative
4	Producible
5	Risk worthy
6	Unfamiliar process
7	Early Adopters
8	Organizationally viable
9	Widespread acceptance
10	Routine.

Ratings O through 5 focus on technical feasibility. Ratings 6 through 10 zero in on the market and organizational side of adoption. The rating is displayed on the horizontal axis and the priority/urgency is displayed vertically.

The matrix below startled the participants and is the central picture of the condition of our industry. The information captured from the participants indicates that there is a barrier to moving

critical objectives from implementation hung up against this wall: to production. The industry has little difficulty developing and demonstrating new methods and technologies; it just can't incorporate them readily! This "wa11" represents a management mind set reluctant to embrace emerging technologies and work strategies. This barrieris holding back not only applications of better computer systems to the industry but also the whole industry's effectiveness and efficiency.

Half of the objectives critical to the advancement of our industry are

- Process Definition
- Product Model Exchange
- Product/Process Model
- Industry Cooperation
- Configuration Management
- Service Life Support.

The first three of these are among the top four in priority!

All 12 objectives are portrayed on Figure 2 below. Behind each of the objectives stand detailed action items.

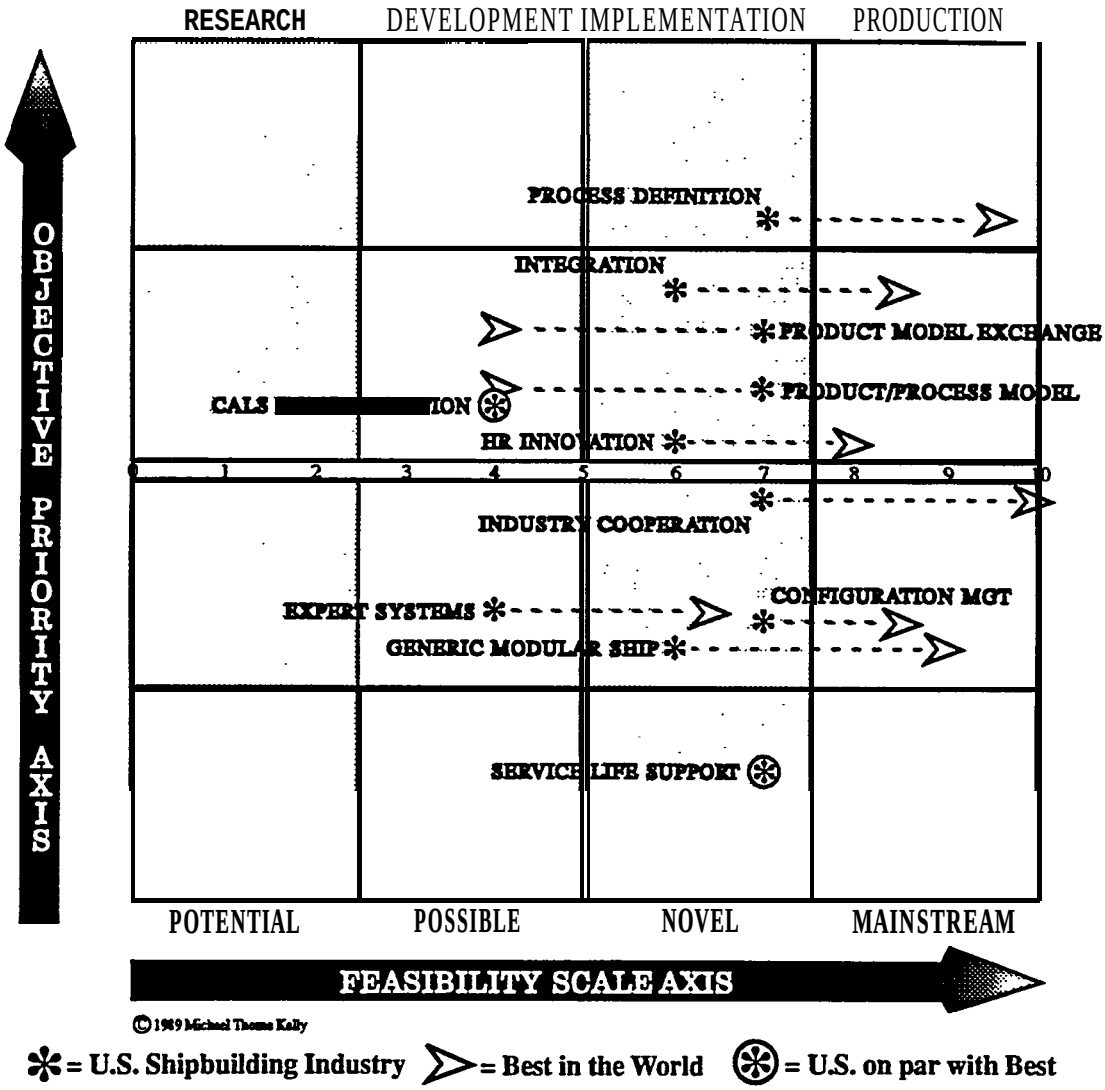

Fig. 2 The Feasibility Matrix with industry benchmarks.

DIAGNOSTIC

The workshop participants were asked to focus on the current stage of performance of the objectives within the industry as a whole using the performance stage scale illustrated below. The priority axis is the same as for the feasibility matrix.

The diagnostic matrix illustrates the optimum path for accomplishment. It shows the relationships between objectives as they participate in fulfilling the vision and how well priorities are managed.

Figure 3 below shows the priority order of action necessary to move the U.S. shipbuilding industry into viable global competition through computer technology and changes in management practices. It graphically illustrates the fit between priorities and actual use.

The meaning of the peformance stages is described below exactly as they were presented to the participants.

Performance Stages

0 YOU HADNT THOUGHT OF IT UNTIL NOW.

1 YOU ARE THINKING ABOUT IT; WONDERING IF IT WILL ACCOMPLISH WHAT YOU INTEND.

2 YOU ARE THINKING SERIOUSLY ABOUT IT; EXAMINING ITS IMPLICATIONS AND FEASIBILITY.

3 YOU HAVE BEGUN PLANNING. IF THIS WERE A BUILDING IT WOULD BE LIKE HAVING THE ARCHITECT BEGIN THE DESIGN.

4 YOU ARE OPERATIONALIZING IT. AGAIN USING THE BUILDING ANALOGY, YOU NOW HAVE YOUR PLANS, SO YOU ARE CALLING THE CONTRACTOR, THE CEMENT COMPANY, AND ETC. AND ARRANGING TO HAVE THEM CARRY OUT THEIR TASKS AS REQUIRED BY THE PLAN.

5 YOU ARE READY To INITIATE IMPLEMENTATION.

6 THE PLAN IS BEING IMPLEMENTED BUT AS YET YOU HAVE NO FEEDBACK ABOUT WHETHER OR NOT IT IS PROGRESSING SUCCESSFULLY.

7 THE PLAN IS BEING IMPLEMENTED AND YOU ARE GETTING POSITIVE RESULTS BUT, AS YET, YOU ARE STILL INVESTING MORE THAN YOU ARE GETTING.

8 IMPLEMENTATION HAS ACHIEVED INDEPENDENT MOMENTUM. YOU HAVE PASSED THE BREAK-EVEN POINT.

9 YOU ARE MANAGING IMPLEMENTATION. YOU HAVE CREATED AN EFFECTIVE, EFFICIENT SYSTEM THAT REQUIRES THAT YOU DO NOTHING MORE THAN OVERSEE ITS OPERATION.

10 PRODUCTION PROCEEDS EFFORTLESSLY. ALL OF THE IMPLEMENTATION IS DELEGATED LEAVING YOU READY TO UNDERTAKE YOUR NEXT PROJECT.

The lighter area on the matrix is the path of optimum accomplishment. When activity and resources are properly aligned with priorities, objectives fall on this path. According to the participants, the U.S. shipbuilding industry has fully 75% of its activity off the path for achieving the strategic vision.

When objectives are behind the path, like Process Definition and five others, it means that there has been insufficient assessment of the risks, rewards and demands involved relative to achieving the strategic vision. When things are ahead of the path, Service Life Support and Configuration Management in this case, resources have been prematurely allocated.

According to Dr. Kelly, this is the graph of an industry which will be repeatedly blindsided in its attempts to fulfil the strategic vision unless crisis measures are taken to thoroughly assess the effectiveness of the objectives that are behind the path and clear the way for developing them. It will also waste resources on efforts that, though perhaps successful in themselves, will hit a glass ceiling and fail to contribute to accomplishing the vision.

His comment was that 'This is a catastrophe in the making. This is the graph of a start-up industry where no one really knows what they are doing or why. The fact that the shipbuilding industry in this country is two hundred years old and encumbered with all the unforgiven sins of the past foreshadows

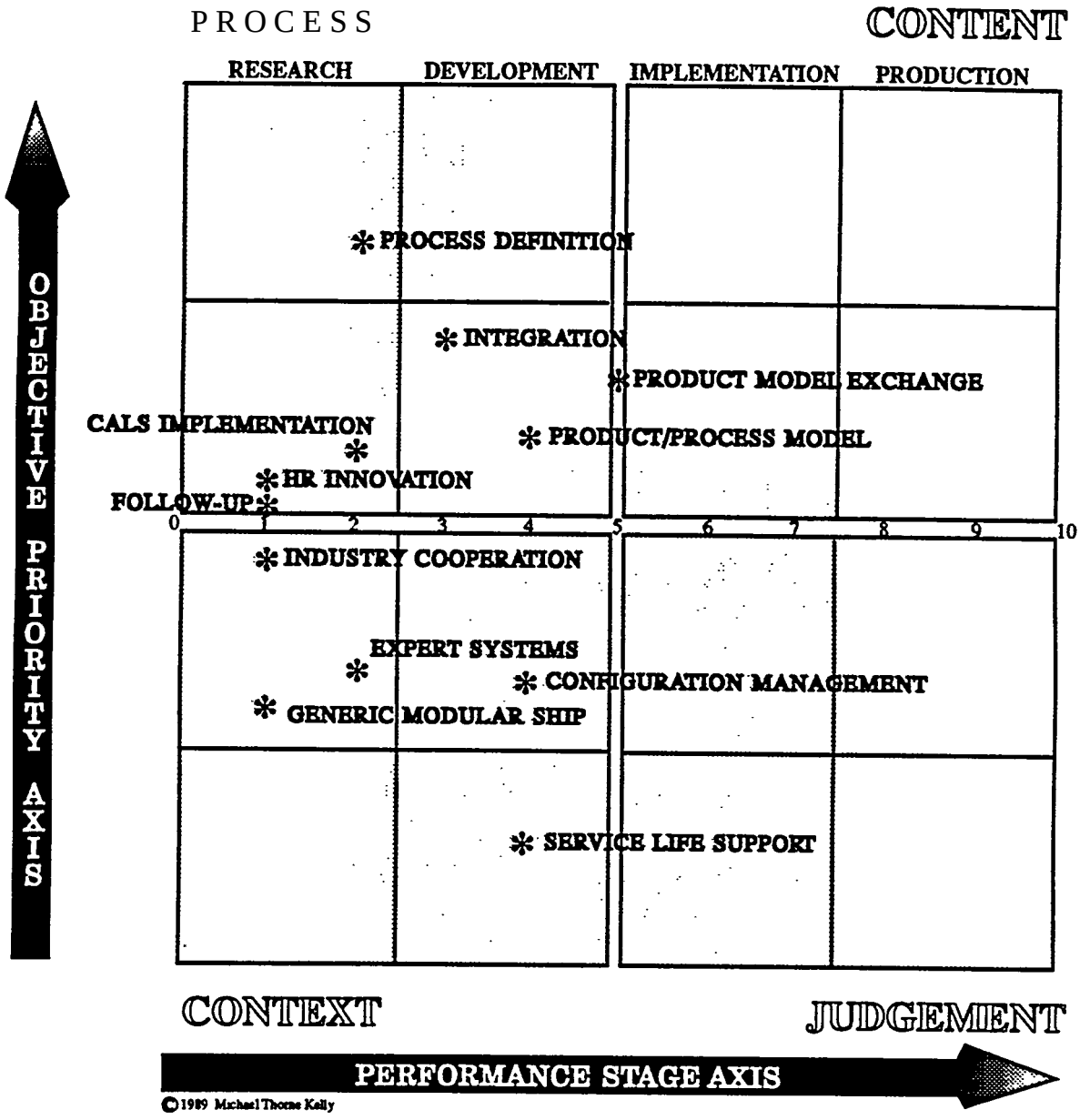

Fig. 3 The Diagnostic Matrix

a repeat of the U.S. steel industry staggered pattern of collapse."

For more detailed information on how to interpret the diagnostic matrix turn to the Appendices under *How to* Interpret the AMCat Matrix.

COMMENTARY FROM PARTICIPANTS

In order to add depth to the initiatives proposed by the participants. Each person was asked to respond to a set of interview questions and pick several initiatives to discuss. As indicated in the discussion of the feasibility matrix, all participantresponses were tape recorded. A sample of the comments on the interview questions follows. After that the full text of the interviews with the discussion of the initiatives is included.

SAMPLE OF COMMENTS

1. What is your assessment of the vision relative to where we are today?

Everyone agreed with varying degrees of enthusiasm that the vision represents a worthy goal for the industry and is based on a relatively accurate overall assessment of the industry.

Repair and ship overhaul is the near term future of the industry, not new construction.

Unless there is general cooperation to support this vision as a Computer-Aided Acquisition and Logistic Support effortit is all over

It is a great vision but culturally the industry isn't prepared to understand it much less implement it. Moreover there are concrete structural impediments to realizing it.

What if the industry isn't a shipbuilding industry but just a defense contracting industry tailor making ships for the Navy. The vision is an affirmative vision, an aggressive one without question, but when you recognize that there are people in the industry capable of supporting significant steps toward it right now, it isn't impossible at all, more a question of will than substance.

2. How can our strategic plan strengthen the Computer-Aided Acquisition and Logistic Support (CALS) initiatives?

The CALS initiatives could use a lot of strengthening. After six years we don't even have a plan.

It appears to me that what is planned and will be planned as a result of this workshop will feed right into CALS."

Some questioned the relevance of CALS to commercial shipbuilding; however most agreed that it is relevant to government regulation. It is certainly relevant to the computer tools because it makes the data exchange and making sure the government doesn't ask for stuff they really don't need or will use, which they have a tendency to do

Implementation of CALS is a means to achieve some strategic notions that we discussed. In addition I think the strategic plan probably would be a help to implementing CALS from the standpoint that it tends to address the issues that CALS doesn't deal with. It establishes a

context for CALS.

The strategic plan could function like a bridge between CALS as technology and shipbuilding as business. "There might be some commercial experience that might trim some stuff out of CALS. The proof of that pudding is interest in buying **CALS."**

3. What constraints need to be eliminated to strengthen the industry?

"I'he main thing that I think is holding us back is a lack of understanding of what the potential is that is at hand right now... The potential is to eliminate the false work, the retrieval effort, the transformation effort that occupies so much of our everyday working efforts."

We are constrained by lack of training, of enthusiasm among a gutted user community and lack management support.

There is a concern that unless progresses made on a broad fiont one area will advance at the expense of other areas.

The industry is locked into a drawing mind set which dictates that you haven't finished the design without drawings to use as the essential basis for activity. We have to break out of that mold and accept a digital mode for product models. We need to see the drawing as something that exists only in the computer.

Functional similarities across companies are much greater than our differences but our perception of our self interest drives us to block the progress possible through collective agreement. For example, the government is maintaining our industry but not supporting it to make substantial leaps forward.

It is difficult for us to relate to each other because we lack a common terminology.

The industry thinks that the Navy is the only game in town and consequently is starving in the midst of global abundance. We need an Apollo style program to build commercial ships for the world.

4. **What management attitudes need to be changed?**

"Everyone must realize that information technology is no longer the domain of specialists. It is having a pervasive effect on all aspects of NAVSEA'S business. Because of the current fiscal environment, the rate of change is becoming revolutionary. Every one is involved!" (7).

The old theory x management style where a manager manages by intimidation is still prevalent.

We have too many layers of management.

I'm pretty optimistic about the way our unit is transforming itself-I just hope we can do it in time.

I would focus on changing the attitudes of middle management rather than senior. Many of our middle managers, especially the ones who are real good at their job, because that is what they have been doing for along time, are hung up on the notion that that is the way God intended it to be done. I see that as our shipyard's biggest impediment. I would focus on middle management attitudes and there is no specific attitude that

needs to be changed other than a willingness to change.

The industry is caught up in the attitude that all workers need a crisis to promote productivity. This palpable lie is worn out.

Management has to take the attitude of "What does it take to be profitable in the commercial business?" The next question then is "What are the appropriate computer tools for profitable commercial shipbuilding?"

5. What management methods hold the greatest promise for implementing this plan?

Total Quality Management provides an opportunity to create solutions as long as it isn't presumed to be the solution itself.
"The operating philosophy should be one of continuous improvements

Employee empowerment — including trust.

Self directed teamwork leads to the kind of employee empowerment (at the process level) and motivation necessary to global competitiveness.

We need to identify and implement management methods which support faster cycle times, continuous improvementand more efficient use of resources.

Leadership needs to be taught at all levels of our business. Management confuses it with authority. People out on the floor aren't trained in leadership because they are expected to be followers.

6. **What is the best approach to standards development for the industry?**

"I have been involved with the data exchange standards and they sure have been painful. There has to be a better way."

Were the industry participants to collaborate on and finance standards the outcome would be positive.

"I think our strategic plan has to get the vision right first, we have to know where we are going. I think we have the foundation in the vision. Then we complete the analysis of best practice for a world class competitive commercial yard including identifying what tools are in that yard informational, structural or physical tools. After that we decide which of those tools would be used across the industry. Then we standardize the tools that are in this new commercial/ military shipyard. These are the tools, especially those tools that help, which are capable of migrating and communicating across shipyards."

Electronic Data Interchange is a viable approach to promoting standards in the industry.

FULL TEXT OF COMMENTS

1. What is your assessment of the vision relative to where we are today?

Dan Billingsley

The assessment that was carried on in the group session was reasonably accurate. It certainly had the opinion of a lot of experts. However, I had thought

that we would concentrate more on the computer tools and information aspects and less on some of the broader problems of the marine industry that certainly need to be addressed. On the other hand, I think the purpose of vision assessment was to fit the computer aids into the broader goal.

Carl Bryant

The vision statement is reasonably good except for the final comment that says that the world will be beating a path to our door and we'll have a significant share of the world's market and be a pivotal part of the United States economy. I'm concerned that by setting a goal that high for something five years down the road will take away some credibility. Other than that I think it's fairly well articulated.

Relative to that vision, we are starting down the road of putting vision pieces in place. Although I have been away from shipyards directly now for 14 years and about four and a half years away from shipyard suppliers, I'd like to think that there has been some progress since then. I would say the groundwork for many of these items is beginning to fall into place. If on the other hand people are deluding themselves only by talking to others in their own community and sort of talking back and forth in the same context without seeing what is outside of their context, then I would be worried. Without spending a couple of days going through a shipyard and seeing their computers, in both their engineering data side, it would be hard to make a judgment.

As one of the few people at this conference who delved deeply into financial management iformation. I think the vision is headed in the right direction. What you want is cost information to the first estimate, the way the job is going to be done and then collected and analyzed consistent with the way the job is done. Dealing with the Navy or the direct supplier to the government artificial constraints are put on that which increase the overhead. I would hope the vision pushes toward a closer relationship both between the shipyards and the customers or lead to that kind of cooperation. Much of the discussion during this workshop was focused more to wards the technical side.

It has to be realized that whether it's to satisfy your customer or just for your own purposes you have to know how YOu are performing in your schedules essentially on-line. I have been fortunate in that I've had the opportunity not only to work in the shipyard environment but also all the way down to a very small discrete manufacturing situation where the pieces that we were building would sell anywhere from 250 to several thousand dollars apiece and would occupy about a cubic foot. This expedience gave me the opportunity to play with more classical manufacturing systems and to drive them to just in time reality. It was a challenge, and there were unpleasant parts of it. We would look at set up times and all of those things. But you get a sense down on that micro level of where the constraints are. The goal in that situation was taking our minimum lot size down to one and we were able to do that hence the idea to build one as cheaply as twenty.

I think the building cost is certainly worthwhile to shoot for. There is always a little bit of startup and creative engineering, but I think you need to do anything you can to try to take that out.

One of my individual recollections of Bath Iron Works was discussion of the learning curve with first production cost X then the second item was X minus some percent and then down on the curve. Where the actual expedience was the first item of production was X and the second item of production was X plus something because of the requirements to build up raw talent. I suspect two or three items down the road began to get down on the curve by that time I was out of the picture.

Testing time and the nature of progress payments in the shipbuilding industry in the United States forces excesses in inventories, excesses in buffers and all of the lost motion and extra time in handling. That is because the shipyards are rewarded for buying all that stuff early. Whereas, if the shipyard had to arrange the being of that inventory itself, even if the financing cost was allowable in some way, I think you would find a different attitude and would remove some of the constraints.

Dan Cada

I think that we have a substantial way to go on meeting that vision. There are certainly some members of the industry who have made progress, when you read the vision, which is of course in the future, some distance, it implies that degrees of cooperation establishing things like standards and well defined and agreed to processes have been accomplished. I don't think we can be at the level of competence and competitiveness until we have come a long way from where most of the industry is today. The good news is that we have plenty of examples of how to get started and get going. We just have to catch that "virus" throughout the community.

Mike Connery

As a relative outsider more in tune with the aerospace industry, I see lots of parallels between the shipbuilding environment and ours 4-5 years ago. I remember similar management meetings then. We were looking at the same sort of evidence early on.

People understood the dire need to reduce cost, increase cycle times and be more competitive. There also seemed to be major disarray in the positioning of our businesses. Our biggest advantage was that we were many departments and divisions within one corporation trying to solve our problems versus trying to attack an industry-wide solution to competition. The ultimate solution to industry-wide competition comes in two parts; 1.- To get one's own company under control, and then 2. - Teaming agreements to take on the international trade.

James Crocker

I think the vision generated is quite good. Most people in the workshop felt that way. The vision focuses where we need to be. As far as where we are today, we are describing two different worlds. This industry is nowhere near there now. Talking to representatives of specific yards, you realize that there is considerable variation. Some feel they may be closer or further away from achieving specific elements of that vision.

Lorna Estep

I'm really impressed with the clear statement of the vision that came out as

part of this process. I'm a little concerned about where we ended up on the line towards achievingit. There seems to be a clear consensus within the group on what the vision should be. What is not so clear is how we are going to execute that vision. This leads one to believe that we're really not all committed to the vision because we have not gotten that far along. On the other hand, I think the community you are dealing with, the folks that were in the room as part of our assessment process, really spent the time on what needed to be done rather than necessarily looking at what was being done, so I think that may lean too much toward the negative rather than being an accurate portrayal of where we are today. There's certainly a lot of opportunity.

Paul Friedman

It struck me as appropriate for the vision to be very aggressive, very far out there. Yet my difficulty with the process is that it was so far out, so much beyond what we are doing today so much remains to do, particularly in an "industry wide" context. The thought of doing any of these things is not particularly fire, but the notion of doing them on anindustry wide basis actually is. While there are efforts around, they do not amount to much. Culturally the industry is not prepared to consider much less implement these ideas.

The necessary cultural change requires a change in perception. Perception can be changed given the right light and right attention. Unfortunately, I think there are some harder, more tangible reasons why the vision will be difficult to achieve. Real structural impediments exist. Situations in which you have direct conflict between near term and strategic objectives are common. This puts the strategic and operational sides at odds with each other.

One of the main difficulties in our industry is that near and long term objectives are not only different, they go counter to each other in many ways. The most obvious case is the cut-throat competition for the remaining Navy work. Because of that much of what we talked about in the past two days, I personally would be a bit reluctant to share. Some of these people refereed to senior managers who wouldn't want this vision but it isn't just senior management. Given the notion that there is only so much work out there to sustain shipyards in the near term, as a middle manager, I have trouble with this vision too. Our primary mission, our most immediate mission, is to survive. Becoming more competitive takes second place. Yet, the strategic vision, with which I do agree, is to become more competitive on an industry wide basis so that we can compete commercially and internationally, hence the conflict. To survive in the near term you have to compete like crazy to survive in the long term you have to cooperate like crazy — very schizophrenic.

Due to the near term competition some yards will die unless somebody steps in, we get more subsidies or whatever. Although I was a bit skeptical of the feasibility of setting up a consortium, in some ways it makes a hell of a lot of sense. It represents a means for putting conflict aside. It would be like saying "We are all going to work together over here for the long term independent from what we are trying to do in our separate yards in the near term." Obviously the consortium must be a totally independent entity in which all the parent com-

panics are co-owners. That is a possible solution.

Right now we are all fighting at the moment. So what are my thoughts on the vision. Academically it is a great vision and I think it fits all of the requirements of a vision, but practically there are some real hard nuts to crack before we can even seriously talk about achieving it.

Jim Hutto

This industry can't decide whether to be a unified government supplier or a set of corporations that happen to be in the same manufacturing arena. If the latter, they are competing in a global commercial market. The objectives, the priorities and the problems are totally diferent for the two scenarios. In the last two days we positioned ourselves as a fledgling industry looking to embark in a new direction. This is new territory because the companies participating here all learned their current business by being suppliers to the Navy as opposed to being commercial entities.

As we see in aerospace and other places, the approach and the requirements for supplying to the government depart radically from those in a commercial arena. For instance the government will issue a list of requirements for competitive bidding with the anticipation that once awarded the requirements will change as evolving combat and other systems supplied by the government alter the design and fabrication process. The government effectively says "I will award you a contract, but I intend to manage your company throughout the construction process. This makes it a custom process where the customer is actually controlling the learning, engineering and the solutions. In a commercial arena, the customer comes with a wish list and determines who can provide the most competitive product. The customer knows that once the vendor is selected he doesn't get to change his mind, the solutions are pre-designated.

Douglas Martin

I was favorably surprised that it came out looking so good. I understand that it is similar to what the executives came up with in Ann Arbor.

Compared to where we are? It is a long way off.

Jon Matthews

The overall assessment for the industry as we project it is pretty close but I think some individual shipyards, those with a chance to survive, are considerably farther along than the analysis suggests. The five or six most progressive yards are much farther along – at least in their minds.

The slant toward new construction bothered me. I think the good repair yards, and the new yards that have gone into repair consider that for the next few years ship repair and ship overhaul willI rank considerably higher in priority than we suggested yesterday. From the point of view of a joint industry R & D program like the NSRP it is pretty accurate.

Richard Moore

I separate the industry into providers and users (ie ship operators and shipbuilders/repairers). US ship operators seem to be limited to those who follow the Jones Act Trade. I am a little

out of touch with those US companies which have a significant impact on world shipping practice and display a national direction/interest. I think that input on the shipping companies, their global ranking, tonnage registered by country, and plans for ship acquisition would be helpful to update the group on current available customers. In general, I view most of the US companies still having a significant fleet as international companies with no strategic interest in the US shipbuilding industry. I feel that the captive Jones Act and Inland Waterway fleet operations will not sustain the shipbuilding base and we must enact the vision statement to re-establish interest by US fleet operators, and then foreign fleet operators, in US shipbuilding.

US shipbuilders appear to be divided into five segments; naval new ship construction, commercial new ship construction, new small craft/inland construction, naval repair/overhaul, and commercial repai/overhaul. The industry is composed of both public and private sectors with a strange overlap where public yards do no naval new construction by virtue of their poor past performance yet have a "lock" on a significant portion of the naval ship repair/overhaul work based on "national defense industrial base" requirements. All portions of the industry are heavily dependent on government funding or loans with all of the heavy lobbying and political influence placed on contract award. I believe that the vision will be effected by the following shipbuilders who have the current capacity and organization to compete for commercial ship construction and increase the value of ships built for the Navy

Newport News Shipbuilding
General Dynamics Electric Boat
Bath Iron Works
Ingalls
Avondale
NASSCO

Other shipbuilders such as General Dynamics-Quincy and BethShip have capacity that is currently inactive.

AU of these shipbuilders are currently engaged in a diverse mixture of the five categories. All are currently dependent on Navy work and only those with little hope of continuing work are actively seeking commercial business. None of the yards are placing process improvement as the first order of business (it seems to be status quo). There is no sense of trying to compete in product, time, or cost with foreign shipbuilders. The US shipbuilders seem to have no method of combining financing, design, and schedule to form an attractive proposal at present. None seem willing to bet the company on any approach to change current conditions.

Marion Nichols

It has critical components of a good vision. It has a lot of the outrageousness essential to an aggressive vision. I work on a program in Augusta which has that same sort of outrageous aspect to it but it's not so fanciful that people say "forget it you can't even start down that path." I like the affirmation, this positive image of what could be. From the discussion during the feasibility analysis, clearly enough pockets of excellence exist in *various* parts of the industry to make this vision plausible. In spite of the grim state if the industry right now, everybody in the room agreed that the vision is out there.

Though coming to a consensus took awhile, there is a cathartic effect in being able to sit in a room and admit to the problems without being dismissed as depressing or defeatist. You recognize that things are so bad that we need to get together and do something. It was an opportunity for people to speak to the sadness of their position and articulate their fear that if we don't do something we aren't going to be here. At the same time, people rallied with all sorts of positive, very positive, ideas about what can be done. I think this was clear in the diagnostics.

It can be done: others have done it. It is monumental in an industry as complex as shipyards to get everyone to agree to work together but it is possible. We did it for two days. If you do it for two days then you can do it for two more days and soon. Now that we have objectives, it is key that we repeat this kind of process on each of them.

Robert Schaffran

The vision is excellent. Today, we are not even close to it. I am not even sure we are within 5 years of it. It might take longer than that; which doesn't make the vision less valuable. It is not a short term goal, it is along term goal. Actually I would like to take this vision and send it to all the NSRP Executive Control Board members and combine it with their vision, their mission, their goals and objectives.

Jim VanderSchaaf

The vision necessarily focused on the marine industry, rather than "Computer Aids in Shipbuilding". This was appropriate in order to set a context of necessary action. Clearly, we are not now where we wish to be in five years (the vision). The need to change is recognized (a crucial first step) by the participants, and, is probably shared by abroad segment of the industry. The ability to achieve this vision will require a significant effort. The primary emphasis to achievement of these goals must come from within each and every involved organization. Stimulus can be provided externally, however the drive must come horn leaders in each organization.

Jim Wilkins

While it certainly doesn't describe where we are in very many areas, it definitely describes where we should be. It is a perfectly appropriate vision; the best I have seen, excellent. The methodology of the meeting is interesting. Even with so many people there, they all agreed to it and yet did so without sacrificing their differences. Jim Hoto had some very interesting comments for instance. He sees two different possible environments. One is a unified industry supplier to the government. The other consists of individual entities competing in the world market. You approach things differently depending on which of the two situations you think you are in. Mike indicated that companies that do business with the government in Aerospace set up separate corporations to deal with those two environments. Very valuable stuff there.

Dan WooIey

It is a good vision but I didn't get the connection with computer aids until the second stage, the initiatives. I think we got everything out on the table, but

I'm concerned about things I think we need to work on.

Joe Wudyka

The vision is excellent a **far** cry from where the industry is today but that is ok. To set a vision well out into the future is fine. My biggest concern is that the industry may not have time to do it. I am always amazed when I sit in meetings with folks from this industry. They are all so bright and know their work so well, but they don't show any sense of urgency - that time is running out. It reminds me of change management or human systems work - when people go through the denial stage. I think this industry is in the denial stage. They realize there is a heck of a problem, but they are not anxiously, eagerly working on a solution. Everything seems to be ok, everything apparently has time and will work out ok. Unfortunately there isn't time and it will not work out ok.

We talked quite a bit about a 5 year horizon for this vision. It hink it has to be done in the next year or two. When you factor in some of things that Jim Crocker from GE pointed out about the competition, you realize that this industry doesn't stack up against the competition. There is no time.

The vision embodies one strategic business move. If the US industry puts its resources together and the combination competes as one of the competitors in the worldwide market place, then it becomes formidable. This industry could be very successful in a worldwide market. If they continue to scrimmage amongst themselves for a non-existent, purely US market, they will never get anywhere.

2. How can our strategic plan strengthen the Computer aided Acquisition and Logistics Systems (CALS) initiative?

Dan Billingsley

The CAM initiatives could use a lot of strengthening. After six years of flailing away at CALS, in many regards people are still trying to figure out what it is they are trying to do. A series of workshops over the last winter for participants from several different systems has produced a second draft of its report. During these winter sessions we tried to get the group thinking in terms of a product model. As I recounted our philosophy and experiences when I recently talked to the CALS core group about a product model, there were a lot of knowing nods around the table. I think many of them are into 3-D product model concepts related to what we are doing. They have a CALS Phase II focused on implementing traditional aspects of CALS and a Phase III to get the product model working in the 1999 or 2001 time frame.

I pointed out that if our Ships entering service in that time frame are to be working in the 3-D integrated weapon system databases, (IWSDB), we need to be developing the ship designs from a product model point of view beginning next year. You can not add it on later at an economical cost. It has to be built in and captured as the information is developed in the design and construction process. Whatis planned and will be planned as a result of this workshop will feed right into that.

Several of the initiative areas identified the day before yesterday were heavily product model oriented. In gen-

eral it seems that the NAVSEA 05 is the lead activity for product model type activities in the Navy and our role in that is recognized reasonably well in the Navy CALS organization Certainly by the NAVSEA organization, the business unit manager for design and engineering. They seem pretty much the folks leading the parade on the product model side. Conversely we are trusting others to bring the applications from the traditional side to the table. From their point of view they can define the roles of fleet support such that we will be able to utilize other's software techniques. It would be a symbiotic relationship.

Carl Bryant

We need to encourage the initiatives that relate to anything that would help an interchange of data, standards and common means of accessing other computer data bases. I suspect that there are probably several places where the whole index of part numbers resides —in separate computer bases. We need something readily accessible across computer programs and systems.

Dan Cada

The CALS initiatives focus on what you do with your data and, hopefully, that data is in digital form. The strategic plan would pull at a lot of those things together. It would be easy to lose sight of CALS in the strategic plan except that CALS relevant activities are the only way to get there. That is not egotistical or centered on any one group, CALS is the computer aided part and I think we all understand that it is the only tool we have to get the high degree of involvement and exchange that it takes to get good and be competitive.

Mike Connery

Every organization should be doing CALS anuyway. Call it distributed databasing, call it concurrent engineering. Anything that solidifies standards and data transfer is going to help the CALS initiative. The big payoff behind CALS to me, and to the bulk of us in aerospace, is data reusability. Throw away nothing from design concept to supportability. The spirit of CALS is to capture that data and maintain it. Maintaining its integrity. Not a cheap process either.

James Crocker

If I'm a Navy yard, I care about CALS and CALS is a great thing. If I am a commercial yard, I may not care about it —maybe there are other ways of doing it. Maybe there are things that are a lot less structured.

There might be commercial experience suggesting ways to trim some stuff out of CALS. The proof of that pudding is interest in buying CALS.

Lorna Estep

In terms of the application of computertools, this vision necessarily brings with it a requirement that we examine the interfaces between companies; how we communicate, and how we support electronic communications. The output of the improvement process is going to be contributing to the entire CALS activity.

Paul Friedman

I don't know how that could hap-

pen. I could see it the other way around. Implementation of CALS, is going to give us a broader basis for cooperation. CALS helps the strategic plan more than the strategic plan helps **CALS.** Some of the specific things we talked about are things we have to do to implement CALS anyway. (Yes, the specifics within the plan support CALS. Having the report from this meeting would be a help in implementing CALS. What we did tends to address the issues that CALS doesn't deal with. CALS tends to focus on the technical, but doesn't get into the details. It addresses what sort of data will be carried to where and for what purpose. This plan has the potential to address the cultural side; to function like abridge between CALS as technology and shipbuilding as business.

It would be a big help to the implementation of CALS as a vehicle to make it more tangible to the business leaders of the industry. Setting aside that CALS from the technical, engineering, and logistics side is a great, the only reason the businesses are interested in it is because the Navy wants to do it a captive audience. If this plan could help address more business-like issues on behalf of industry-wide CALS, that would fit the hole that exists today.

James Hutto

If we look at the industry as being a homogenized set of companies supplying services to the government, CALS is important to make moving information between each of these entities more effective. The strategic plan identifies our current status with respect to the standards. It demonstrated that the entire community is sensitized to the need to exchange not just data, but processes and efficiencies so that learning experiences move from one location to another in order to assure good products to the government.

CALS initiatives are not clearly enough defined, never have been. In the plan we include a lot of line items about production of digital deliverables for making customers and senders capable of implementing and executing CALS technology so it can strengthen CALS initiatives —mainly in the data transfer area. That is one of the areas where, because of Navy funding, we are farthest along. The second highest priority, data transfer capability being deployed to both the customer organizations and the industry itself is one of the key objectives and easy to envision happening

Data transfer is the basic link that has to be forged before we can do these things but it is not something that the industry needs to do in order to execute the rest of the plan. For the industry as a whole, it is not at all clear that CALS is a real important factor in terms of cost saving through time savers. It would be if we were a different industry, structured more like aerospace for example, where you have a lot of subcontracting. There you need to put product descriptions out to a subcontractor base, have them quickly react and then produce a product in response.

We tend to be pretty much self contained with some exceptions. Typically those subcontractors aren't in a position to make use of a digital deliverable in the first place. They wouldn't make much use of it even if we gave it to them. I'm thinking about some big foundations or racks for pipe units — that kind of thing. In the area of VFI it would be of benefit to us, along with the inquiry purchase order. For example, if we got a

magnetic tape or a floppy back from the vendor for the design of a pump or any type of machinery unit, we would then be able to move from block diagrams into electrical and electronic systems even if it went beyond the block diagrams. The FFG7 class could be the guide for these designs or some other appropriate class like that. Something more than just a equipment footprint is needed for design development, although that would be a good starting place.

Jon Matthews

CALS is what one chooses to make it. To be CALS compliant today all you need is a word processor. The computer tools that currently exist in the shipyards are probably considerably more advanced technically than the current CALS vision, with one exception. The ability to transfer data from one system to another is limited because the **CALS** environment hasn't forced the contractual issues necessary to make the decisions that are needed to stimulate effective data transfer. It's basically not so much a technical issue today as it is a contractual issue.

In order to knock down that contractual barrier the acquisition managers have to believe that the digital communication of engineering data and manufacturing data helps them. That Will be determined by actions rather than specs or desires. The contractual issues will settle down when the economics justify those decisions. It's not going to happen through directives. It hasn't. That's been proven.

Richard Moore

Shipbuilting is one of the few industries where effective automated production (accuracy, time, and cost) can only be achieved using model based design due to the limited number of product items of any single design (ie the prototype sail!). As a result, activities involving the Navy-Industry Digital Data Exchange Standards Committee (NIDDESC) have brought shipbuilding to the forefront of US industries leading in research for long term CALS projects. Shipbuilding needs to keep pushing the product model technology already underway. Imaging and technical manual techniques for creation and storage of conventional hard copy documents will continue to develop in other areas such as electronics, weapon systems, aerospace, vehicle, etc. None of these other products will require the significant system based design integration which ships require, and no-one else will have the knowledge and interest to develop a product modeling design system useful in shipbuilding.

Shipbuilders can also gather potential business born life cycle logistics processes used by airframe manufacturers (ie Boeing). CALS is requiring this type of capability but no commercial activity is currently leveraged off theNavy's investment is CALS systems. Again, the US Navy seems to control this activity with internal initiatives to the point of excluding the shipbuilders from making a cost effective business from their requirements.

Marion Nichols

What you are shooting for is the standardization which allows you to talk to each other; design together, and share together. By standardizing across shipyards you could buy the same sort of

products from the same suppliers in the same way under the same process versus asking a supplier to dealing with eight different shipyards on a custom basis.

The partnership between suppliers and customers is critical. We saw this across the multitude of DEC sites. We all buy from the same suppliers and we had 15 different ways of doing it. Now, we rigorously combine agreements with the suppliers so that there is a DEC/supplier relationship versus a site/supplier relationship. You are getting at the same kinds of things with CALS.

The scale is enormous doing it across an industry rather than just in a corporation but the benefits remain the same: you make it easier to do business with your suppliers.

Before you can go to your suppliers and ask thereto sign up for long-term partnerships in order to drive down purchase lead times, design cycles and so forth, you have to be an organized customer. So this really acts as a precursor. It need not be done sequentially but it is one of the critical pieces before you can begin such supplier relationships.

You have to be willing to stand together.

Robert Schaffran

I am not sure why we want to strengthen the CALS. The CALS initiative specifically addresses setting up an integrated weapons database so you can support and maintain the data for the life cycle support of major weapon systems. If we were successful in doing that, I am not sure it adds to our competitiveness in the world market as shipyards. If we are able to share data and have distributed databases that people have access to, it might help us in providing a service to our customers, but we have a lot of other things qto do besides the CALS initiative to achieve our vision.

The CALS initiative is concentrating a lot of its efforts on transferring the Navy's existing paper into digital data. In the long term the objective of CALS are good from a military standpoint. You have digital data from the time you start the design of a weapon system. You start out storing data in a useful format. As you develop design and construction plans, the database grows with the construction of the ship. You design training aids for the sailors and support the weapons systems; all in digital format. Tech manuals are done digitally. The whole goal would be to eventually eliminate paper in the design, construction and life cycle support of ships. All the data required to support ships or weapon systems is in a format that could be computer accessible. Instead of having tech manuals on board ship you will have digital repositories of data and when some sailor has to go down and fix something, he will enter that repository and print out what he needs so it won't really be paperless.

From a weapons maintenance standpoint, CALS provides lots of savings because the logistical support of weapons systems is probably more important than the acquisition cost. For a commercial venture, which our vision statement is addressed to, there are portions of CALS that might have some very strong application. But not as important as in the military. Some of the more advanced commercial operators will probably be interested in having digitized data, but I would say the bulk of the shipyard owners to whom you will be exporting ships probably don't even know what computers are. They are still using

third world crews who Can't read or write. You have to be realistic. You are not working with the high tech owner in the international market place.

Dan Thompson

The "A" part of CALS is the big one, the acquisition cycle. The acquisition cycle initiatives within the Navy are actually one of the few areas that the Navy has really leapfrogged ahead of the other services. And the DOD count as a whole is I understand being led by the Navy. This is a real opportunity for our power of collaboration so to speak to strengthen that somehow. And the question is how best to do it.

The acquisition piece of the pie is what can be done to transfer data and manage data in a computer environment that provides material on time for the acquisition process. Both government furnished material and contract furnished material. It's very, very broad, although Jon Matthews mentioned in an earlier interview that it is really contractual and that is why it's taken off. It's really government initiative to try to make the government piece of the total system of producing ships, they have to be acquisitioned as a whole so the shipyard is only one small part of the total acquisition cycle. It's a very broad view. Also it was mentioned that you could comply with the contractual requirements of CALS simply by having a good wordprocessing system, so it's clearly not all encompassing it is a flawed view and more and more people are looking at the flawed view and trying to support it. And I think we can.

The acquisition part, the 'A" of CALS and the logistic parts of CALS recognizes that from the external view of the industry you need to have it's so complicated that if you said to yourself what is it that takes the longest to buy of anything on earth, next to a spaceship, a ship, particularly a complex warship takes longer than any other possible thing. So the acquisition cycle is a long list. Then the logistics part of it, not only in its service life but in the logistics of the material flowing to the acquisition because there is so much laid on the government to be able to bring the materials that they must provide which is often as expensive or more expensive than the platform that is carrying it. So the CALS initiative is attempting to get a computer milieu in which all these things can be made smoother.

There is also an intention by standardizing across shipyards to establish a partnership between suppliers and customers. Boeing, for instance, pioneered in this. Vendors look upon Boeing computer and other management initiative with them as being Boeing-ized To some extent that is happening here. Before you can go out to your suppliers and ask for people to sign up for long-term partnerships with you to drive down purchase lead times and design cycles and so forth you have to be together on the other side in terms of being a customer. So to me this really acts as a precursor. I don't think it has to be done sequentially but it's one of the critical pieces before you can begin

Jim VanderSchaaf

Several of the initiatives directly support the implementation of CALS. Much work has been accomplished by the industry in support of CALS goals; more can be accomplished by focusing on the implementation tasks associated with

CALS. Specific actions on several initiatives are discussed below.

Jim Wilkins

If you take CALS initiatives as a means to provide adequate logistics support information, CALS seems like an attempt by someone to take over the world, probably in the right direction finally. When *you* extend logistic support to include design and everything, it gets rather broad. On the other hand, it does address the integration of all the pieces of this whole process because you can't do logistic support unless you get all the information - configuration management and all the other things.

This plan, with all the integration and the use of computer aids is certainly directly in line with CALS. The report and evidence from this meeting of the direction in which we see ourselves needing to go and wanting to go, the fact that it does not compete with CALS in any way, but is supportive of CALS and is directly oriented to what shipbuilders need shouId dispel any concern that they are in conflict.

We need to convert some of these potintial initiatives into real projects, do them and demonstrate them. This report sets the frame work and if we use the NSRP process in the way we set it up — to extend over several years, each of these initiatives could bean individual project as well. So it not only provides a framework of prioritizes, it provides the evidence that there is concrete industry wide support for doing what we say we need to do in order to meet the vision.

Dan Wooley

The data exchange portions of our objectives direct support CALS. The objectives that deal with Contract Design Deliverables (CDRL'S) and government requirements on the filters wiIl directly affect CALS.

CALs is really a DOD effort. Commercial customers don't have the same kind of requirements the Navy does, so I'm not sure it is relevant to the commercial shipbuilding world.

A couple of items in the plan addressed the way the government collects costs, almost encourages inefficiencies. You get paid for a certain number of man-hours and your profit is based on those man-hours. If you use less man-hours you get less profit - a kind of negative incentive.

Joe Wudyka

The vision really doesn't contain the spirit of CALS. Nor do the objectives or initiatives, but I saw quite a bit of skepticism about CALS. There were some people who, even after all of the years CALS has been in existence, really didn't know what it means and there were others who thought they knew what it meant, but didn't embrace it.

At Digital, we think CALS is just good business sense. We don't look at it as something somebody told us to go off and do. We think that if you want to be able to respond quickly to customers and suppliers, you have to be interconnected. You have to be able to communicate rapidly — to electronically ship drawings and what not around the world. We do it all the time. We have design groups on one continent who work with factories on another continent and they communicate instantly, all the time. That is **CALS.**

It is something that helps you be-

come more competitive. And the plan isn't adequately pushing industry in that direction.

3. What constraints need to be eliminated to strengthen the industry?

Dan Billingsley

The industry slack of understanding of the potential holds us back right now. The technology exists to make really dramatic improvements in our processes: not star wars, not developmental, but at our fingertips. All we seem to be lacking to really take advantage of it is the corporate will and organization. In many cases, we probably just need a full emotional recognition on the part of leadership of the potential of these tools to revolutionize ourprocesses — to eliminate the false work, the retrieval effort, the transformation effort that occupies so much of our time everyday. Management is a constraint. The technical issues are not constraints. We have the tools, but we don't have the commitment of top management to go forward with this. The CALS initiative gets a lot of visibility, but that in itself is going to be a long process, we can't wait for that.

The pronouncements from top levels have been very proactive for CALS type things, applications, etc., for a number of years, and the increasing body of young people, 40-42 years old and younger, who have had hands on experience with the technology support it. But only a minority of the middle cloud layer who did their time at the working level and moved up in the organization without ever having hands-on experience with the technology have conceptualized what it might do and are taking good advice and having good luck with it. The others never really came to a conceptual understanding of how many ways the technology can shortcut existing processes and make easy things that in the past were difficult or impossible.

For instance, I think overall at C05 we are making progress reasonably quickly given what I've said. We are constrained primarily by the available number of willing, trained users and management support. Of the nine factors that you need to make a computer application go, we only have 7 l/2 but the principle among them is the contract vehicle and the money and everything else needed to bring all the workstations in We have that. The major upgrade underway in our equipment facility wiIl enable us to handle stuff on a computer basis. As will the training going on for those folks.

We can train the users, but we can't make them willing. Fortunately the problems that exist there do not run across the board. There are a lot of people just dying to get their hands on one of these things. They actually nag us about when they will get their workstation. Some of the problems that occur spring from the cultural changes and switch in mindset occasioned by the serious cuts in our in-house staff from that setback in the 70s. We were cut from a 2,000 person to a 1,000 person organization, while we went through the Reagan era build up. At one point C05 was farming out something like 7,000 man-years of work with 1,000 technical people to supervise. This led to a culture which values management skills more than a hands-on "I'm going to do this engineering myself' attitude. Now a significant part of C05 is trying to reverse that

trying to re-breed a culture of hands-on engineering. This shows clear signs of succeeding.

With the ability to short cycle the non-value added work inherent in these machines, we expect to reduce our farm-out work significantly. Other groups in OC haven't taken the support. They consider this is a "pipe dream." All they see is the current work load and the background and training of their people. They cannot see casting out their contractors. They refuse to have their people working on the CAD system or managing people who work on the CAD system. Their response is, "Get out of here, what do I need this thing for?"

In my experience with shipyard design, applications that have failed or have been less than successful, the ingredient that most often seemed to be missing was management support.

Carl Bryant

The first constraint is the adversarial relationship between the customer and the shipyard. I get the sense that there is at least some dialogue going on between the Navy and shipyards at this point.

The other constraint is the lack of cooperation among shipbuilders in contrast, for instance, to the aerospace industry. One of the things that really struck me about aerospace companies was the amount of teaming and collaboration that goes on. They seem to have sorted out where that boundary is between what you have to tell the guy you are teaming up with and what isn't safe to tell him because of competition.

A good manifestations of that is **the** FAT program. MacDonald in St. Louis and Northrop out on the West Coast are building halves of an airplane using a common data base. The program's goal is paperless manufacturing. The two halves are joined in St. Louis.

Another one, shrouded in a certain amount of controversy and secrecy, is the B-2 program. Again, three airplane builders work off of a common database and bring the pieces together for final assembly. In both cases, these same companies simultaneously compete against each other for other acquisitions.

You just don't see that in the shipbuilding industry except for veiled comments about people teaming with foreign companies. There should be a way for a shipbuilder, with a contract for a new shipyard in the country on a subcontract basis for any aspect of the whole project. And do that without moving people so that you eliminate the wild staffing fluctuations, especially in technical areas but also in the factory areas. You don't see that type of cooperation.

I've seen things that would blow you away. You are apt to see big companies like Raytheon, Hughes and sometimes GE all together going after a job as a team And yet you can see they are competing on other projects. It is one of the ways of responding to a contracting marketplace. For them it is not an all or nothing proposition. They hedging their bets a little. They figure that 25% or 30% percent of a project is a lot better than one 100% of nothing. The people buying these systems actually encourage it to some extent because they know they are getting a pool of knowledge rather than just a single perspective.

Dan Cada

Some level of middle management

and upper management needs to be convinced that we have to do this. Rightnow those folks are worrying about theness health but they don't have the vision of a way to get out of this. While most of them will cooperate to some extent, they need to signal to the legion of people who watch them for guidance that this is serious, and these initiatives and these plans for cooperation and integration of procedures, policies, practices, must be implemented. There is no other way for this industry to be effective, let alone be competitive.

Mike Connery

The constraints are usually competitive constraints or financial constraints or something of that sort. The way we have gotten rid of most of our constraints at GE is by mandate from top management that there be standardization across the company to insure the reusability of data and technology.

This standardization appeared in several different ways. One, called EPI (Engineering Productivity Improvement process) was a conscious effort by the aerospace organization to seek out financial deals with vendors; namely Sun Microsystems to get the best price possible on equipment and standardize on it, and then take the whole engineering staff, at great expense, through a series of productivity incentive training programs. I don't know the monetary amount that we put into it, but when you train over 40,000 engineers in a central discipline it is expensive. The payoffs are enormous. Everyone understands the same process right from drafting to systems integration to text. People understand what the previous step is to get the product to them and how they influence it. Which understanding leads to shorter cycle times in the cost analysis scenario.

James Crocker

I saw two threads running through this workshop. One is that there is a single customer, the Navy, and the yards are overhauling their processes in an attempt to remain competitive in capturing an adequate share of the diminishing Navy ship procurement. They are doing a lot of that on their own ticket as fast as they feel they can. That they are competing for a single customer's production is probably pretty uncompetitive.

The other thread is to make these yards commercially viable on a worldwide basis and eliminate the need to be subservient to the whims of a single customer. The fundamental question for the industry is how to get competitive on a global basis in order to share both Navy and commercial construction.

For the yards, commercially viability is mandatory. Otherwise the industry goes through the throes of what happened, for example, after the Apollo program. For years American industry took on the challenge to put people on the moon. They did that. They were successful and within a few months the whole program crashed to the ground. There was nothing left. There was no follow-up. The United States military, the Defense Department along with the shipyards have produced world peace. That's over. Now they have a choice. They can make commercial ships or they can go through what Apollo did.

Lorna Estep

The basic constraint lies in the consistency with which the industry pur-

sues this vision in its activities. If this vision can be continuously reinforced by the decisions made within the industry, then things are going to move from the development phase into implementation and production. If there's no clear consistency of portrayal of the vision then I don't think it's going to make it.

Paul Friedman

The main constraint is that it is virtually our mission to put each other out of business in order to survive for the next couple of years. As an industry, I don't think we are going to get out of this hole without government investment. For example, talking about a consortium of eight shipyards doing something together struck me as just assembling eight essentially bankrupt companies without the resources to do anything.

I don't know if needing government support is really a constraint. I say government because the Navy may not be in a position to improve the industry and I also agree that a lot of the Navy's investment today is along the lines of subsidy, just keeping us going without improving us in any tangible way.

That is another type of constraint. In spite of the fact that we really all do the same sort ofjob there is tremendous variety in how we do it and what terms we use. The end result is pretty standard, even the high level flow charts sort of look the same, but when you start talking to the tradesmen and examining how the designers and engineers interact there is a lot of variety and a lot of difference in terminology. This makes it diflicult for us to relate to each other be. There are tremendous differences interminology because we really do look at things differently. I'm convinced if you stand back far enough you find that they are not really different. But when you talk to the guy responsible for doing the job, he can't understand the fellow at the next yard who does a very similar task.

Jim Hutto

I think the government is a key motivator in providing the tools and mechanisms to reinforce the business justifications for these companies to work together. There is a need for them to compete financially in order to survive. Current constraints force us to compete across the entire process rather than providing mechanisms for the companies to join forces and go after a major program together so that each one benefits financially. Each yard can bring to bear the areas of their most efficient processes to provide the government with an optimum product. It becomes a win win situation for everyone involved.

Douglas Martin

There are slot of them. One of the constraints is kind of a chicken and egg thing. Somewhat like Avondale, we face a discontinuous order flow. That forces us to do some real destructive things to ourselves, mainly in terms of people. Our manning, headcount, curve continuously gets into a pattern of peaks and valleys which damages our ability to successfully and efficiently execute the next program. It adds an additional, substantial burden of training, lead time and learning curve costs which add no value to the product.

If our product were continuously ordered, or if we invented products that could be continuously produced, just the continuity of people and understanding

of what the processes are would make a significant difference. In some respects because of that same discontinuous order flow we have a capital spending philosophy that doesn't really promote a continuous improvement mentality. Only when we get the next contract will we spend some money and by that time we have really lost the bubble. It is too late to spend the money.

We are fighting that right now. I can understand why we are not spending the money, but it is frustrating strating not to be able to make the argument that it is costing us more not to spend it than to spend it now and carry those costs; a difficult thing to document.

There are slot of other constraints that are more traditional regulatory inefficiencies - design requirements. If you were interviewing Brad Clausson at our place he could probably spend a whole day telling you about those and what they cost us.

Relative to computer aids, one of the items in our list highlights the need to make sure that management and supervision understand the routine capability of these systems now. Dan Billingsley relates the story of the VIVID system in Newport News. He talks about his experiences showing some personnel, accustomed to doing full scale mock ups, Navy chiefs, the VIVID system and getting them oriented in how it is used. It is very important that these people have a first hand experience with such a system.

I have been going through a process of trying to get people to do just that for the last several months in my company to stretch their imagination and understand or suggest efficiency improvements and savings areas in their particular function if such a system were available to them. I am encouraging them to characterize what it would look like, what the database would contain and the responsiveness of a system where you could sit down and ask it query X and it comes back with answer Y.

At first we weren't getting anywhere. Our guy, Don Spanniga, suggested that they really did not even know what we were talking about. We thought, "Well, maybe not even though you think you have explained this thing." It is hard to take on board if you really haven't touched it, so we had the vendor come down. We setup a little demonstration of what we had done on the previous contract and took 60-70 people through It. That made a big difference. Two days later we followed-up with the group of folks from production and planning. This time it just flowed. The stuff came out.

One way to relieve this constraint might be a video, something that goes around to the shipyards communicating the routine of business using the VIVID system or its use at Ingalls. I am sure there are people in executive positions who also need that kind of exposure. Dan Billingsley pointed out that capable, designers, when they got this tool, quickly saw its advantages because they were able to use it and recognize it as a tool. Whereas if someone is not use to it or is not a designer and doesn't understand how this helps the designer, he can't appreciate the difference that it makes.

Somebody else used the word liberation. Think of a typical design manager who came upon the board and now is responsible for 150-200 people. He has never had the chance to just sit down with one of these things and play with it. He is expediting late drawings, ECNs and personnel issues. With this blur of lateness going by, he has never internal-

ized the potential of this thing. When problems come up that could be addressed by the system, it sits over in the corner: the connection is never made.

We haven't done a good enough job of education-exposing people to it. Once you see a 3-D CAD system with a few examples worked through, a lot becomes clear. You don't have to be a rocket scientist to see the potential.

Jon Matthews

You really have to separate this into two elements. The Navy business represents captured procurements and economics are not factored on a world basis because essentially we compete with ourselves. Even the government procurement people have difficulty analyzing efficiency from one year to the next because the complexity of the ships varies so much. A submarine ten years ago isn't the same as a submarine today and so on. I suspect that the real cost has come down but I don't know how you demonstrate that.

On the commercial side, which is really where we have to compete internationally, we don't compete and really haven't had the opportunity to demonstrate what we're capable of doing. The only commercial ship that's been built in the last five years is a Matson RORO ship being finished now at NASSCO. That took a long time and I'm not sure how successful it is.

There has to be some jump starting of commercial activity. One would like to think we could take work away from the more productive countries in the world today but that's not going to happen without some external help. The Sealift program actually affords the opportunity to jump start the industry but by itself will not be the total answer. The yards with new building activity over the next ten years will have to join forces with the foreign competition, much like Chrysler did, to take advantage of superior practices and, in some cases, technology.

The human computers more complex than any of the computers that we can purchase today at the local store. The IHI experiences are very important because the U.S. shipbuilding industry invested millions and millions of dollars in many shipyards to try to take advantage of Japanese technology. Some of those techniques in fact are being used today, but the overall ability of the yard to be as efficient as the Japanese appear to be clearly didn't work. It's not because the people in this country aren't willing to change, as a matter of fact we're probably the most adaptable country in the world. It's that there are fundamental cultural differences limitations to what any trainer can bestow on his students. It's a labor intensive business even in Japan or Korea despite their efficiency. As a result you get the perspective of a dozen or so people who come over to act as the educators and that is inadequate. It has to be done more as a joint venture in order to wash out the cultural issues by having top management all the way down to the shop floor participate in a hand holding operation. I don't think it can be done just as a bunch of consultants.

Richard Moore

The knowledge of just how far we trail our foreign competition in Shipbuilding practice—in marketing/financing ship projects to our customers, including high value design, ship produc-

tion cost/schedule differences and relative ship quality— is a major constraint on US Shipbuilding Executive and Govt Policy Makers. We do not need to be cheerleaders for our current practice if current practice is not competitive. Hiding behind the assumed value of “foreign subsidies to make up the value difference to potential customers won’t do it either. Bob Schaffran’s concept of "benchmarking our competition” in their production processes vs ours is the only way to create the objective information needed to gain the required knowledge on this issue.

Current US Navy construction is providing a continuing base of new construction work which ends up retarding needed change in both process and product. The Navy construction projects are no longer “real world” for the 1990’s and beyond. The funding for these projects at current levels of technology and cost have no commercial counterpart. Who else wants floating nuclear power plants with SDI weapons capability? Can we continue to pay for these systems as tax payers?

Marion Nichols

The boundaries/barriers we have traditionally built between ourselves sticks out most clearly. The yard to yard boundary. The yard to Navy boundary. The shipbuilding to computer industry boundary in the sense that your work is different from my work there fore we don’t have a lot to talk about. The United States ship to foreign ship boundaries. When you start talking about bench marking and collateral relationships you need to be willing to share what you do well and what you don’t do well. You have to be willing to say “we tried that and it really screwed us up bad, or” we didn’t get what we wanted out of it,” or “this is what our change of direction was,” or “learn from us instead of going down that path,” or "have you ever experienced anything like this before?” or “what can you guide us with?”

In recent years at Digital, we had to do that. There were very traditional boundaries between plants - ”l’m building com gear, you’re building storage devices, we don’t have anything in common.” ‘We are unique.” "We are special." "We have very unique manufacturing requirements.” we couldn’t possibly get any help from you.” As somebody said about your industry, you can go from shipyard to shipyard and it’s not all that different. I was amazed after being here two days to realize that the issues you are dealing with are exactly the same issues we deal with. The scale is different and our particular acronyms are different but it’s the same stuff. Exactly. Some of us may be a little further ahead in some places and some of us aren’t dealing with equivalent levels of complexity so it’s easy to make fine distinctions that are really irrelevant.

Dan Thompson describes his experience at Bath Iron Works working to introduce statistical process control and MRP2 and his discovery of the parallel between ships and satellites. They were really canvassing the country, the world for common things. One of the Vice Presidents of the company was visiting plant in New Jersey building spy satellites and said they ought to look at that. So he sent one of his staf there. This fellow came back with his eyes aglow because he said it was extraordinarily comparable to what they were doing. The satellite has 7 million parts. The same number of parts as a cruiser. Much

smaller, about the size of the room and they only build five a year. So the number coming out per year was about the same. And it's an extraordinary parallel between a boat and a spy satellite.

Once you move past the object and to computer systems in the aggregate, once you connected the pieces together, it is extremely complex. We try to bring it back down to a manageable size by focusing on the pieces. It's too big you know we can't do it within a yard so how can we do it across the industry. How could we possibly do it across commercial and Navy ships at the same time.

But if you let yourself perceive it as a system and see the pattern, and you know there are a lot of people who have already dealt with lots of the pieces, you don't have to start from scratch and do it all over again. You've just got to go get some of those pieces, plug therein so you can model them and suddenly it's like a puzzle. The pieces begin to fit together.

I have a sense of recognition. Periodically over the two days I felt a little bit out of my league here. Then all of a sudden the conversation would take a turn and I would realize that it is the same stuff I've worked on for years.

Even though my experience is with a scale which could only be looked at under a microscope I've seen the pattern. To do this you have to buy into process. You leverage and seeking out people, for instance, who are MRP 2 continuous improvement experts even though all their experience might be in electronics or even unrelated. What you build becomes less significant other than that it defines the order of magnitude.

Robert Schaffran

The answer is sort of tongue and cheek Basically it is the mind set of our senior management. Our industry has been geared, for over 20 years now, to go after a captive market place. We have not had to try to really sell our capabilities in order to compete in the international marketplace. We have to change ourselves from a reactive industry meeting customer demands, whether from a subsidized ship owner coming to the U.S. or from the Navy, providing their design for us to bid on and produce. The rest of the world is proactively understanding the market place and coming up with designs that will be competitive and then going out and actively trying to lure customers in to build that design. For example, in Germany, the Bremmervolken shipyard's marketing division physically contacts (not by phone — it visits) customers world wide, 300 customers a year. They sit down and talk about some of the products they have and identify needs. Based on three hundred visits they write about 60-80 real proposals and typically win 30-40. Again, very proactive, out there beating the bushes, constantly listening to the customer needs and designing in response to customer needs. We don't do that.

I don't seethe external constraints to dealing in the international market that a lot of people say that we have. There is one, maybe, the environmental restrictions we impose on shipbuilders. EPA is starting to come down with more and more restrictions on the environmental impact of the industry. Perhaps this puts some constraints onus that the rest of that competition doesn't have. As far as our ability to be as productive as anybody else in the world, I don't see that there are any constraints that we can't address. As far as building ships the Coast Guard and ABS regulations are

successful Some foreign shipyards have very strong unions, in some cases militant, but they still deal in the international market place. We have to stop looking for excuses for why we can't compete and start figuring out how we can.

People talk cultural constraints in terms of the Japanese work force, with its homogeneous, sing the company song and do push-ups regime. All the things we have seen reflect a very highly analytical managementteamthat structures work and the work force in a very efficient way. There is no magic to it. There is slot of hard work and you analyze, and analyze; not the seat of the pants kind of management we have a lot of

Jim VanderSchaaf

The process by which we change is ineffective and inefficient. It is too bureaucratic, lacks sufficient focus, does not involve all the right parties. More than at anytime in our history we need a ways to manage change.

The process by which we manage is outdated. We are too tied to the past, have insufllcient focus on hard goals, act too much as authorities rather than as leaders, and have yet to apply the best ways to involve, motivate, and stimulate people.

Jim Wilkins

I guess my problem with answering this questions is that I don't see any constraints restraining industry other than what is internal to the industry. I think the industry fully has the capability of doing the things they ought to do and its not doing it. It is not because someone is keeping them fiom it. (There aren't external?) I don't see any other than I'd be giving you somebody else's thoughts than mine. I think Doug Martin had a good point. One - just the cyclical aspect of our industry where you have a bunch of work and then suddenly you don't have any work for people and that doesn't help and there is slot to that and I don't know that you are going to change that. I was taught that when going through School - that shipbuilding is a cyclical industry, always has been and probably always will be. That you have to recognize.

Dan Wooley

The biggest problem we have, and it showed up in our priorities, is understanding and constantly improving the overall process of shipbuilding. We focus in on things at a micro level instead of a macro level (this is my opinion and I hesitate to speak for Newport News as I am a fairly small fish in a big pond). In the Sea Wolf project for example, we took a more macro view of the design process. It was painful, we had to break down slot of barriers to make it work, but I think we successfully implemented it, at least to my understanding of concurrent design. We have some software that enables that technically.

There is some technology that you need to have to enable concurrent design. The big constraint whose removal will strengthen the industry is the drawing mind set. We still think in terms of drawings. We haven't broken out of that mold in terms of thinking of a product model. The drawings are still the gospel. In Sea Wolf that was the biggest hurdle we had to break and we still haven't totally done it.

Most of the industry still thinks you have to have a drawing before you

are done. One of the initiatives I suggested was to replace drawing swith product model. That requires some technology including very user-friendly access to the computer model. There is no reason why we can't put all the data we try to put on drawings into that model and make it accessible. Then we don't spend moneymaking drawings. We save thousands and thousands of man-hours that have limited added value. Why not add that value to the product model and not spend the time and money to make the drawing?

I'm not sure it will ever totally eliminate drawings, but there are an awful lot of drawings made that aren't necessary technically. The technology is there to do it. I think that is one area we can cut costs a lot in commercial ships.

Joe Wudyka

There is a massive constraint and it has nothing to do with technology. It has to do with what I was calling change management. We ended up capturing it as cultural and organizational objectives. On the one hand the industry does do more cooperating within itself than any other industry I have seen. I am not an expert on all industries, but I have never seen or heard of anything like it. There is slot ofinteraction. The problem is that even though they do a certain amount of interacting amongst themselves in helping each other out, there are huge walls beyond that point that all refer back to the history, the very rich history competition between these shipyards.

They have to get themselves to look at a new paradigm, a new model for the industry. It has to be a model of cooperation, because I don't see how each one of them can go off and successfully compete alone in a worldwide market place. Can you imagine every shipyard in the US, even though there aren't that many of them anymore, setting up its own worldwide marketing organization, worldwide sales organization, and dealing with the governments of each maritime country around the world.

Granted the shipbuilding companies are big, but why do they all have to go off and do the same thing. Why can't they get together to do it once and help each other. Why have five different sales forces out there, why not have one? To get to that point, to get to anything like that, you have to get these constraints out of the way. The fundamental one is the cultural issue that existing American companies, because they have been so rocky in the past, have gotten into this squander ous habit of competing almost to the tee. They must somehow learn to work cooperatively, at leastin some functions. For example, let's say shipyard #1 has to do automation projects A & B. Another shipyard has to do a very similar project involving A &B. As things stand now, each of them goes off independently to do A & B. If done serially this way, by the time both companies have finished B, a long time has gone by. What they should do is work in parallel. One should take A, the other take B. They should work for each other, with each other. Production time theoretically is cut in half. This represents a major paradigm shift but time is a critical competitive weapon out there. These kinds of changes will make them much more competitive.

The human systems kind of constraints, cultural and organizational stuff, are so great that I wouldn't spend any money on automating anything until I started to get those barriers out of

the way. I wouldn't wait until they were gone because it takes too long, but I would begin working tomorrow on removing those barriers. Then I would get into automation, internal collaboration first, automation second. We area computer company. It is a heck of a thing for a computer guy to sit here and say don't automate.

At Digital we have made some significant automation improvements over the last 9 or 10 years-major, major changes. But when you look back over what happened as we did those things, where ever we stumbled or failed to pull off some major change, it was because of people; never the technology. The technology always works. The failures were because of people and resistance to change. In response to recognizing that, we made a key discovery. When we invested as much in the people in an automation project as we did in the hardware and software, we were successful. As long as we thought we didn't need to spend money on people and just brought in the best hardware and software, we failed — very consistently. That is why we ***now*** have a lot of people in our company who do internal consulting. Every time we go out to make a major change, internal consultants deal with our own people to support it.

4. What management attitudes need to be changed?

Dan BilIingsley

Generally we have been getting the right kind of support from within NAVSEA from top level management to be on track. After putting together a lot of the technical and hardware aspects of a successful implementation program last summer, we realized that from a staff perspective we weren't positionedto deal with some of the personnel and resource issues that had to be addressed. To facilitate that we formed a group of senior individuals from each of the groups and also from 06 and called them CAD Execs. They meet every couple of weeks to take on the resource and personnel type issues. They have been very effective. We set the ground rule fairly early that they represented their group and that we were going to take them at their word as being representative of their groups functions. In general that has worked very well. The only rough spot is the turn over in the front office staff of 05 and 05B — a matter of getting them up to speed. They aggressively want everything to happen immediately in contrast to Mr. Gong's very cautious "show me" attitude. Between the two halves all aspects of this thing are completely planned out and handled.

Carl Bryant

Even in the vendor community you don't have the sense of working together toward a common goal that you need. Whether the contracts are fixed price, incentive or whatever, these days there is this constant drive to get the vendor down to the lowest price. Then when delivery dates stretch out or something elsewhere gives because of the cost compromise they get all upset. From a vendor's point of view, the FLP program was a little better in that regard. There was a long production run at an aggressive fixed price at the outset. The fixed price provided a great incentive to improve our methods. We were able to make some money doing that, which ultimately resulted in lower cost on the

DDG 51 and CGs. They were using the exact same system to reprice down the road, so the profits on that job were plowed back into the assets of the company. As a result the price at the time I left had been cut in half.

To get back to the management attitudes, there has to be a sense of collaboration or teamwork between the shipyard, it's contractors and subcontractors. The same goes internally. If you have walls built up around each other, you end up being very insular. If you only get together at meetings like this and with other groups, you get individuals, generally from the technical and working levels, talking to each other but you still don't get that sense of awareness of what the rest of the community or the rest of the world is doing.

Shipbuilders need a more global sense of both their own industry and other industries. I remember the rhetoric that shipbuilding is different from everything else, and you hear it today. Every industry is different to some extent but there are things that people are doing that you can look at and learn horn.

Dan Cada

The attitude that goes "I'm surviving, so it's o.k.." Without a focus on actually assessing how well you are doing, the analogy is with a guy falling from a ten story building, and at the fourth floor he's still not dead. They have to realize that free fall is not where you want to be, you want to be propelling yourself someplace, not just still alive.

Consider the turnaround at General Electric's offices. The one I'm most familiar with is in Morristown. In the past three years they have carried out both a culture and a leadership change, it takes both, that has really gotten them saying "We're going to do this. You don't have to ask us, you don't have to tell us. We're not here for a handout on some program we don't understand yet." They're doing it because it is smart. They invested in a number of gatherings they call "Workouts." I don't know the substance of those, but I think we ought to take a look at what they undertook in those. It seems to have made a dramatic change in what they're doing, and they're doing it because they realize it's good for them.

Mike Connery

I am coming from a company who's doctrine was either be #1 or #2 or you are out of the market. That management philosophy, although eroding somewhat it is still prevalent. There is leniency in that we all understand that in day-to-day competition you maybe #3 bordering on#2. Ourmanagement attitude at Ocean and Radar Systems is called speed and simplicity. You have to shorten cycle times, do things faster which relates to cost. I really focus in on the simplicity part. Too many organizations are catching on to buzz words like CALS and concurrent engineering and automating for automation's sake. Examples - we do a lot of what is called process mapping. For example if we were to do process mapping on an assembly line, you would first clear the line of all materials and all people except for the essential ones to get a specific process done. In 99% of the cases, if you take one widget and run it down that line, you find out the process time, the actual touch labor to build, produce and put it out. If it were to take two weeks of actual time, chances are in

your production cycles that would be a 6 month endeavor. So the message there is, if you just sit back, analyze the process — just watch what the people are doing, you will see immense amounts of slack time in there. People tend not to believe that. They say "we have the system honed, we have done this for years." When anyone says "I have done this for years," that is a good area in which to do process mapping. Clearing out the rudimentary biases that these people have in the way they do things can make an amazing difference in cycle time.

We have a program called Workout. Workout is based on empowering people and what they do. I have a saying for Workout "When you teach a bear to dance, you better be ready to dance with him." Empowered people feel a sense of ownership in what they are doing, it is hard to say no to them when they want to do more and more. The management philosophy must be, going in, that this is going to cost money. You have to get people together on the company's time to discuss these things. In the end they will ask for processimprovement, which eventually will lead to capital expenditure. It is a powerful thing to have these people behind you - they are the ones who know what is going whatever industry you are in. You go down and talk to the metal bangers. They can tell you how to get the job done, but there has to be a reason for them to do that. We find that giving them control of their destiny is the reason that works.

Let them be part of the scheduling process and the methodology process. If you have a master shop schedule, you call a meeting of the principals of the work cells and say, "We have a challenge here to reduce the cycle time by 30%, I would like you to go back, bring your teams together, elicit input and come back to me with some way to do this - and oh, by the way- I will hold you accountable for what you bring back." If that effort is successful, the chain goes on and there has to be some sort of compensation for these people so that the salary structures are redundant.

Setting this up is not an easy task. It is not a one or two year thing, but again, as an outsider looking in at the shipbuilding business, I sense there is a significant backlog of work in the yards. Unlike aerospace, you have time to get ready for whatever this thing is you are getting ready for, this doomsday effect. Some of the yards have a ten, eleven year backlog an eternity in some businesses.

I am a believer in competition. I think the aerospace industry is highly competitive. There were x amount of aerospace companies last year and there will probably be half that in two years, so I appreciate the fact that there will not be as many shipyards around in the future. I think the whole management philosophy of the shipbuilding industry has to change from short term to long term visions starting today. Look at process. Process is the key. If you get process under control, cycle times will come down and cost will come down. The work force will also come down, but a highly effective group of people remains.

My career has centered around automated systems; going from manufacturing to systems engineering to running infromation organizations. The key was in office automation. In many offices I've seen automation used when a file cabinet and a calculator would have done the job. Everybody uses this term "return on investment" or "return on sales." I have anew one Called"return on knowledge." I see the best return on automa-

tion coming in some form of expert system which captures the mind set of the highly productive but aging segment of the work force in a rules-based system. You have an opportunity to capture those learning curves, and learning curves are nothing but the rules. What is the quickest way from point A to B? You can let me learn that way through many obstacles and tollgates or you can show me that way and save us alla lot of time. We are losing that. The retirement of our aging work force is hurting us terribly. When you say expert system, people fantasize about the year 2050 when computers do your work for you. Computers can only do what they are programmed to do and unfortunately we are losing the biggest programming base there is — the aging work force. We have to capture that somehow and it is not an easy thing to do. It is an expensive thing to do.

James Crocker

The attitude needs to be, "We will find a way to compete on a worldwide basis." We have our Navy customer with its high tech requirements, reporting feedback requirements and constant migration to better technology. That is a piece of our business. And we'll manage that business accordingly and we'll satisfy that customer and all their needs. However, concurrently we also have or should have another set of customers. Those are the people who buy commercial ships. They are also a reliable set of customers and need to be satisfied.

We need to develop plans in the yards or in a consortium of the yards to demonstrate that we can make a viable commercial ship profitably. The management attitude needs to be, "What does it take and what process will be employed to make a commercial ship in the United States at a profit? What does the yard look like? What are the primary production processes, secondary processes and the integrating support processes? What are the enabling technologies like EDI and what are the physical support tools.

As long as I'm focused squarely on the Navy, then we probably don't do too badly. But we only have one customer . . . .

Lorna Estep

There is an absolute frustration at a lot of levels. People seem to know what needs to be done but there appear to be barriers preventing those things from occurring. These barriers probably have to do with traditional business as usual type issues and attitudes of the sort, "If it's not real broke let's not mess with it." This has got to change. Consistently we've seen it is broken. No more "business as ususal" activity.

Paul Friedman

There is too much emphasis on what appears to be the wrong performance measures. The focus is on costs when it should be on time and quality. We are in a funny position at the Iron Works. We actually have, at the very top anyway, management with, to a surprising extent, the right attitudes. They seem willing to try innovation, especially if there is good potential for tangible benefits. They still set up some pretty tough criteria, but in the past couple of years our management has shown greater and greater interest in the notion of improvement. We still have a long way to go and lots of things to be learned — primarily horn our own people. I think

it is only a matter of time before we begin to recognize that the same notion applies outside our borders.

I would focus on changing the attitudes of middle more than senior management. They are the people who have grown up in a certain system and think, by and large, that it is the only way that the job can be done. Regardless of whether it is good or bad. It wouldn't hurt to get these guys into other jobs or overseas in order to give them a broader perspective. Many of our middle managers, especially the ones who are really good at their jobs because they have been doing it for a long time, are hung up on the notion that their's is the way God intended it to be done. That is our shipyard's biggest impediment. Unfortunately it has been reinforced by many failed attempts atimprovement. I would focus on middle management attitudes and there is no specific attitude that needs to be changed other than willingness to change. It varies with each guy.

I guess there is one other notion and I'm not sure how to fit it in. It is very difficult to transmit the seriousness of the industry's situation down through the organization. This may be peculiar to Bath, I don't know. The problem is, we have heard it too many times. We have cried wolf way too often and the Navy, interestingly, has some culpability in that. The contract structure is such that we are constantly being shifted from apparent cusps of doom to being fat, dumb and happy. As a consequence, nobody knows who to believe or what's the truth. In fact there is no truth, beyond whatever is selling at the moment.

On the white collar side, we seem to go through six month cycles from potential famine to real feast. It seems, literally, on a six month cycle that we have to get together and go through the agony of figuring out who we are going to lay off and then not lay off anybody. The blue collar side of the company is in fact down-sizing so that tends to confuse everything. We are in different worlds. In fact we work on some contracts that require high numbers of white collar relative to blue collar personnel.

The problem is that we reach a level of anticipated reduction in activity that forces us to announce three to six months in advance, depending on how many people are involved, how many people we are going to lay off. This is not simply a matter of management making contingency plans and then being told everything is ok. In some cases we have actually notified the work force that in the next six months they probably will be laid off. We notify them as required by law and then we don't do it. You never know what to believe. It is not an intentionally abusive system. It is part of being in a very closed society with subsidies and whatnot. That's a real problem.

Jim Hutto

Little motivates management right now to maintain equal footing with other members of the community. There is a tendency to compete; to believe you can solve the problem better than anyone else. Government agencies must find new procurements methods which allow different business units to compete on the components level rather than on entire vessels. With more suppliers for single vessels, more people will be able to keep their employees fully utilized.

Douglas Martin

Management is going to have to be

ready to take some risks; more risk than they normally would in order to implement a lot of this.

Jon Matthews

Only one management attitude needs changing the emphasis on short term profits. Every CEO in the ship building business is interested in improving. The problem is that the industry is driven by financial people who are looking for the immediatiae return. That acts as a restraint on establishing the long term vision that really needs to be there.

We're very creative in working ventures. We're very creative in individual elements. Computer technology is one example. The repair end of construction in the U.S. shipbuilding in dustry, is significantly more advanced in terms of computer application than any other shipbuilding nation in this world. The one thing that we exportis computer technology.

That's driven by the hightech side of the business; the Navy weapons systems and sophisticated Navy ship construction.

It's more exciting to attack the high tech stuff; it's more exciting and more stimulating mentalIy, certainly for technical types, to demonstrate a 3-D model of a ship rotating on a TV screen than it is to say I'm going to take 12 minutes out of the material handling cycle for pipe hangers going from the warehouse to sub assembly in the shop. And I think that's really the problem.

Richard Moore

That the industry will solely continue on the basis of defense industrial base requirements funded by DOD new construction.

That current practice represents "a best value practice" in terms of product delivered to the Navy. (ie why should anyone deliver a better, lower cost ship in a shorter time frame to the Navy)

That the changes needed to compete for commercial work are too big - so we won't try, rather than take a combined industry or radical internal approach that says - we can and we will!

That executive managers are the only resource to solve this competition problem for our companies (ie the work force - both white and blue collar - is not asked or empowered to help and there ***is*** no cooperation between companies)

That process and product improvements are not as important as making revenue and profit. (ie in general, managers do not see product, process, and schedule improvements as having any significant effect on revenue and profit)

Marion Nichols

Do you value what the individuals holding the hammers and holding the torches can offer to the process? Do they stand with equal weight next to management in terms of having a solution. That is a tough one to climb over in traditionally heirarchically oriented cultures where you feel you have people who know and people who do.

It's not just management's attitude. Management needs to be effective in communicating all the way down to the last person down the line, that how they do their job determines the future. I can see the difference even at Digital in the last ten years where the traditional view of work on the production line was people lining up at their benches and not moving off them except at break and lunch time. Today you see people study-

ing trend graphs and doing problem solving. You cannot underestimate the value of that environmental change or the change management techniques and training. You can't just say okay, tomorrow we'll get into groups and we'll solve our problems. It takes years for people to feel that they really are valid, that this isn't management coming down and asking me my opinion and then doing what they want to do anyway. We had to change, we still aren't there yet.

The attitude was that if you had everybody at their bench 7 and half hours a day, that was good news. If you had anything less than that you weren't in control. Now we are recognizing that if you take an hour to put people into a problem solving group and they come up with an improvement that reduces cycle time that hour was much better spent than an hour of assembly. To keep building through the day is not a goal. In fact it's counter productive. It's better if you finish the job early because you figured out a way to do it faster.

People have to see management leading it. But management works in terms of problem solving and isn't out there saying "great, you finished the job in two hours rather than four. There needs to be a reward system for the innovations that everybody buys into. We've done it. People have to know what it is you want. It is evident all the time what our primary goal is; cycle time reduction, getting the job done on the day it's supposed to be done, reducing set up time or reducing the number of shortages. Whatever it is that you've decided is of critical importance. Management's role is to start the ball rolling like setting the key metrics to focus on, the visions and how do they translate into the first tier of goals? And get the rest blown down, people invested and committed, people visually in front of people, people feeling as though they're empowered.

A technique we use is called a tree diagram which is simply being able to say here is a plant goal: 96 percent ship requests. In terms of wiring that tree so that every individual in the plant can see, this is my branch. This is where I fit. If I do this job here well, and pool these things that I'm responsible for, I can see how it's going to impact these goals.

People locally know their effect on the whole, feel it; they see it, they know it, they believe it. It's part of their job performance reviews. It's part of their job plans and commitments; a term that we use is that it's wired, that you see the relationship between what you do and whether the plant stays open. There is nothing more effective than having that linkage for people. We've struggled this year because it has been scary, you can disable people very rapidly. Some people are highly motivated by threat, the threat of closing or failure. Other people don't know, they wring their hands. That again is part of management's role in terms of change to help people through those kinds of things in the variety of ways that people go through those things.

Robert Schaffran

Some of the management in this country is really starting to change; to take on a global outlook. We hear about a lot of things going on in all the yards, but several are really trying to bet the company on the market. They are doing some pretty bold and innovative things; coming up with build strategies almost unheard of as far as time and construction in this country. They feel they have the capability to doing it and are already

setting up lines offoreign supplies, equipment and components so that they can get rapid delivery.

In some yards the efforts may be too little too late, but I think changing management's attitude has required crisis. If they don't do something different, down the tubes they go. For the first time in the last 20 years an environment of crisis is forcing these yards to innovate. In other cases yards are waiting for Congress to bail them out. It might happen.

Competitiveness in the international market place requires a change in top and middle management attitudes that has not been there and has not had to be there for many, many years. There are some people we have talked to in middle and lower middle management with a lot of good and innovative ideas and things that they would like to see done. They look at upper management as a hindrance.

Jim VanderSchaaf

The potential for positive change that is available through a more cooperative and knowledge sharing environment. This is possible within divisions, within companies and between companies.

Jim Wilkins

The management attitude that needs to be changed is that we are doing pretty good. Many of these people really believe they don't need any outside help, that they are doing all these things themselves and are pretty satisfied with where they are. They entertain all kinds of rationales for believing are different from the Japanese and they can't do what the Japanese have done. I have been in all these shipyards. In every single shipyard I can see lots of improvements that are needed, but when I speak to management about them, they have reasons why they aren't doing them rather than saying, that's a good idea and we really qneed to get on it. They are in denial about all the things we already know we have to do. Frustration to me.

Our attitude toward the market has to change. In this country we waited for the customer to come to us with their requirements and then tailor a ship in response. The rest ofthe world functions in the automobile model. They turn out classes of ships and modify them to the customers needs. We have never been in that mode that I know of and exactly why I'm not sure. There are people thinking that way now. It requires that you ensure that there really is a market.

One of my interviewees had abetter analogy for this than I would have thought of by myself. You can go to Ford and buy a car in a lot of different colors with a bunch of different options, but basically you buy a standardized model with various modifications geared to meet different levels of the market. On the other hand, if you want a race car, then they build you a custom race car for a million plus bucks. Our US shipbuilding industry is oriented to the custom business rather than the standard production line product with options.

As someone who has been a top level manager in a shipyard - we are guilty of the same short term thinking that we blame all of our MBA schools for generating. What is the profit going to be this quarter? When Avondale was owned by Ogden, the chairman of the board of Ogden was a very dynamic gentleman who knew that putting out a dividend to the stockholders was very important. But he was a very shrewd guy and tried

to find a balance.

Dan Wooley

The old theory xmanagement style where a manager manages by intimidation is still prevalent, although it is fading. We have too many layers of management which costs slot of money without adding equivalent value end product. We talked slot about empowerment and as a supervisor there are a lot of times when you feel responsible without authority. An awful uncomfortable feeling. Empowerment means that your authority comesponds to your responsibility. One of the things changing, at least at Newport News, is the quality - continuing process of improvement mentality. In the design side it is really starting to take hold. We are not there by any stretch, but we have made significant strides. I'm pretty optimistic about the way our unit is transforming it self—I just hope we can do it in time.

Joe Wudyka

Attitudes — the battle lines were drawn 50 years ago and they still remain there. I am referring to the empowerment of people angle. As I understand the organizations in the shipyards, they are all very vertical and the whole process of getting anything approved is a very slow one. That reflects an attitude which has to be changed. VPs get promoted, they begin to bring other people under them who want to have power and prestige, those bring in others under them and before you know it you have this tremendously vertical hierarchy composed of message passers. All they do in the middle is pass messages and screw things up. This territorial head set has to change. People in organizations have to do real work and they have to do it quickly.

To change that attitude you need to empower people to do their jobs. I came to this meeting empowered to act for my company. When I wrote this thing up I said I was coming for Digital Equipment Corporation because I am committing my company. I was really surprised to see how unempowered almost everybody in that room was. That was clear from the way they were very careful about saying anything, about committing anything. Think again about time. My company was ready to move and nobody else (taken with a grain of salt) was ready. The process died. I wanted to walk out of the session with commitment to the action items we created. I wanted to say, "Who wants to do what. I want to work with you to help you do that." And it never happened.

5. What management methods hold the greatest promise for implementing this plan?

Dan Billingsley

Our technique is to get groups of people together as steering groups overseeing the development of specific areas within individual funtional areas. It might be worthwhile to think of the people who are in the group. From 56 we have Mike Pats who was at that time a subgroup director and very proactive in introducing CAD and other automation tools in his subgroup. Shortly after the CAD Execs were formed he was staffed out to the 56B position. He continues close involvement but his proxy, Ray Penny, his understudy as we call him in the sense that the show must go on, now

fills the role for 56. 55 has been either Dave Byers 55B or, amember of his staff Frank Pierce. 50 is Dr. Dietz or Kit Ryan his understudy. 51. has gone through several people and has ended up being Jeff Hobb with Mike Bosworth. For most segs we have had Don Spalcier and Joe Singer, both guys with excellent backgrounds. These are people who were at the echelon where they had hands-on experience. They have tangible experience of the division and have gone up into management far enough to relate to upper level management. They articulate what the issues and controls are in terms that upper management understands. Rounding out the group we have me and our staff with Jim Given and his staff. Both of us have staff support roles and Captain Whitten,the director of the group was the NAVSEA visionary.

Right now, an organization exists in NAVSEA to deal with information technology and information resource management issues. At the top level it is ISEB (Information Systems Executive Board) which is a board of directors in another incarnation. Basically it comprises the civilian directors and then working for them is a group called the Visionary Working Group. The Visionary Working Group (VWG) has a senior guide, Captain Whitten. Presently it is I on his behalf. The VWG has among them six individuals who are tagged as being the business unit managers representing each directorate. The information resources strategic plan considers these six units to be part of the operation. The groups, in general, are supportive as well. I mentioned a cognizant layer before that which is continually shrinking and thinning, but it is still a factor.

How much shipyards do this is just smatter of persistence and lining up all the pieces. We had a discussion in the open session about getting involved in so many things on such a broad front that you didn't do well at any. Here, you were Virtually forced by the nature of the problem to proceed on a broad front because if you get one aspect ahead you end up being constrained by the other, but if you get the other aspect ahead you get constrained by the first one.

Carl Bryant

It varies from company to company, depending on the culture and the way they approach things. I think the common denominator has to be recognition of the individual's value; of contributor's ability to make something happen and participate in something creative. There has to be a a discussion of the power of the employee. In the manufacturing industry you can't let everybody do their own thing, they have to work together as a team. You can encourage that sense of teamwork and encourage constructive feedback about the process. If a team is asked to do whatever chore it is assigned, there has to be an incentive or reason for them to want to make that process better. The methods should focus on reasons.

Dan Cada

This one Ihad some difficulty with. I guess I don't have a good library of management methods. Continuous process improvement I think is a management method, certainly it's a feature of TQM, which is well known but probably not well understood, and maybe not well developed and therefore not well implemented. It seems to offer a focus that . people can understand. It is meaningful

to them, they are not left wondering what a QNB is for instance. When you talk about the processes they use, that's something people identify with, whether it's a program office or a manufacturing facility. They know they have a process. We need to get a clear view of those processes and then we need ask what we have done for CPI today.

Program managers, for the substantial number of suppliers for the AEGIS Program, provide the government furnished equipment and information going into the shipbuilding contracts. The program tells the suppliers what the performance standards are and how we, the program office, measure them to that level of pefiormance. It then rewards them both by recognition of good performance and by reduction of the dreaded oversight — the number of times the government steps in looking over your shoulder. The program bases itself on a definition of what we expect to come out of a given supplier and the way he does business. This goes beyond the quality of the parts to how he manages them. His logistics are tracked continually and reported on regularly. As a consequence I see suppliers in that program striving to improve. They do it because they understand what's expected, they understand how they're measured, they can check themselves to see if they've gotten somewhere, and they see the payoff. The payoff is a preferred status recognition, and reduced burdens of oversight.

Mike Connery

I guess I can only talk to the ones we are using right now because they are successful. This is the speed, simplicity, and confidence you get from empowerment of the workers. Managers find this hard to do because they have to delegate their power. My experience of being a manager over the last eight years is that you don't manage. I can't sit here and tell you that I manage a group. I have 220 employees but I don't manage them in the traditional sense. I facilitate their actions. I act as a mediator with them. But if I were to have to sit down and manage — well, no one person can do that. That was not my attitude three years ago. Then I felt that I was responsible for the whole area. I wanted to know everything about it. I wanted to detail it. I wanted to structure it financially. You would have thought I was doing a good job until you actually see how the people can support you. Once they get in and they do it, it just becomes second nature. Being in that kind of environment excites you.

The self perceived uniqueness of the shipbuilding industry is agoodissue. Many, many times on the aerospace councils, especially on the CALS aerospace councils that we sit on, someone has brought up their uniqueness. In our organization of 14 divisions, effectively 14 independent companies, the buzz word throughout is, "we aren't unique."

I pose to you that however unique your products may be, your processes are not. You have to drop the ego stuff and look at that common denominator set that I bet you everyone is using. Our field organizations at GE are an example. These are the people who go aboard the hull to do cast reps and install equipment, we have a contingent right up here at BIW. These people bid on schedules to install certain pieces of equipment. In the past we had teams of five or six individuals; highly skilled people who really know the system. I went to these organizations and I said, "Folks, I have

an opportunity here either to go out and hire a bunch more people, or throw money at a learning curve to help you guys or give you a chance to come up with some sort of method whereby I can take your knowledge and spread it. Within two weeks after giving them the mandate to pursue it themselves, with the understanding that I would fully support what they came back with so long as it was feasible financially, they provided a solution which saved me a considerable amount of money and the support necessary was trivial. They pointed out that within the subset of them there were x number who really knew the system, but that we were sending five highly expert people to each hull to do the work. After they went through and dissected the whole job scheme, they found outitreally only took two knowledgeable people and four standard grade technicians to do the job. Instead of 40 individuals comprises as five teams, were arranged the staffing and practically overnight I had eighty teams out there. If I had tried to force that on them it never would have worked. But because of the camaraderie, the bandsmanship, whatever it is they have, they understood there was a situation. They understood they could be major contributors. They were challenged.

In essence I just said, I don't have the answer folks. I need your expertise and your help to do it. What they came across with, because of the short duration, was, "Yes, we don't need to hire, let's just lease this technical base from somewhere and you don't have to do all this hiring and firing." The central initiative was to secure their jobs and make sure there was a floating work force below them.

The biggest empowerment and Workout stories come from the world of manufacturing and cycle paths. People know in a manufacturing environment who is not doing what or what is the most stupid thing happening on this line and all you have to do is listen to them. You start by having these empowerment meetings, town meetings, where you bring in a select group of people. The first 45 minutes of any of these meetings is full of venting. You have to be willing to listen while they get everything out on the floor. The management key is to pick up on one of the things that they are asking for which is really noncommittal; better lighting, parking spaces moved around a little, a casual day when they. don't have to come in all decked out, things that are not in the income things that accompany the plan. You let them have that and truly it gets them into the cycle of doing things.

Even taking it out of the rigid disciplines of engineering and manufacturing assembly tasks, we have seen a lot of good Workout activity in the administrative arena — such as in contracts; what it takes to turn a quote around, what it takes to do a modification to a contract and again. I had an opportunity, looking at a $2,000,000 retrofit contract, to try something different. I assigned one individual full time for a week in take that piece of paper and waIk it around. He got it through the whole mill in 2 l/2 days. Our average cycle time for turnaround on quotes prior to that was 39 days. I made sure he was an outsider and knew nothing about the contract process so he asked all the right "stupid" questions; like, why do I have to wait for this, why can't you sign this, why do I need that piece of . . . . We came up with a whole dossier of the tollgates in that process and eliminated them.

Back to logic. No automation. The

whole basis is speed, simplicity, self confidence and empowerment. Each feeds the others once you get the thing started. Underline those; speed, simplicity, self confidence in what you are doing and empower the people. That is the infrastructure. Once you empower people and they get the speed and simplicity down, the self confidence is just naturally there and they just keep going with the thing. Be warned that you will not accomplish this with a one or two year effort. Jack Welsh, our CEO, even stated as a policy that we were not to measure Workout. He said he didn't want to know what it costs, that eventually someone will know what it costs, but the carrot out there is not the return on investment for doing this, it is to get a culture change. Youj ust can't put a price tag on a shift in culture.

Cost collection and allocations have been a problem for a lot of industries. In Syracuse, we do things at a WA or work authorization level. That is nothing more than a work breakdown structure with the status of the cost collection pool. The perfect example of where costs will do you wrong is in printed board assembly. The charging mechanism to collect cost was at a board level. When you finish a pc board that was the cost account you charged to. In that was pooled all the material and labor that put that board together so that you had no visibility into cost below the manufacture board level. You didn't know how long it took to do insertion or to do bonding or wire wrap because everyone was charging everything to this number. We decided that the best way to solve this was to lower the granularity down to those tasks. Well you fast approached a, for lack of better words, a break even point where that became a little bit ridiculous. You had so many different cost buckets out there, it was crazy. Analysis showed that it wasn't cost effective.

People have to factor in the cost of post installation support for any automated system you put together. In trying to get that granularity out of a system, you just add more bodies to the support structure. It doesn't make any sense and you aren't going to get any value out of it. We found that the problem isn't with the materials or the automated fabrication process. It is in the labor charging side of the house, not the materials side of the house. We did institute a labor collection system in our factories, but very sensitively. You do it so that when a part comes down the assembly line, it is registered by some serial number as it comes into a work cell. The system in the background automatically logs the time it enters the cell. The clock is started. As it goes through that cell you dock it on the way out and of course you structure the cells via process mapping in the working nest so that you truly have captured the time in and the time out. The key to that is databasing of the identification number of that board. You start putting attributes against that icon in that database and the attibutes are timed at each station, reworked through the station and the key is that the operator identifies himself by a bar code.

He arrives in the morning. I pull up the data on a workstation and now I know who is there. So it starts rolling all this data up against it and now you can go and measure your productivity in the work force. Since there is so much camaraderie and networking going on with the supervisory staff if you have someone who isn't up to par that you need to take disciplinary actions against, I have found it better to take a supervisory

person from another work unit to do it. People hesitate to discipline their peers.

The message is, and this is something I truly believe because I have lived it (though it's a hard pill to swallow), change is good. Move people around. If someone tells me they have been on the same assembly line for 10 years, it is time to move them, time to cycle these people through. I hate to say it, but the same is true with management. I firmly believe management, whoever is in charge, needs to understand the product and the customer. That is critical. We have lost that, we have broken that infrastructure in a lot of these fast turnarounds, but it is not to say they have to have the ingrained knowledge that someone there for 40 years has, they just have to understand what the product does for their customer and deal with that customer. This two year cycle of bringing high pots in and pushing them out again is destructive, totally destructive. I think we have learned that lesson We try to keep the infrastructure intact the best we can. It is the knowledge base again. Don't break the knowledge base. That is your competitive advantage, yet you tend to push it out and that doesn't make any sense at all to me.

James Crocker

The yards need to adopt an operating vision more or less like the one that was generated at this workshop. Who we are, what we are about and where we are going. ln my view those yards that choose to compete on a global basis need to incorporate that decision into their mission statements; that they are going to be a a commercial yard as well as a Navy yard. Step two is to adopt a set of opersting philosophies in which everybody can focus in on the high level target. In my view there are three of them. The first, continuous improvement, should permeate the organization, it's customers and suppliers. The second, an empowering environment, allows people to know what to do, do what is right, do it everyday and feel good about it. The third piece speaks to the issues of time base competition and cycle reduction, being faster and better than anybody on earth, and incorporates in that the whole idea of non-wastefulness. The bottom line is a no waste, extremely reduced cycle time, empowering environment searching for continuous improvement. That sets the stage for the yard to make a global shift. Below that sit the enablingtools; MRP, EDI, concurrent engineering. These are the big, broad, multifunctional based, enabling tools which allow the implementation to take place. Below those reside the specific tools that will be brought to the party which computer, which software etc..

Lorna Estep

I think providing tools that support continuous change in environment must be addressed, it's a significant retraining, re-thinking, paradigm shifting activity that needs to be supported at every level both in the tools that we provide, the training that we provide, and the consistency of purpose in terms of our direction in new development in baselining and improvement.

Paul Friedman

Clearly the employee empowerment approach has the most attention, but at the same time more emphasis needs to be focused on establishing lead-

ership qualities. I personally don't know if leadership is something that can be taught, but I certainly agree that clearer leadership will be required.

At the same time it would empower and allow people to make decisions, or at a minimum tell us what really is going on. I also think we need fewer committeemen and more leadership at the higher levels. On the surface of it, it sounds like a contradiction, but I don't think it is.

Jim Hutto

Among the management methods holding promise for this, certainly the executive planning councils are an important. The government has provided some key strengths in leading that process. The standards communities by involving the technical folks in standards development have helped the process. The exercise we have been going through for the last few days, to identify where the industry as a whole stands, is importantin establishing visibility for boththe individual companies' management as well as the consortium, where I use companies and government to mean a single entity. They can identify the current status of the industry and from that generate the milestones to keep the industry as a whole moving forward.

Douglas Martin

I guess I can't think in terms of methods so much as getting back to more primary things. I would be happy to spend $4,000,000 on implementing these initiatives, if I knew that I had a reasonable chance at a firm backlog for the next 4 years on which I could implement the past learning curve, the changes in processing, etc.. And I could begin getting some returns.

Richard Moore

The process of group dynamics appears to be the only method to me to change a declining and perhaps dying industry into the one we have visioned. Knowledge is Key. Know the Truth, and It will set you Free! Some set of factors must instill sufficient fear in the management teams of shipbuilders to cause them to adopt a knowledge building process within their organizations. As our group "grouped", visioned, schemed objectives, and evaluated options based on a shared agreement of facts, so must individual companies and the industry place enough interest in improvement to begin working.

Once the groups are formed,many specific methods for product, process, schedule, cost and quality improvements for shipdesig/shipbuilding can be effectively evaluated. The current and initial problem is lack of an effective structure or forum to initiate the change process.

The only truly time effective method to solve this problem is to throw a lot of tax payer money at the industry with specific requirements to adopt our vision. This might actually work. It was the recognition of the additional social costs from closing shipyards which caused UK shipbuilders to be moved born nationalized to private competitive companies.

Marion Nichols

It includes the many things we touched on in the list of initiatives; educating management in terms of the value of team problem solving, change man-

agement, continuous improvement activities, and small group improvement activity teams, It is managing the delicate balance between participative management and directive management. For years it used to flabbergast meat Digital because any time we wanted to make an organizational decision, particularly things that involved office layout, we would move immediately into the participative mode. What happens when you ask people where they want to sit? You get into this mire of "I don't want to sit next to so-and-so because they smoke." '1 don't want to sit here because my plant will die because it's not near a window." You get into this mush that lasts for weeks. At the Ironworks the technique consisted of management gathering in a room with a blueprint of desks and chairs and the next morning you were assigned to your new chair and that was it. There was no discussion I used to feel very often when we were mired at Digital for a while wouldn't it be wonderful if somebody would make a decision. We don't need to spend this kind of time at this level. This is not helpful participative management.

People need a certain amount of direction. It's a continual challenge and you don't always figure out the right combination moreover the combination changes with circumstances. If you are in crisis there needs to be a sense that is somebody has got a vision and they are nudging you in the right direction. Then that takes a certain amount of participation so at least you feel invested and involved and you own part of it.

To much participation or direction drives people out of their mind. That balance is part of management technique and also management development because those are not skills that people necessarily show up with. You've got to help people develop the skills and figure out when they need to be directed when they need participative. It's the ongoing process of helping people through that. And being able to honestly assess when it's helpful and when it's not helpful, when you need to change the style and when it's working well..

Those boundary issues need to be looked at, with the willingness to tear down some of the boundaries. You need the willingness to invest in collaboration, if you want some of your key people to spend time working with the other shipyards. You've got to be willing to give the people time to do that and the rewards for doing it well.

We found that people who tend to gravitate to collaborative work very often do it because they they find it very personally gratifying. Much like people who go into social work, they don't do it for the pay. You do it because the common good is more inspiring to you than just going it alone.

There is a trade off. Unless the supporting organization values that effort, you saw the limb off behind these people. Their co-workers end up saying, Where the heck is Mary, she hasn't been in the plant for three weeks. She is out on the West Coast working with Todd. What goes?" You need to value that work.

Robert Schaffran

The biggest change we have to grapple with is this whole concept of time reduction and increased throughput. It is a total change in the way you think, plan and organize your work, and nobody in this country has tackled that problem.

I took a crash course at the Uni-

versity of Michigan on how to become better in the international market place. We did a lot of case studies showing companies who wanted to out perform their competition. They would put all their efforts into reducing cycle time to as short a period as possible without even thinking about cost or anything else. The moral was "Get the time down to where you can beat anybody to the market place and then go back and see where you can reduce costs." The costs were not even in their minds.

We have not addressed that at all in this country. As a matter of fact, our management for the last 10 years has been locked into the military mindset in which time is not the problem. In some cases where they tried to reduce the time, the Navy didn't want to take delivery of the ship have trained crews to put on them. We in the Navy have encouraged the failure to address the time issue. To this day, it still spends lots of money doing cross time studies on various things.

If you use the theory of constraints in order to reduce cycle time, it forces you to adopt the whole concept of empowering employees and multicraft groups. It forces you to do all the right things because in order to reduce the time of the total process, everybody has to be involved. It forces you into a total systems approach and actually if you take that approach everybody understands how their piece of this whole process helps the company become more productive.

Jim VanderSchaaf

Probably the best management methods are those defined as the TOC (Theory of Constraints) by Dr. Eliyahu M. Goldratt and documente inthe books "The Goal", 'The Race', 'Theory of Constraints' and 'The Haystack Syndrome.' Key concepts include identification of constraints, always working on constraints, and maximizing throughput. Also recommended is the process employed in this workshop. In a two day period, it was very effective in goal setting, brainstorming, organization of initiatives, setting priorities, and aligning resources with priorities. These are the essential tasks of leadership required to stimulate and change our industry.

Jim Wilkins

The the most effective management methods are the consensus building techniques that are currently in vogue. You get people involved so that it is partly their idea. Then they will buy into it and do it because they are internally motivated rather than externally motivated.

A management attitude that needs to be changed, is the fear of computers. We are in that older level - they are just beyond the age where they have grown up with computers and someone decides "I will never have anything to do with that and I don't need those things." They do not appreciate the impact of the technology, of having up-to-date data and information available to them on a real time basis. They do not understand what that means to them in terms of productivity.

That needs proving. They are always going to say, 'What's the pay off, how much is it going to cost, how much am I going to save." That is often one of the very difficult areas to demonstrating — how much it will save and how much it will cost. You can't tell how much it is going to save and you can't prove how

much it will save because it is a cost avoidance type thing in many cases anyway. You don't do two absolutely similar projects, and then compare the costs. You are always making cost estimates that people tend not to believe. The management method has to be participative and involve people in some kind of process. Maybe this isn't a method, but I think techniques have to use pilot projects in some way meaningful to the managers you are dealing with, so that they can see and feel the difference. You can't train your boss. You have to convince him whether through demonstrated success by a competitor or whatever. Try managing people not under you - that's called selling.

Dan Wooley

That goes to total quality management. The managers that are willing to empower, don't have to control everything. They can trust their people and give them the authotity they need to get things done. They show the willingness to try new things; take risks, calculated risks to make things better. I guess that kind of goes along with #4. You need those kind of attitudes to implement the stuff we talked about, particularly the product model stuff, breaking the drawing mentality. All of that will take management with vision to see a better way and be willing to try it.

Joe Wudyka

The greatest thing in here we kept putting at the bottom of the priority list. Somebody has to be the leader of this, the cohesive point and has to keep pulling it together and keeping it on track. That is the most critical thing for thefuture of all this work. Somebody has to drive it. I'm Willing to help,to get involved in it. If you need meeting facilities, I can get an auditorium or a Digital facility where you can bring people together. If somebody needs to see how Digital is doing concurrent engineering, I'll set up something and people from the industry can see how we have done. Nobody is going to try and sell them anything come on in an look around. We might ask to go into some shipyard after that to see how you build ships so we will be more successful when our sales people deal with some of the shipyards. I look for a give and take kind of thing.

Without somebody pulling this thing together, like a Dan Thompson, then the whole thing collapses and becomes a meeting for the sake of having a meeting. Let me describe the degree to which I could get involved, based on internal Digital goings on. I think it is important for you and Dan to understand it. Right now, internally, I am funded to go off and work with US Government customers. Like in this situation, let's just call it Navy, very clearly fully funded. Anything that came out of this that said Navy, I'm raring to go on it. If it is something strictly shipbuilding, I have to hold myself back a little bit because I'm really not funed to go off and spend a lot of money helping commercial development. However, I have a proposal into the company to do that on a worldwide basis and I very strongly believed that it will be approved. While today I have to sit here and say, I'm the Department of Defense - I'm Navy, in two months I really believe I will be saying, l'm worldwide shipbuilding as well.

The greatest threat to the established US shipbuilding industry is some-

in the country, who comes along and gets rid of all the old ideas, takes the talent (what a talented bunch of people in this country), and directs it to an efficient shipbuilding operation - wow.

6. What is the best approach to standards development?

Dan Billingsley:

The ones of primary interest to me are data exchange of product model type information. I am continually impressed and amazed by the progress the NIDDESC group has made on this. It is a basic cost sharing cooperative effort that involves technical expert — people who really know the business. With that environment and letting them work over a long period of time in a cooperative effort they have produced world class results. They have also addressed some nonproduct model data transfer efforts. For example, they have reworked the Aegis subset. The original MIL T 2800 implementation for the subset was generally regarded as unworkable for transfer of drawings from place to place. NIDDESC told them and generalized the results from the Sea Wolf program DDE effort, staffed that around the general engineering industry in the U.S. as part of the Aegis Product Data Exchange Standard (PDES) organization and interestingly some full two years after NIDDESC completedits work and turned it over to the Aegis PDES organization, continued to bird dog it through the Aegis PDES organization for the two years required before that actually became implemented as a MIL standard. It is a long lead time process. The basic, almost agricultural, approach of establishing a cost sharing cooperative environment and getting people who really know their stuff to participate in it on that basis, works. We talked before about CALS. One of the major slams on CALS for the first many years was that CALS continued to promulgate standards that just weren't workable. That gave CALS and standards a bad name. I think that over time now a lot of that early crop of dysfunctional standards is starting to get weeded out and cleared up.

Carl Bryant

First you need common means of communicating, start off with the standards that your computers use to talk to each other. Then you work outward from there; standards for the way you describe plans all the way up to the components. Those are more difficult.

If you make it very easy for me, for instance, while I am at one shipyard to call up a representation of machinery space from another shipyard and convert in whatever form I'm working with, the standards will happen all by themselves. It's easier for me to borrow what was done last time around than to create it.

I'm saying it is a bottom up process. If you can make it easy to cormmunicate with each other without having to travel but simply by turning on a machine and typing the right numbers, then the standards will sort of evolve almost on their own.

It's going on in other places. It's what they are doing. The people who develop computer software don't have to go in to the office to develop programs as long as they can tie into the office network. You pull the information down on your home computer, whatever piece you have been assigned to work on, you do it right there and then load it back into a

database to be used by others. Doing that depends on standards. Down to the very lowest level is a whole set of standards in the computer industry which determines how you communicate.

Some standards will come out of the collaboration; parts of the standard were already out there. I heard people talking about versions of IGES, having to do with transferring design and graphics type information. We need to encourage those types of things and push harder. I'm a little distressed by the way CADII has gone. I gather it's become a proprietary system, which means that unless everybody invests in the same boxes and the same hardware, it's going to be a lot harder to access each other.

If you ever get the opportunity to see a preview of this effort, take it. I think you will find it very interesting to talk to Admiral Gary Tuttle. He's supposed to become head of Naval Air. We don't hold that against him. His big crusade in Me has been around computer systems, in a tactical world. It's the same issue. If you can't talk to each other, you can't work together. They look at it as a forced multiplier. That's what you are trying to do here. But his big crusade has been to get away from the proprietary architecture. I don't care what the box is, I want that software to run. His views on that, coming at using computers from a slightly different perspective, would be very interesting to you. Again, it's a dialogue between different communities.

Dan Cada

NIDDESC is the way to go. I can't see any other focal point. If we leave people to their own, they will invent the best standard for themselves. NIDDESC is not threatening. I'm not a member of it, I've heard of it for as many years as it's been in existence, and it seems to be effective. I think the next step is implementing NIDDESC'S approach into real things. People have to start taking those standards, albeit imperfect, and using them. Then you localize the strengths and weaknesses. We're probably at a standstill in taking what that group has done and actually putting it into our contracts. That is our relationship and our statement to the industry. This is what we want to go do, and we understand sometimes it will be tough and that's why this body exists to smooth the rough spots or encourage a solution that will take us through the rough spots. I hear people avoiding standards because theey're not perfect, and my attitude is work to the standard, work to fixing it where it is, and when breakthroughs come, you'll all enjoy them. If you don't, you won't enjoy the breakthrough either.

James **Crocker**

That's a tough one. The minute anybody says standards development, people immediately think of lethargic people camping out in a resort for multi-decades. Unfortunately that tends to be inaccurate characterization. If we count the resorts across the world we'd find a few thousand probably.

Standards are necessary. They allow us to avoid getting into the situation of deploying resources in ten different situations in order to get the same result and then ending up with technologies that are not transportable. On the other hand, the people who generate these standards need to be very, very focused, polished, articulate communicators and negotiators. Conversely they also need

to be technocrats. They also need to know what they are standardizing. And there has to be a receptivity in the yard to accommodate those activities if not fully support them. That's a very diflicult thing to do. That's among the more diflicult on the list?

There are some great examples coming from General Electric with regard to electrical distribution specifications for residential and commercial construction. It's not only non-standard universally but even within a locality.

Our strategic plan has to get the vision right first, we have to know where we are going. We have that foundation in the vision. Next we do the analysis of best practice. We analyze how a commercial yard would be world class — what tools are in that yard, informational, structural and physical. Then we decide which of those tools would be used across the industry and focus standardization on those tools that are in our new commercial/military shipyard. Those are the tools which are capable of migrating and communicating across shipyards. Underlying these is a tool that will be used to interconnect or to migrate technology from shipyard to shipyard, therefore it needs to be standardized. So let's get that piece of technology standardized, at least in the yard. And take a very focused approach to it. Changing the world takes forever but but changing a company or a yard, that may be quicker.

Electronic data interchange is a communication device. It is basically a paperless communication system between companies, suppliers and other organizations - banks. It allows data to be transmitted in an electronic form that really supports the invoicing schedules, purchase orders, and MRP II If you were to integrate the broader process moving through the yards, the next step would be to get the matetials to flow through at the time or on an as needed basis and in much smaller lots. Some contractors may buy very large amounts of a product and store it in the yards, but we would rather have the suppliers meet our requirements as needed, or we move them into the yard as necessary, so that we don't have to handle them 15 times.

When you move to that philosophy of continuous flow MRP scheduling production, or GID co-production, in the yard, you will find yourself with many, many more deliveries than you have now. You will get smdler lots of material a lot more often. What happens is the paper that is generated in the old system is voluminous. EDI Allows purchase order schedules to transmit purchase order purchase schedules and receipt information electronically from a supplier to the yard. With that, now the material moves through a bar coded delivery system, instead of the old paper system of multiple copy purchase orders with paper and warehouses all over the place. General Electric was involvedin a large study six or eight years ago that documented the benefit of EDI in the General Electric company.

Lorna Estep

If companies team together and begin to actually use the standards and stress the standards, it will work. Modeling it one more time is probably not going to work. I think we have sufficient models to go out and begin the process of actually doing it. Then we can read feedback into the models, the issues that need to be resolved, as we're stressing the model. We have good demonstrations of that already. When you begin to

address the issues they get resolved, but if you just model them you don't get them resolved. There's no incentive.

Paul Friedman

Probably the best approach to standards development is to first work out some common forum for the industry. We talk about the industry with a "I", but I am not sure it really qualifies. We need to establish that we share a common destiny. I don't think that is clear or necessarily believed. That would be the first task, but I have no idea how to approach it on a technical basis. The toughest part is making sure that you are not preaching to the choir. The risk is that fudamentally the organizations are not in agreement, but they sent the people who would be to this meeting. We have to break through that somehow.

Jim Hutto

The standards community has been fairly effective, us being one of the vendors of products in that area. It has been our observation that the government has successfully inspired the user community to sit down, define the information that they need to move from one operation or business unit to another. This evolution has been progressing at a positive rate. It is an evolution because as the discussions proceed it requires buy-in from the ultimate customers; the government and the suppliers (including the shipyards as well as their vendors). Everyone has become educated to needs and solutions simultaneously. As the solutions are developed then the planning is made available to acquire and install the solutions into the production cycle. So I think the approach that has been going on with the standards thus far has been successful, moving at a reasonable rate and just needs to continue. The government is primary in ensuring that the effort is continued.

Douglas Martin

The example we have so far is the NIDDESC project. That seems to have worked pretty well in terms of meeting objectives and producing a pretty good product which will eventually become a mill standard of some type. Or maybe just a project to procure your document on a case-by-case basis. It is a cost sharing thing very much along the line of other ship production committee type activities with the exception that it is really multi-organizational. The organizational representatives meet regularly and co-develop the ultimate product.

In terms of other areas of standards related the data transfer world, there is a whole set of procedures that have to be in place in order for that to work like a production line rather than like a job shop. I am talking about setting up the procedural environment for data transfer. It is something that NIDDESC realized in the early discussions of what it was that we were going to do. It was very important, but the more important job for us then and still remains to be defined is what it is that gets transferred. Not procedurally, but how do you go about managing a data exchange process and certainly there is a lot of configuration control aspects to it. But there are a lot of lower level data validation kind of things. Take the example of the Sea Wolf exchange. Those guys could sit down and abstract their procedures into probably a fairly brief handbook which would be real useful for

people just getting into it. There are going to be a lot of us out there. The first time this NIDDESC spec shows up as the mill D 20,009 or something everybody is going to stand around with their jaw hanging out because they just are not going to be ready to deal with it.

Jon Matthews

We need a national policy on shipbuilding. The problem here is that we mix up the contractual and political issues of a subsidized industry with a national direction towards standards.

It needs to be in the form of an IEEE type standard or set of standards that deal with or are used With the contractual development of new construction. We've got to get away horn terms like Standard Marine Practice which historically was an unofficial definition of quality which existed for commercial construction. For those of us who were in commercial construction, good marine practice was an unwritten rule for determining quality of construction for commercial shipbuilding, and it was perfectly acceptable; it was developed in a back room, probably in the Whitehall Club in New York with a bunch of cigar smoking ship designers and ship operators in the 20s, 30s, 40s and 50s but it worked. Today we area very pragmatic society driven by the government's desire to have everything written down in black and white, so we lost the bubble in the last ten or fifteen years. That's why commercial and Navy construction have a hard time working concurrently.

It seems to me something like David Taylor Research Center in Carderoc, Maryland, would work, especially witha guy there like Shaffran, who really has some commercial mentality. The NSRP are perfectly capable of creating a set of standards that don't take thirty-five pages to establish a definition of a bolt but with enough detail and enough competency in the specs to guide the contractor.

Richard Moore

Write specifications for standards into a significant ship acquisition.

Implement answers to Questions #1,3,4 & 5

Marion Nichols

Will people recognize the value in being consistent; that there is value perceived in grouping to gether— you give a little and I give a little inorder to get something close enough for me to integrate it into my business and gain the benefits of being able to speak with you electronically and share libraries. Having that functionality well outweighs the fact that I really might like to have my vendor code ten characters longer than we decided on. I hate to reduce it to that but it gets to that level of detail.

I was looking at the vision again this morning wondering if it conveys enough to people that we want to bring into this. Do people reaIly understand its importance? Atone level it is the foreign shipbuilders against the United States shipbuilders. If we don't gang together, you know we aren't going make it. But even if there weren't foreign shipbuilders, I would like to believe that the advantages of collaboration could be a motivating force. It's too bad that it takes an emergency and life threatening circumstances to get us to work together.

Standard setting very often is the stumbling block that prevents people

from collaborating. It is the point at which people get into detail and slam each other with their differences. Yet when that is behind you and you start to do the work that uses the standards, all of that seems trivial. For example, we are doing electronic interchange with all of our suppliers, paperless purchases, paperless invoices. Somehow the standard setting seems to seems to trigger this. Why does it take so long to agree on a standardized purchase order format? Why did it take take us so long to agree on a standardized invoice format? Who really cares in the scale of things. You've got to help people see that stuff because you don't see it when it's in front of you. You see the mountain of trying to get one hundred people in a room to agree.

Robert Schaffran

The biggest effort underway right now in computer standards is this standard, neutral database format whichwill allow us to exchange data between dissimilar computer systems. That is an important effort. What is more important, in regard to achieving the goals of the CALS initiatives, is to achieve international competitiveness. Competitiveness basically consists of adopting equipment and process standards. The best approach for accomplishing that is to go out and buy what is available; not reinvent the wheel by developing standards here. There are international standards that we can be buy right now. We can put together a team to go through them and select the appropriate ones.

In regard to computer standards and data exchange standards, the work is underway right now. NIDDESC is probably as good an approach to doing it as any. All the major shipyards are involved including some of their best and brightest people. They pushing state-of-the-art rather than following the world.

We have not included any of the commercial operators. The Navy is the operator pushing CALS. Some of those advantages would be equally applicable to commercial operators; the APLs of the world. We have heard the Germans now offering data management of the ships that they sell as opposed to the marketing scheme. The ships that they sell to their owners come equipped with computers and a satellite hookup right back to the yard database. Wherever they are inthe world, they canimmediately download the data on anything that needs to be repaired. They can be in a shipyard somewhere in Singapore and get the data digitally downloaded to their computer.

You don't need standards for that. In the shipyards standards might even be perceived as a disadvantage because the shipyard could put a computer on the ship that matches their computers at home and nobody else will have that, they have a direct link and nobody else can provide their service.

The whole concept of data exchange standards is that in the long term it will be very beneficial, but what you need is this ability to transfer product model data. The PDES initiative is still an R&D effort. It is not going to be some thing implemented in the very near future. It could be five years before we have a minimal standard available.

Jim VanderSchaaf

Standards development is a very difiicult process by itself, especially in the absence of a specific contract or project for application. My experience has taught me that the best method for complex

digital data exchange (PDES) is to apply concurrent engineering, namely, to concurrently attempt to define the standard for the Industry (NIDDESC effort), and, at the same time to define, develop translators, and test on a real program (DDG 51 effort with Navy, BIW, Ingalls Shipbuilding, and GE). As a result, we currentlyhave a proven and tested means of exchanging Product Models between the Navy, BIW, Ingalls and GE. The PDES standard is continuing to evolve.

Jim Wilkins

I have been very much involved in standards. We have a standards panelin NSRP. We have a maritime standards group in the American Society of Testing Materials (ASTM) and many of the shipyards participate in both of those. ASTM is largely vendor and equipment oriented, so shipyard processes are not being included there. Shipyard processes have not been emphasized particularly so the yards have not found either of those forums particularly of use. Moreover, they don't want to share these kinds of things. They have standards with in their own shipyard and they treat that as an area of proprietary information. This gives them a leg up competitively. If I know how to design and build some part of the ship in a better way than my competitors, then I am not going to share in a standards organization which will tell them how to do that.

The best approach to standards development is the NIDDESC effort. That approach is partially government funded, partially government driven because the government wants it done. Whether the shipyards would have ever done it if they were all building commercial ships, I very seriously doubt. That's unfortunate. I'd rather see more industry moperation, rather than government driven cooperation, because government driven cooperation is not usually as non-self serving as NIDDESC or useful. Self interest is still the greatest motivator. I think our best approach is to do what we are doing, hopefully identify standards that are truly of interest to the industry and useful.

Dan Wooley

The government obviously imposes standards, but in the commercial world it is really regulatory policy that impose the standards on the ships. I have been involved with the data exchange standards and they sure have been painful. There has to be a better way. Part of the problem I have observed in doing data exchange standards has been the lack of funding. The NIDDESC stuff has constantly been on-again/off-again. Several times we have been told to stop work because we had run out of money. It also is a limiting factor as we can only work on so many standards at one time as we only have so much money. I don't have a good approach to that because I guess the industry consortium idea, where all the companies buy into it in the sense they are willing to put up the resources to develop the standards, would I think be the only way to go.

The government can only do so much. Certainly NIDDESC wouldn't have happened if it hadn't have been for government money. The Navy decided to have the product model data back when the design is finished so there has to be some government money involved too. What is the incentive for the shipyards to work together on standards. Internally the shipyard sets up stan-

dards, but why go to the extra expense to negotiate with Ingalls or NASSCO on standards if there is not a customer out there demanding it.

Joe Wudyka

I had trouble in the meeting understanding what everybody meant by standards. In the computer business we have efforts underway to establish standards so that computer equipment will be like stereo equipment. Why don't the computer industry and the shipbuilding industry get together to set standards so that everybody comes out a winner. I'm ready to support that.

DISCUSSION OF INITIATIVES BY OBJECTIVE

OBJECTIVE I PROCESS DEFINITION

1. Make sure processes are necessary and good before automating then

Jon Matthews:

This initiative deals with all of the processes of the shipbuilding business born conceptual design through delivery. I really don't want to go into the life cycle side of the business yet. We have identified over the last fifteen years that technology transfer and the desire to improve efficiency have been buzz words in the industry. There are tons of very desirable practices: some developed here, some developed elsewhere in the world and imported. I don't think that's where our problems lay though some of us looked at individual elements as "the" technique for solving the "boiler plate" of the industry. We need to make an accurate assessment of the practices that exist and attempt to redefine those practices in terms which can be understood by the management process within the shipyard. There are lots of them which are not really understood. We have a disjointed group of processes that, individually, are very good but have never been integrated into a cohesive approach.

Line heating is a perfectly good example. It is a technique for straightening a plate, deformed during the manufacturing process, without very expensive spot welding it's done for efficiency. At best it is a "black art". We certainly use it, as do many of the more progressive yards in this country. What we haven't done is determine how we will eliminate the distortion in the plate subassemblies without line heating. What are we going to do when we use computer aids to design a ship? What are we doing to analyze the structural configuration in subassembly form to minimize the need for line heating? It is an extra cost.

We've got the same situation with pipe spool manufacturing. We have a technique, using computer aided design, to accurately and efficiently lay pipe into a ship so that we maximize the efficiency of manufacturing the pipe. Yet in practice, we disconnect the process of design of pipe from the manufacture and installation of pipe. If we took that one as an example, we would find that the geometry which is established on the design side has been manually reworked in some way before it goes to the ship. If it is not done in a pipe shop (pipe sketches), it's going to be reworked someplace else in the production engineering process.

Through computers we now have the ability to very accurately place this pipe and describe its manufacture. I'm

not talking about robotics or any very expensive capital investment I'm just saying that the geometry now is accurate to four decimal places and can be maintained at four decimal places. The design process could create the pipe sketches. Even beyond the pipe sketches it can generate information for some quality control inspection at the pipe spool level so that when it goes to the subassembly or on board, it is accurate. Those tools and techniques are easy but they're not integrated. They're not pulled together into a cohesive shipbuilding practice.

I think integration of the process has to start at the top of management and filter down. I think at the top of the pile very few CEO's are going to argue with efficiency gains. They just want to understand the economic value of the gain. It's not enough today to talk about doing a job in less man hours; I'm going to be twice as productive or my productivity is going to be twice as high as it was. It's now critical that we talk in terms of dollar savings. Bob Schaffran is right, and I heard several people talk about reducing time, time is money, there's no question about that but we fundamentally have to be talking in terms of dollars, we can't be talking in terms of days, weeks or months, and I'll give you a perfect example meaningful to those of us who have lived through the CAD design development in the world. When we first brought computer aided design into the design office, Ibelieved the computer salesmens' discussions about four-to-one productivity and in fact its probably pretty close to being right.

The only problem was we weren't dealing with an integrated process. A simplified process in a drawing office consists of a geometry layout based on some design criteria, but then you have to go through what we described historically as a checking process, which still exists, it's a validation of the design before it leaves the drawing office or the engineering office environment. That validation effort, say ten years ago and perhaps even today, is a manual process. Historically it counted for, in a manual environment, perhaps 15% of the effort and so those of us who were trained in engineering management intuitively knew that to develop an old ink and vellum system drawing took a hundred hours, 15 hours of that would be attached to a checking process, checking and cleanup process. What that really did was validate the information Got the spelling mistakes out, made sure it was usable, made sure it was tied together.

When you go to the CAD environment the drawing effort can be done in a quarter of the time. If the checker and that drawing room process isn't automated and unless the whole series of steps are treated in a more efficient way than it had been done historically, all that happens is that the designer is now able to produce something, and instead of taking 80 hours he only takes 20 hours. The designer is then going to sit around for the other 60 hours, because he's not going to have anything else to do. And so it became a problem of changing the entire drawing office process. It wasn't until we made a few mistakes in that environment that we really recognized what I just described. That's a fact that anybody who's lived through the drawing development world can relate to.

Joe Wudyka:

A lot of times as we talk about these, I will refer back to Digital Equipment Corporation and the experiences

we have had; because these are real outcomes, real observations that we have seen repeated over and over again within our own company

There is no sense automating processes because they are too slow or they are inefficient. If you really want to make your business efficient, critically look at that system, that process and say, "Do I need this thing at all?" The first reaction, getting back into the change management and human systems side of the thing, will be, "Absolutely, you idiot, we have had this here for 30 years, we will get these 50 people over here and do this!" You get all of these objections. But, if you change the "headset," you can begin to say something about how we have to make massive cuts, massive reductions in the amount of computers we have in this place, the number of people in this place, the number of square feet we use to keep those people and computers and material.

You have to be really critical and say, "Why automate?" Let's think about what happens if we eliminate it and work from there. It is like the zero based budgeting kind of concept a Dr.Deming process, where you go in, take it and flow chart it, take it apart to see if you really need to do any of this stuff anyway. Harvard Business Review had a really great article on that about 1.1/2 years ago and they referred to it as re-engineering. They coined the phrase. Re-engineer your business. Just don't simply take it and make it faster. What good is something faster that you don't need at all?

2 Analyze process improvement

James Crocken

The analysis of process improvement I like to look at in two flavors: Internal and external processing. From the point of view of internally analyzing any process, whether it be the lofting process or whatever process, I like to suggest this: First thing we do is map the process. We have get a physical picture of whatever process we are attempting to do. And that is taken down to elemental analysis of each step. So if we were going to go out to the lofting process we would take a given part and we would say okay, step one is the elemental analysis. That would boil down to the procuring, the set up, the runing, physical welding or whatever, any batching that goes on like any heat treatment or any process that takes X amount of time and coupled with the move to the next element.

We have to get a picture of each element in the process and then we take those pictures and we build ourselves a process map. Here is the physical process that this product went through. This is the map of that process. Here is the elemental analysis of each step in that process. Then we take a look and look at the map of that process and analyze that. We take a look at the balance, we look at the reliability of each element and the reliability or the process itself, the reliability of the people, the reliability of the vendors that support that process, the reliability of the tooling and the fixtures, we take a look at the balance and the constraints of the process. From that analysis we generate opportunities. Then we prioritize the "heavy hitters" from an internal perspective.

Concurrent with that or in a very parallel situation we also figure out whether this process is state of application; are there other, better processes out there, and are we using the best process. The idea is we take an introspective look

at the external view and we look at this thing and decide am I using a state of application process and if not what is the liability of not being state of application. Step two is what is the reliability of this process?

I mentioned that we need to look at the balance of processes. Balance was represented in the assembly line of 1929 when Henry Ford allowed everybody a minute to do something. Today I find throughout the United States that our processes are tremendously out of balance. If you look at a given product and try to flow it through the yard, you will find that some operations take a minute while some operations take hours. These things are not good process engineering for distributing the tasks so that we can work continuously.

Jim Wilkins:

I am glad to see process definition show up on the top of this list as things that we need to do. I don't think process improvements that we are talking about here, at least as I envisioned it, are necessarily computer aid oriented, which is a point that we didn't bring out particularly in the meeting, but you will see it infused in my interviews as it is a feeling that I have. The important point, and it goes back to management attitudes, is that the Japanese didn't use computers or computer aids to put the US shipbuilding business out of business. It wasn't because they had computers/computer aids that they did this. It was because they did good production engineering first. They thought the process through and did it right and we are still not doing that yet inthis country. So that is where we have to start.

The thing that I like about computer aids now in this process is that the aids maybe in fact the leap forward that we can introduce to save an additional amount of time and reduce ship construction efforts below whatever our competitors around the world are doing. Yet we must recognize that competitors around the world, in Europe, are using computer aids to do these things. We are even behind that "eight ball," but I just always make the point and distinction that when we are talking about the important need for using computers and computer aids that we don't put the emphasis in the wrong direction and essentially say if you don't have computers you can't do this. Because that is not true. You can do it without computers and you can do it a whole lot better with computers, but lets get on with doing something. Don't wait for the computers.

We have to be looking at process improvement with or without computers. People have been saying and doing it to some extent. I go to Bath and see things that need improving and some people acting like they understand and are trying, and I go to Ingalls and see things Ingalls could do better, and I have been to Newport News, and I know there are things they can do better, and yet it is hard to find anyone who will actually do any thing a bout making those improvements. It is almost as if they don't believe they need to.

3 Develop simulation tools for the complex problems of shipbuilding

Lorna Estep

The initiative for developing simulation tools or tools for baselining the industry has to do with tools such as

IDEF modeling and some other baseline. Generally it takes a good deal of time to not only be trained in the tool but also to actually use the tool to baseline the process. If it takes YOU 18 to 24 months to gather the data and get the right people in the same room in order to develop the baseline itself, you're losing that amount of time in actually going through and improving your processes and additionally it is somewhat complex in keeping those models up to date. Generally what we do is do them once and we put them on the shelf and we don't use them again. It doesn't promote an idea of continuous improvement, so we need to develop better tools that can use the process or that can be used in the process.

There are some software-programs such as IDEF that assist in the automation of the actual modeling process. The problem still is generally the people that have the information, that know how the process works, are not people that are trained in modeling techniques. It is a very structured model and requires some amount of training in order to be able to use it. On the other hand, there are some simulation tools that are beginning to come into the market place that are more graphic oriented, more Windows process oriented that would be easier for someone that is used to the process to grab in symbols or grab in information, that are closer related to what they actually do in their business. You can then model the process and do some connectivity and I thiink that's what I meant by some of the simulation tools that will help do that.

In addition, the output of those tools are somewhat graphic and oriented and when added to some specific data, for instance on cycle times of the process, can then graphically start to portray what the constraints of the process are in such a way that not only the owners or users of the process understand what the constraints are but can present them to management as well. It starts tying in using the tools for a continual improvement mode and then changing some of those processes in a very rapid way, seeing what the impact of the system is, so you can begin to get into a mode of using the baseline as part of the improvement process rather than just putting it on a piece of paper or storing it on a diskette somewhere and putting it away.

These techniques promote the whole process of change by allowing us to rapidly go in, simulate a change to the way we are doing business, and in 10 minutes see what that change will do to us two years horn now. This includes every thing fiom a specific process on the shop floor, in a manufacturing process, all the way to complex interactions between management and technical data, with our paper flows, even how we interact with our suppliers. You can start building models for specific areas and then essentially build a consolidated type of process where at every high level someone can look down and understand very globally what's going on in the process. You can delve quickly down to a specific issue in a specific process.

There are some examples of this, but there are still some technologies that need to be developed to help in the whole complexity of the issue so right now those technologies have been used either only very globally and not to point all the way down to the specifics that you have to get to if you're really going to streamline the process or they can go very detailed into one particular area but they can't be easily expanded to take a look at the whole business. Of course it's so com-

plex, you need to be able to capture those interactions.

For example, we are in the process of applying such computer tools right now in something called The Joint Initiative for Factory Simulation in that we are taking the full process for the government to support spares parts by determining a requirement, going out to a production facility, having that product produced and then having it delivered to us (the government). We're trying to reduce those cycle times from three hundred to four hundred days to less than thirty days so we can start getting direct support to the fleet without maintaining extensive inventory.

We did some simplified examples of this using a simulation tool called Witness where we actually, at a very high level with specific functionality, monitored or measured the process and we had some recommendations specifically on where the constraints to the system are having to do with manufacturing/engineering. The thought was that, if we could streamline the engineering process, we could drive down the cycle extremely and we could meet those thirty day windows; but when we modeled it and did some things like: what if I added ten more manufacturing engineers and a work station that reduces the time by half that they have to spend on process planning? We found we still didn't get anymore throughput from the system. What we really found was that the area masked the real problem which had to do with getting raw material to the shop floor and so by using the simulation tool we were able to show management that we shouldn't run out and buy new manufacturing/engineering workstations. We should, instead, address the issue of our supplier relationships and how to get raw material. We were able to make some inroads into that; we're continuing on that process; we started it specifically looking at one part family or one set of parts and following that through the cycle; because, one of the barriers to the process is we do not capture data in our systems today that deal with cycle time.

We deal with cost data, we capture profit data, all sorts of cost information, but we don't really capture cycle time orelapsed time very adequately. So we've really had to go through and install some capturing "bickets" so that we'll understand more of the impact of the time and be able to use that in the software. Our approach has been to select seven different depots within the Services, not only shipyards and shore stations within the Navy but also we've got the aviation activities as well from the Air Force and we have Army activities. The fascinating thing about it is that, although they all think that they're different — their processes are different and they can't use the same tools because they're so different, in reality the processes necessary to support getting a product out the door are fairly constant. What we found is that when we built the basic generic model, it essentially can be used in each of these activities and modified somewhat. So it is suggested that between the industries or even between a generic product you could put a standard model together that could be used by each of the specific processes to delve in more detail down into their process activity. And in that way you can leverage resources at a very high level but give a tool that a specific activities can use and can continue to use in improving the process.

Beyond training is one big issue of

data capture. If your vision is to reduce cycle time, then you'll find that we don't really have enough historical data to actually measure the process in terms of cycle time. We capture all kinds of associated data but it's not really addressed to the visionof we want to get the product out the door faster, and so I think that's a major constraint as well.

The other thing is the whole change, paradigm shift, if you will. We don't really want to measure labor cost or man hours or how many man hours are spent on this because that's really not the issue. The issue is, "Did I get the product out the door, and what can I do to better use the resources I have to get the product out the door?" There's a lot of paradigm shift that has to go onto use the model because everybody is trained to think in terms of manhours; I always have to be busy, if I'm not busy then I'm not really working and supervisors are in the same area too; if some body's not busy at that machine cranking something out then we're not utilizing our process efficiently. What they might be doing is actually contributing to the fact that there's aqueue some where else down the stream; where that person could actually remain idle and work for the system better. It's a hard shift to make.

The tools could be used to support entire enteprise modeling, but I don't know of any instances that it's been used that way. I mentioned earlier that we did a modeling where we showed that the real constraint in the business was the raw materials and the relationship with suppliers, and we're now beginning to try to work with suppliers to model that interchange as well. It's a little more complex because you're asking someone to enter into a partnership with you on a process where traditionally there's not been that interaction. We've found that probably 30 or 40 percent of the suppliers that we do business with are willing to work with you in that area and in fact start getting interested in doing the same thing in their internal activities.

I think the tools can be used, the issue is still developing a cooperation between those industries to their mutual benefit and looking at it as a full ecosystem, if you will, rather than trying to say I'm going to be very efficient because you find that your constraints in the process are generally where you're interfacing, whether between departments within your activity or between somebody that you count on for another service or product to get the activity done. In the repair business or in the organic overhaul business we probably do 40% of the production work inside an activity, 60% of that relies on some outside process and if you look at the manufacturing floor itself in terms of automating the shop floor, you're talking probably 10% that occurs within aparticular shop, you've still got plating, you've got other processes that have to go outside, so the complexities start getting in with the interrelationships.

4 Identify the best processes, tools and metrics supporting the vision

Marion Nichols:

I think the inclination when you move into automation is to automate. That's the goal. The goal is not to automate, the goal is to simple the process. Then automate whatever is left that makes sense. Only automating those things that are critical and add value to the process. We are very quick, particularly when we have visions, to leap into

fixing things long before we've looked at the best processes, tools, and metrics to support them. So I think that for me this particular initiative speaks to starting from the beginning approach even though we in some way by virtue of the name of the conference assumed a solution since the computer aids is what we need to do. The name had an implied solution, but the subtitles and the charter are a little more specific. There is the need to conduct an assessment of where computer aids are appropriate and where they really support simplifying the process. I think to a large extent we did answer that question and the question is critical.

The tools are not refined. They are there. It really answers that question the question of capability. We don't need to spend a lot of time debating whether it can be done. The question is should it be done? What I think is critical here is what are the best processes? Are those the best processes that you within your own shipyard can figure out? Are those the best processes that you and 7 other shipyards can figure out? Are those the best processes that our competitors are using?

I recommend the bench marking. That is, global bench marking the competition, the best in the world. Maybe you can do that in increments. Maybe you start with the patient is bleeding to death over here and the best process now is one that stops the patient from bleeding. Then maybe the next step is what is the collaborative best among us. The risk in spending too much time on that is that the competitor is getting further and further ahead of you each day so you have to get on with figuring what is best in class. Part of the excitement of that is that it begins to break down these industry barriers. The best in class might be your satellite example. A place where you might never have looked before because they weren't shipbuilders. So it's getting to the best and understanding it.

We have in the last couple of years participated in a number of these benchmarking. MIT has done a number of them; again there is an investment of time; because if you are going to do that you better have people who understand the details of your business well enough to accurately assess where you are today. And again it's that willingness to say we are not doing that at all. That's okay. We are not doing that. A big goose egg over in this column for that. Then you begin to get the information back, the comparative information about where other people are, who is best in class who is closest, who you go to learn from.

We've talked about collaboration here among the shipyards and among the United States industry. You really want to collaborate as much as your competitors. That is the tricky part. That is the tricky part of letting go of the age-old behavior I think we talked about the very first day we want to get out there and dominate. Is it you really want to dominate or you want to participate? You want to get the best of everything. Because everybody leverages off of everybody else. It's identifying those steps then moving onto figure them out.

James Crocker:

That's something I find is extremely important having done this for a number of years at General Electric. The first issue is the generation of what is best practice. That comes in two parts: Generic best process, that is a generic good, and to focus that specifically at your vision, your vision as the shipyard

or your vision as the General Electric power generation business or your whatever, once you get your vision squarely in focus, this is who I am and this is who I want to be. The next major part of that process is what changes need to be invoked to become the world's best.

What we like to do is identify the best practice obviously. In my view having been through the workshop this is a sharing process. The workshop itself is a sharing process to the extent that the shipyards can feel Comfortable sharing that technology. At this point I think there is some concern while they are competing with one another. Of course, there is some amount of sharing at least a the conceptual level, but real "knock your socks off" technology may not be really popular to be shared at this point. That's another issue.

From the point of view of how to generate andidentify best practices: first and foremost to the extent possible they should be able to share their experiences (this is how they did it ; this is where they've gotten the big hits). The other thing is the experts, people who are in the industry or been around the industry for years, need to be tapped. They need to communicate their expertise. Those people should be brought to the party to share their technology and expertise as it applies to the shipbuilding process. Seminars, consultants, universities, particularly benchmark competitors. How do these other guys do it. If it's welding does it have to be shipyard welding. Can it be direction welding? But you need to benchmark yourself to make sure you know where you are and you know where your competitors are.

And it's not enough to have a best practice on a design that is inherently difficult to produce. It needs to be redesigned. That is why the best practice includes certain things that are generically good. But the real benefit of the best practice is to focus on the integration of best practices across the whole vision of the best shipyard. That is the key. Manufacturing Resources Planning (MRP) may be the best for scheduling material into a shipyard to a point of use, but, if the building material is extremely confused or if the product is not designed to flow, you are going to get less bene fit from that tool than other wise. So the trick is to get the confluence or the focus of the best practices and the best tools evolved and focused into a given vision in a given yard where one can take advantage of not only a tool but also the synergy of correctly applied integrated best practice. That is the trick.

The real "whiz" in business today is we will compete and we'll compete with empowered people and we'll make a lot of money and we'll continuously improve our process and we'll beat the hell out of everybody, because we have incorporated all of these best practices. We'll bring in the MRP and the secretary of the Association of Retired Persons (ARP) and all the rest. But we'll integrate that into making money.

5 Create costing structures that adequately portray the specific unit

Jim Wilkins:

Costing is an area that I think very important. Unfortunately one of my other interviewers commented on this sort of area. If you are trying to demonstrate that something will save you money, you can't do that if you don't have an adequate cost collecting struc-

ture so that you can compare what the impact of the process change has been. For various reasons the shipyards tend not to collect costs to a low enough level of detail to do that. Therefore, if you make a change how do you prove it's effect. It is easier to lump all of these costs into one barrel.

Costing structures in shipyards are very, very private. They don't want

elling them how to do it, then that creates great fences and resistance and yet the govenment wants to know why it costs them so much to get things done. So they have some costing requirements, but that will lead me into a whole discussion on cost schedule control systems, which is the government's technique of collecting costs and is a very, very marvelous syste but like many other good systems - when it is poorly applied, it becomes a bad system and has a bad reputation and that's the case with cost schedule control. So often it is brainlessly applied and made into a great mystery. Basically, it is the right way to go and anyindustry, any company that is not using it to manage themselves is losing opportunities.

Here is an area that we somehow need to work on in my opinion. Create cost structures that adequately portray processes; when it says portray the specificunit I'mnotsure precisely whatthat is; I can interpret that several different ways. Specific modules, the construction unit of the ship-but that is only one way I want to Classify costs. I'd have to have it several other ways and then unit by unit. That in itself is not enough. This is not a technical development. It is definitely feasible. It is simply a choice of doing it and understanding the value of doing it.

I was part of a study of naval shipyards and my element of that was engineering, budgeting, control, and costs. The overhead functions in the shipyard are just charged to an overhead job order number and no matter what in this whole section of 20 guys are all charging into one job order number every day of all their lives. I said, well how do you tell how much it is costing you to do this function as opposed to that function - they didn't even care. How can you improve yourself if you don't know how much it costs if you make changes and how are you going to know if it has reduced your cost and improved your efficiency? They had no way of knowing whatsoever. That is the kind of thing you find, and it is very frustrating. I was trying to argue with the supervisors - well don't you realize that if you could show to your management that by doing something how much you are improving your efficiency would be a positive thing for your rating as a manager. You can't show it with this. The reaction? They are happy living with a system that they know. (Management didn't care either.)

I particularly chose this initiative. This is one I would be interested in working on anytime because I know well enough about it that I could help. I assume that one of things after the report is written, that the next step is actually going to be picking, poking and improving on these things: Actually putting together some implementation proposals on how to go about doing this project.

Lorna Estep:

Generally, the way our financial systems capture costs today have to do . with direct labor, with large overhead

pools, that do not provide a good, accurate finding of what a product actually costs. In terms of, for instance, and I'll use a shipyard example, the shipyard in Charleston, when we went in there and took a look at their machine shop and what they were doing to produce products. One of things they wanted to do was use that capability to produce other things besides by-products during the overhaul The specific problem was we took a look at their costing structure and the relationship of direct labor to overhead costs and found out that the machine shop overhead also included the waterfront operations, which are very capital intense and very manpower intense. So what happened was the automated machine shop actually was being charged for work that was being performed on the waterfront even though that work never even went to the waterfront, so the customers who were paying for products on the machine shop floor were actually offsetting costs to the waterfront. So a decision that management might make to do some things or to be competitivein some areas would be driven by that cost structure which is not adequately giving them the real information.

The other piece of that is: if you're looking at reducing cycle times, then some of the information that we have in our financial system that we tend to use to try to model our baseline is really inadequate. If we try and make decisions based on that information we are going to be making exactly the wrong decisions, we're likely to not take advantage of opportunities where we might because we don't really understand the implications.

This is very parallel to Goldratt's Theory of Constraints. Our data is really not available so that management can make good, valuable decisions. In item 3 under the first objective, the key there is to develop simulation tools. I think we probably need to develop a good basic computer application. I think we have the tool set. I think what we probably need to do specifically for the shipbuilding industry is to develop that tool set into a general model that could be more specifically used by the specific industry. In producing a ship there are general processes that we go through and we ought to be able to develop that model. So in the general sense I can give you the simulation tool and then you can use it to break down specifically into how you do business. Generally designing and producing a ship you go through certain standard functions and all we need to do is capture those standard functions so that each individual company doesn't have to do that. We can get one commercial tool set where that company can then use that to further improve their processes, and the interface issue will be a lot easier if you do that. As you are relying on other pieces of the industry you get some commonality in your description that you can now begin investigating. Your interrelations and modeling really needs to be done rather than running out doing basicresearch on simulation tools.

Computer Aided Software Engineering (CASE) tools have a place in this area. There is some work going on once you've modeled the processes and have gotten a lot of data and developed the background. The simulation programs that will actually take those simulated processes and turn them into software support or CASE support for directly use. To improve your process control system or some computer aided tools,

you can actually model the changes to that process and then use that to generate the software to improve the process.

The question here is on specific tools that are computerized, that are available and that have been used. In the area of IDEF modeling and capturing IDEF as well as some of the higher level process. IDEF DACOM has a tool, an automated tool. There are some other CASE tools for instance, DEC has tools in the case environment that can be used. The one specifically in terms of simulation that we're beginning to use and are very happy with is something called WITNESS. It's a simulation tool that can be used on a PC and it's actually manufactured by AT&T and its very graphically organized and user friendly. We were able to do our first initial models on that within about a four hour period. I do have points of contact and phone numbers for people that not only actually sell the product but are familiar with using it should anyone want some training and assistance with it.

6 Identify the critical path processes for automation prioritization

Dan Cada:

This initiative speaks to critical path processes. It's clear if we don't focus on and decide which ones are the most critical or valuable to us, we're going to have each person working in their area of expertise or interest and*we're going to* get a 10% improvement in a thousand things but not a 100% improvement on anything. So the message is: pick your successes so they can survive. Why you picked them, of course, is that they're on the critical path, or the most valuable, the most payback. Go to work on those, and I think they will vacuum the rest of the world in behind them when they see the successes.

My own personal experience is that there's more value and payoff in a few total successes that in doing all of your jobs fairly well and we have to avoid that. The implementation pretty much boils down to the group agreeing that this effort, this hull, this design, this manufacturing process, this phase, some phase that's big enough forrecognition is the one we're going to go and fix. That will prove to the world that this is an intelligent approach and can succeed.

I have knowledge of the U.S. Navy's formal Engineering Change Proposal process (ECP) example; it's probably one of the best ones because to my mind the information that you're working with is not as critical and just the fact that they've begun to link up all the steps in the process, I think we still need to pick up some of the non configuration management issues associated with ECPs, some of the pricing and the implementation into the contract issues and somehow make those smoother so they get done with as much grace, if you will, as automating and integrating our efforts on moving ECPs through the approval process. So we've got to tackle issues that are knotty, like how do you price ECPs? how do you write an equation that is agreed to and can be run as a model instead of by some team of accountants having to sort the problem out and doing it by hand each time thereby eating up a week or two just for one proposal, a modest proposal, let alone a "biggie". That's the rest of the system that has to start folding itself into those kinds of successes. After that you can do

it with test procedures, you can do it with almost any other document. It really doesn't matter what you move through a process once you figure out how to write the formula or get the agreement or set the standards.

Robert Schaffran:

What that initiative means tome is getting back to the time issue. With the time issue, you have to identify all those things on the critical paths and those are things that you address by trying to shorten the time of those operations rather than looking at the things not on the critical path. If you reduce the time of those off the critical path, there is zero impact on the delivery of the schedule of the ship. You have to find the things critical to the delivery schedule and try to optimize those. In some cases automation might be the way to do that. I think the initiatives 6, 8, 11, & 13 all have the same in my mind. All basically apply the Theory of Constraints, and all are looking at time reduction, all documenting the critical path, which means the same as documenting the current processes.

7 **Spend money first on systems that improve competitive position**

Joe Wudyka:

Let me talk first about competitive position. The shipbuilding companies have been a captive supplier to the US Navy for so long they have lost that sharp edge, the competitive spirit. They speak competitively, but only as they speak amongst themselves. That Bath Iron Works can build a better cruiser than Ingalls or what have you. And they honestly believe they are talking about competition. That is not competition. That is simple competition. Two companies who identify each other as a target and they fight over the same few ships. When you get to think about competition - lets take the computer industry. Our competition is hundreds of companies all over the place. So we can't set up a plan to compete with each one, we have to think about market place strategies, pricing strategies, distribution strategies, packaging our products, advertising, promotion - you name it, we have strategies.

It is very complex, multifaceted, where in shipbuilding you have a very complicated product, but the one product is the ship, very complicated, but it is a ship. Think about the computer business. The product catalog we have is like the telephone directory, extremely thin paper, very fine print and about 2 inches thick. Think about all those products being sold around the world to thousands of customers in a field in which you have hundreds of competitors trying to sell the same thing. You have to be involved, that's competition. So shipbuilders, I think, have to begin to think about competition in that way and internalize that. Now that I am developing my strategies, my worldwide strategies, what things inside my company shall I automate that help me, strategically. Too many times we get all wrapped up in our internal workings — who cares if you have the best payroll system in the shipbuilding industry or the best timekeeping system in the computer industry — doesn't do a bit of good in the market place. So redirect spending

to have an advantage.

8 Document current processes

Lorna Estep:

The first clear thing that has to happen in documenting the current processes is to completely understand the the vision. If your vision is to reduce cycle time then clearly you need to document those processes in light of that, so from my end of looking at it before you go out and say how do I do this you need to know the context of what you're going to be doing and what you're going to be driven to in terms of improvement. That's clearly the most important thing. Once you decide that then you can get into pretty traditional engineering approaches to take and look at that process knowing what you want to measure. We have established very rapidly some tools that are based onD-BASE 3 that if you're looking at process cycle times essentially will allow you to capture that information. You can do that as an offset to existing information systems that you might have in your organization or you can actually capture that by some other types of motion studies, getting the folks involved in the process.

The thing that we traditionally found is just like when you go into traditional IDEF modeling when you get the people that own the process in the room they can rapidly tell you what is going on in that environment and then it's up to you to look at how you get information to support that in light of your vision. The biggest thing on some of these tools is that's what it allows you to do, to get the actual owners of the process in there where they can get to see what the value of the baselining is and what you're going to do with it. Within a short period of time you can go through the process of doing the documentation and looking at it and then deciding where you want to go into more detail.

My suggestion is to try first at a very high level, look at the full system and identify those areas that appear to be constraints and then delve into them in a little more detail; kind of like peeling back an onion, don't do the whole thing all at once, but look at it in light of your vision and address those areas that after a top level baselining appear to be the biggest constraints to the system and get the details of those. You can study something to death, but the initiative of the issue is to baseline it and use it to improve the process. You want to rapidly understand where the constraints are and delve into those areas that at the top level appear to have the most value in terms of getting further definition.

One can be shooting for targets in terms of cycle time reduction. During Desert Storm I think we were clearly able to show that we can put processes in place that will significantly drive down the processing times, the cycle times. For instance, during the January to February time furame when we really had heavy parts support, we went from doing particular parts that traditionally had taken us three hundred to four hundred days to do them, to doing them through the system in less than two days. That keyed us on what we really could develop in a system that could accommodate that acceleration. We need to look at what we did during Desert Storm to do those sorts of cycle time reductions and see if we can't make that part of the system.

A lot of those cycle reductions are not technology issues, they're not, "go out and build another robot" they're not,

"go out and invest in the next greatest software package." It has a lot to do with simple necessity. When there was a part requirement everybody had to touch and when they all got in the room and said okay, we want to have this shipped by the end of tomorrow afternoon, what do we need to do? All of the people, the supply people, the manufacturing people, the engineering people all understood that the goal was to get it out tomorrow afternoon and they all knew who was involved in it. There was none of the, "I'm going to throw it over the wall."

The part moved through that process very efficiently starting out with having everyone understand what the goal was at the beginning of the period. In terms of institutionalizing that process after Desert Storm was over, everyone went back to business as usual on that same part, back to four hundred days to get through the system. We created this organization to try to see what we could do to institutionalize that process of "we can do it in two days." Let's make that what we do on a consistent basis rather than on an heroic basis. We started out with a goal and it'spretty substantial, we're talking about from going from three hundred or four hundred days to less than thirty days which is a 90% improvement. We probably won't make that for all product lines; on the other hand it's a dramatic change. When you're trying to promote a vision you need that dramatic change to make people understand you're really talking about a huge change in the way we do business.

Right now we're dealing with four specific sub-groups of parts that we're baselining and trying to improve; one is in castings and forgings, one is in the machine parts area, the third is in printed wiring assemblies which we think are going to be pretty complex because of the electronic sub-component issues, and the fourth is in wiring harnesses.

Jon Matthews:

I think they kind of go together. I think that we have an opportunity now perhaps to review the entire method that's available to the U.S. shipbuilder to not only document but to pick out the best options available and to put them into shipbuilding English. I know for those who are not in this business that sounds like a cop-out, but I think what we've just discussed in the last ten minutes is what I'm trying to say there. We have to get the terminology and the discussion to alevel that both high level and low level that are understood by the people who are really managing our business.

The semantics are not only words but also the measures that are used. It has to be done and supported by a group of people who have credibility in the industry, so it's not just viewed as another R&D project that will never be read. There's a lot of good stuff out there that if you understood it is helpful, but it's treated as R&D, and it's not really used by the production guy, and I'm not just talking about the shop floor production guy, I'm talking about the general manager, I'm talking about the CEO, I'm talking about the engineering manager; all are production oriented. You now have an opportunity to put in front of them an operations approach to the problem, not an operation research but an operations approach.

If this were properly articulated and documented it would help to have that management competence that we

were talking about. I think that's the key, you have to have the competence, the guys that are actually going to make it happen have got to believe that it is the right thing to do. I don't think we've done a good job as an industry, as a support industry, in the last 15 years, to make that happen.

9 Make sure that computer aid is essential, not in addition, to process

Dan Cada:

This initiative comes from anumber of years of bad experiences; there is a proliferation of modest but expensive databases in many programs, including AEGIS, and after some time of battling with those guys, trying to get them to integrate or use other databases, someone said one day the reason they don't want to do that is because using a computer database is not the way they do their job. It's really just a data file and therefore, when it's separate from their job they collect data in whatever way they perceive is necessary and they're not wrong, but if we were able to refocus that whole process of thinking, "how do I use databases," to say I do my job on the database, literally in the database, not just store my results there, or pull some raw ingredients up out of it. You could derive a network or a smaller number of databases. Then you would approach the "create once - use many times" concept. Now we create once, replicate many, and everybody uses their own, and it's very expensive and a lot of energy is lost in why my database doesn't agree with your database.

I think the closest success story I've seen is what I saw demonstrated at Newport News on SSN21. They're using one database, thet're doing their work in it: VIVID, sails, linkup and the CAD and three-D, two-D work down there, all driven by one database. That's probably our best example of what's coming together. I think the G.E. Morristown folks are at least a third of the way down the path, they're doing the same thing at the facility which will include people outside of Morristown physically, it'll be Syracuse and others as well, so there's at least two groups that are headed that way.

Paul Friedman:

I would actually split that up into two pieces. Make sure computer aids are essential, not in addition to the process. I agree withrunning them together, but they can also be dealt with separately. First part is making sure computer aids are essential and what I have found, we have found in the yard, is that certain assumptions that we made, a specific example - an area of CAM just through our reading and what work we have done along time ago the assumption was that there is a lot to do in CAM and there is a lot to be gained from CAM. What we are finding these days is that that may not be true - it is not essential, a fair amount of effort to make it happen, requires changing a lot of existing systems and the gain may not be as great as we thought. Firstly, make sure that it is literally essential, because installation of computer aids is pretty expensive. If it is not expensive in material terms, which it usually is, there is training of the work force and probably the biggest expense is having to dismantle the existing system. Maybe risk is a better word, not expense. Essential rather than just attractive and we have

run into that ourselves and found some interesting conclusions.

Also, not in addition to the process, we are desperately trying to make sure whenever we implement a new system, a new process, we don't have the old one still kicking around. That has become one of our measures of success or failure. If we just are working on the new engineering bill of material, if we haven't replaced at least the core system today with this new system, then we have failed. Regardless of how well the new one works. I also agree with the overall statement-making sure you really need to do this and you didn't just tack on another module. Even beyond that, separately it makes a lot of sense as we just can't afford to keep maintaining computer systems and adding to the change in the variety have already have. We have

10 Reestablish process engineering as a discipline

Daniel Thompson

The best form of industrial engineering examines the processes that make industry work. The United States started the science of process study and has seen it spread overseas. We now need to recognize that constant, never ending, zealous improvement in processes constitute the goal of all our endeavors if we are to be competitive globally.

Each element of the shipbuilding and ship repair industry should reexamine whether process engineering resides introduction engineering, industrial engineering, producibility initiatives, or where.

Our educational systems need to recognize the vital importance of process engineering to our national economies. Japanese high school students routinely take courses in statistical process control (SPC). SPC is not even promoted until graduate school in the United States.

SPC was invented in the Bell Laboratories in the United States. Now we need to reintroduce the importance of research and application of our national skill to processes in all our industries, including shipbuilding.

11 Setpriorities based on which processes are on the critical path

Robert Schaffran:

Four of these statements are all identified with the process, identfying those things on the critical path and the reason I chose those because we are doing things in that area right now, a variety of areas, but one is that we have an AEGIS project underway in my office that is the infrastructure study in shipbuilding. That project documents the current process at a high level and as such puts together a time line on that process.

The paper was presented last year and needs more work and we are actively looking to get funding to do more on that, but the sponsor of that work (his office) has now been expanded to NAVSEA and the guy responsible has been reassigned to the Department of Defense. There is no more advocate we can find in NAVSEA that wants to continue this effort. We are running around trying to find such a person.

Let me put this in the context of what shipyards are doing. What we had in our mind with this vision statement

when we started the process is to document the entire process from the time owner has a faint requirement that he might need a ship to the time the shipyard delivers the finished product. There are 3 phases in there. One is identifying the requirements, the second is now how do you select the shipyard together with the process for selecting the shipyard to build that ship, and the third part is the actual construction of the ship. That process right now in this country, and I am very optimistic, is a 60 month process. When we sent that out to the shipyards for comment, they were very critical of the report in saying that there was no way that it could take us that long. In fact it does, and we have tracked it with several real projects. EXXON opened their books to us and showed us the whole process. So we have real data.

The shipyard portion of that 60 months took 6 months for the construction part and half that time was in ship construction process and even that was generous in some cases. We have identified and used a modeling method that is accepted worldwide, AEGIS zeros and process modeling methods, and we took it down to 300 elements and that what we have done now is compared that with the Germans and the Germans have modeled their time method also and used the same modeling process and they have shared some of the data with us. The model they are developing is an European community model so they have looked at the entire infirastructure of the European community and our model looks at the entire infrastructure of the U.S. for commercial ship construction including, not just the ship construction process but also including how to deal with the financial institutions, how to arrange financing, regulatory bodies, etc. A very high level model, it doesn't get down to the nitty gritty. A lot of information there. We plan to continue that and when I said that I would like to be involved in these, We have done some things and shall continue to do things in my office.

12 Benchmark competitors

James Crocker:

Just in my view there is not enough of that done. There is a tremendous amount to be learned from your competitors. Not only what their strengths are but also their weaknesses. And there are anumber of great examples where people understood their competitor's weakness and made a lot of money not necessarily by putting the competitor out of business. They kept the competitor in business in an in aninefficient way and these people 'went to the bank" by keeping the price up. Postage machines by Pitney Bowes are a pretty good example. The bottom line is that if we could learn from our competitors by being on site and sharing what they have to the extent that that has been done a lot in the shipyards, that's fine.

At this point we probably have more to learn from them than they from us. We start to accelerate our evolution and even our competitor's product. Our ability to go on site becmes less and less attractive from their perspective, but there are lots of other ways to do that, for example by looking at the products they produced. How did they produce them? To the extent that we can get their products and look at how they built this, how was this put together, reverse engineering if you will. Take apart engineering. Also talking to their customers and talk-

ing to their suppliers, talking to the people that chose to go to work for us instead of their organization. There are lots of ways to find out how our competitors do things so we are not forced to relive and go through history all over again to relearn these processes.

One of the aspects of leap frogging of any environmental evolution is one of learning from other people's mistakes and not having to go through the time and cost of making the mistake ourselves. So in that respect anytime we are doing a business overhaul for anybody, we absolutely love to get a hold of the other guy's product. How are they makingit? Where is their stuff coming from? Is this stuff made in the United States or Taiwan. What is the logistical impact of them having to get this stuff from the Far East. We want to take that thing apart and learn what their business is from the inside.

I think as a shipbuilding association or being a higher order of things than the yards themselves we probably have more access to the yards because it would be easier to put together a national shipbuilders professional exchange on an international basis. Rather than doing a yard to yard nose to nose type thing. I think it would have a lot more impact because you take a number of players from a number of yards and put them tagether and tour X number of shipyards around the world and now you not only have the benefit of your experience in each of the yards, but you also have the sharing among the five or six or eight yards that are participating in the tour, so now you get the cross organization book from the eight yards communicating among themselves, that's how they did but that's how we did it, but wait a second we do it even a little bit differently over here. There is a lot more cross functional benefit doing it that way rather than a specific yard taking a tour because a specific yard only has still only has one frame of reference, theirs. If you have eight yards, it is best done collaboratively.

Robert Schaffran:

As far as the benchmark competitors is concerned, we have also done a little of that on this IS0 study by going to Germany. We also just set up contacts with the Koreans. Japanese didn't want to share their information. The second reason I marked this initiative for comment is that because there is an NSRP project which we are finding and try to stay actively involved with. It depends on the competition, the technology evaluation, technology comparison anyway, of U.S. shipyards and identifying the technology levels at our shipyards which is a follow up on the thing that was done several years ago by the British.

We are using the British Appledore methodology. Theyrefined that since we began ten years ago, and so that is a methodology they have developed, Appledore has developed the method to benchmark the competition. They have 72 areas of the ship construction process for which they have a grade of 0-5. They have defined these grades at a pretty detailed level: what O means, 1,2,3,4,5 means. So you can walk into the shipyard and very quickly go through those 72 elements defining where you are in that grading. 5 being state-of-the-art, best in the world. Actually 1-5, 5 levels, and 1 being sort of pre 1960s technology and 2 is what they classify as '70s technology and 3 is '80s, 4 is late '90s and 5 is state-of-the art. It is a very well done

benchmark. It is there as a proprietary system they put together, we hired them to do that.

Joe Wudyka:

We do slot of benchmarking inthe computer industry. We have found it is one of the best things you can do to improve your competitive position. Go off and identify who is the best in the class in whatever and to work withthem, cooperatively, to benefit your own company. And I said cooperatively because it is a two way thing. You don't generally go to another company and say show me all your best stuff and then I'll walk away. You say, show me your best stuff in this area and what would you like me to show you? Benchmarking, what we have found, isn't a couple of visits, not a few phone calls. To do benchmarking, it is a setious investment. You have a plan that everybody agrees to. You work your way through a plan. It is not a casual let's get a couple of computer companies together to talk with each other. I think most industries think it is casual and it is not.

Another point on benchmarking is that we have gone off and benchmarked, and here we are a computer company and a systems integrated, accounting system. We have done personnel systems. We want to find out how other companies, who are really good at accounting systems, how they do their accounting. We don't just benchmark with other companies who are in our industry. We also don't benchmark only around the services we provide. We look at ourselves internally and say we would like to improve, for example - our accounting. The point is that you really work hard at counteracting the natural tendency to turn inwards and become ingrown. It is very easy to occlude with each others opinions. Everybody gets to agree with everybody else and they support each others wrong ideas and everybody thinks they are right. When you get your head up and outside your own industry, you see things that are different.

13 Apply Theory of Constraints to the shipbuilding process

Jim Wilkins:

The Theory of Constraints is an area that has not been applied to shipbuilding. It is an approach that unfortunately has been presented to most of us in the shipbuilding business in a way that is very unbelievable and in a style that is in the way of the basic information. When you go back to Goldratt's books, you know all the sense it makes, and you just want to go and do it, look into it. I am not sure it is directly applicable because we are not a pure manufacturing industry in shipbuilding. But, on the other hand we are assemblers and the assembly process is certainly amenable to looking into what is constraining, what is holding you up. Again, Frank Rack of the Goldratt Institute is a gentleman who I know who has worked in the marine area, and Frank is absolutely convinced that the biggest constraint is policy constraints. There are no physical facility constraints to keep us from building ships much, much faster. It is strictly policy. But he includes in policy the fact that we only work one eight hour shift a day, and obviously, if we work three eight-hour shifts, we could get ships done in l/3 the time and you could say if we work seven days/week instead of five days - but I don't think

those are realistic or cultural. Nothing is driving us, and I don't think the rest of the world is necessarily working seven day weeks in order to beat us, so we don't need to go to those extremes. It is reducing the amount of calendar time, reducing delivery time. It is reducing overhead also, because each day is overhead as a day is overhead and you get three shifts working instead of one shift - so there is something to that anyway. I think those are the things that turn people offinstead of encouraging us to do it, but we ought to do it. Some of us, including Bob Shaffran fortunately, want to apply the theory of constraints to some real shipyard situations. It will be done - include me in those who will be interested in doing it.

14 Have management and operations groups co-determine products and processes

Jim VanderSchaaf

This initiative encompasses two related efforts. The first is the need to review current processes in detail, especially as they occur across divisions within a company, with the purpose of identifying areas of potential improvement. A typical area such as material definition, ordering, receipt, warehousing, fabrication, in-process control, and installation would be a prime candidate for review. The second is to involve all levels of management in the discussion and decision making relative to understanding and improving these processes. This approach is directly related to what Dr. Deming introduced to Japan in the 50's: a continuous methodology of process investigation, process improvement, management commitment to improvement, and statistical process monitoring and control.

15 Improve process baselining technologies

Lorna Estep:

It goes back to understanding your process and baselining it and continually reevaluating it and improving it as a basic part of how you can get some dramatic changes in cycle times. I think the issue is we really need to have tools that support that continuous change; a process that makes it easy for the owners of the process to use and understand the implications and the complexities of their interactions and right now we have some tools, but we need to expand those in light of the ADP professionals are not the ones who are going to be using these tools. They've got to be more user friendly, they've got to be positioned in such a way that it's very easy for people not only to use them the first time but to continue to use them to support their business processes. There are simulation tools that are starting to approach that and probably need to be specifically packaged for the shipbuilding industry.

Given the right cooperation, I know that there will be some of the simulation modeling people that would be willing to spend some money on research and development or releasing money to do that if they understood what the need was in terms of the industry. We heard fromhe folks from DEC as part of this process that definitely there's a role for a cooperation between those industries so that products coming will be available commercially and will meet the needs of the industry. I know that the WITNESS people in simulation packaging are will-

ing to do the same thing as well.

OBJECTIVE II PROCESS INTEGRATION

16 Implement seamless integration from design through implementation

Dan Billingsley

There is a basic underlying computer assumed in its cycle of design/development. That computer includes functions of specification, determining what your requirements are, establishing some trial definition, doing some analysis on that, making a decision and typically iterating back through another definition cycle. Sometimes iterating back through another requirement cycle; reengineering your requirements to suit what you can actually meet. These are iterations and value added efforts that have to be worked through on each individual ship design.

Our assessment is that a great deal of our time is spent on non-value added efforts. Recovering information, retrieving information and transforming information from the form you have it in to the form you need it in. Administrative work is not really value added to getting the ship design complete. It is our belief that by organizing your computer applications, providing the proper tools, you can virtually eliminate the non-value added steps. You can streamline and expedite the value added steps and come up with a significant increase in your through put.

I am going to go ahead and walk through this technical thing because a lot of the answers, my answers at least, in these questions are going to be embedded here. There is a paper I did together with Jeff Arthurs, Karlu Rambhala, Bill Schmidt at the SNAME symposium awhile back *(Revolution at NAVSEA Managing Design and Engineering Information,* paper number 14 before the SNAME/ASE Naval Ship Design Symposium, Arlington, VA, 25 February 1992). This paper started off by saying it was kind of ironic that the down turn in business is causing people who maybe marginally looked at computer applications before, to look at them now as their only hope. They find out that just throwing money at the problem and bringing in some technology doesn't usually solve it. That it is a deeper problem. There are three sections - One talks about the problem in a generic sense. The second talks about what we are doing to prepare the NAVSEA infra-structure to deal with the product model level information and then the third talks about NIDDESC being able to translate that information from the Navy to the different shipbuilders, vendors, ins and outs to the Navy and to shipbuilders and the shipbuilders back to the Navy.

The section that talks about the problem, brings out this concept that in the design process there is this basic interactive loop of definition analysis decision requirements, and it also says that in the planning process there is a similar interactive loop of developing a plan, doing some analysis, making a decision, checking the next set of requirements, etc. The two are very similar, in fact intertwined, so that you have requirements which run to cost performance and schedule type activities, you have a plan for how to do it and a definition of what to do, when you decide what you want to build, aplan for how to build it.

You do some analyses that end up in some aspects of cost performance and schedule prediction and you make decisions to proceed, reiterate, whatever. Our thesis is that thereis, I have never worked this plan side, a new insight, and it seems tome that everything from a SCN plan through a fabrication plan, through an overhaul document for a particular pump are all how-to documents. The definition information starts off very flimsy as a parametric blip on a curve and runs through a schematic definition and gets associated with diagrammatic and gradually picks up more information until it is a complete, fully component breakdown piecd/part. The thesis is that essentially there are categories of information that go with each of these essential fictional steps which get iterated and reiterated.

In the requirement area there are explicit requirements. There are also a lot of implementation requirements; General Specifications, lessons learned, policy decisions, etc.. The definition is the three CAD type information, catalog parts, analysis, information on analysis results, design criteria comparable, and in the decision area you have a great deal of configuration accounting information. It is also in our thesis that this part is not keyed to any particular technology. That we have in fact been doing these iterations and gathering, storing and transferring this information forever.

We feel the information is of primary impotance. The reason for that is that the process varies from-project to project almost by defition, by using a competitive process to select the performers and the performers vary even more and the individual performers vary even more as different people come through. Regardless of who doesit, there is certain information that has to be built. We talk a little bit about the different types of information and what the development patterns are, etc. We also talk about the formation engineering techniques we are using, both within the design process and for the data transfer process to really get the information relationships explicitly described and documented for future reference.

In the communication device and a documenting device, the methodology had proved very strong. We go on to talk about how ships last for 50 years. Information systems are going through tremendous changes even in a 20 year frame, tremendous changes in the information systems. It is not unrealistic to expect that the different ships are going to operate at different media planes. We characterize these media planes as a fairly radical oversimplification, but we Characterize it for graphic and non graphic information. There are traditional plans with drawings and documents - what we call the digit traditional and this more or less equivalent to CALS Phase II where you now have digital images, either scan images or 2-D CAD images of what is fundamentally the same document. On the other side, the nongraphic side, scanned images are ASCII text. The third plane we speak of is product model plane, which is loosely equivalent to CALSP hase III or their integrated weapons systems database. The product model is the marriage of 3-D CAD geometric information with database managed nongraphic technical information and the integration of those two.

The technology in truth is just coming on within the past two years to allow all this information to be gathered and associated. When I speak of the

product model, I am speaking of all the categories of information. The definition information which you see most commonly with CAD systems, then also the requirements information, the analysis results, the decisions and conceptually, also the planning information. As we talked in the frist part, it seems that is all one strength. We are taking a distributed database environment where there is a shared conceptual schema, but there are some parts of the information that are going to be at each of these different workstations, soitrequires a fairly strong configuration management technique to tell you when you want a particular category and information with a particular approval and applicability level, which physical device somewhere in the Crystal City area that that information is on so that when you go to do an analysis you really are analyzing the ship you want to as opposed to something else.

There is the general overall approach. We break down the missions, the NAVSEA Code 05 mass against the media planes they will execute, and we come to the policy conclusion that for new ship designs we are going to be proceeding with this 3-D product model level. For ships and service we have to have a capability to deal with them in the digital traditional level. In fact, for a few ships we are allowed to continue to deal with them in a traditional level until they retire from service. We have to be able to have a system that allows us to operate in several levels. Our hardware platform - it is a distributed environment, network environment with workstations, PCs, central processor servers all running off the same environment. We talk also about our software configuration where we are using virtually 100% commercial CAD tools for modeling and drawing functionalities and we are interfacing them with information engineered, modular interfaceto analyze programs, which in many cases are Navy peculiar and not available to the commercial source.

We talked about the problems of transferring information between activities. We talked about for digital traditional which is a fairly straight forward operation because there are standards in place for that, and we talked about the developments of NIDDESC for product model transfers. We point out that of the five major yards in NAVSEA we are using five different computer systems. The good news is that out of those five covered, all five systems in the U.S. can handle product model information, but we have a standard development that is far advanced, and we have translator developments presently programmed to take in each of those areas. We conclude with what basically different people in the organization need to do to bring on this product model; what policy people, programmanagers, the key role and then what design and engineering organizations, etc. must do.

We are looking even beyond the contract design phase and spetications. We are taking a look at it as a cascade, which has appeared in a number of our presentations, where it shows the early stages of design efforts through contract design in NAVSEA and off to lead yard and off to follow yard and back to Navy logistics, planning yards, etc., with this -overlay showing that headquarters engineering needs to be able to interact with all the activities. Our mission statement is such that we go through all stages of the ship's life cycle, which means in all media planes in a number of activities. The NIDDESC models presently have

covered the definition category of information as circle “a” transfer, circle "b," circle “c" transfer, and I speak to definition information as compared to specs and requirements.

The configuration management, which they have covered pretty robustly and then the planning information which they have covered not at all. Planning relates to the design; planning is the how. We focus for sometime on these four: the requirements, the definition, the analysis, and the decision cycle with NIDDESC particularly working on how to pass this basic definition of what it is that is to be built, what is to be serviced (what’s in the databases?). Tangibly it is almost as if you can touch it in real life, it belongs in the database. That is a primary criteria. It turns out that there are many system relationships that are very important to engineering and service life support that are much less important to developing, basically interest in the assembly viewpoint. Many other designers are primarily interested in the compartment viewpoint, but all these three primary user views, as well as some subsidiary user views, are all equally important and all equally valid. The trick has been to develop a definition model that supports all those different views equally. In the process of developing the transfer standards, the steps that have had to be gone through are to agree on a content, to agree on a format, to actually develop some translation software and do some testing and validation. Those are four steps you have to go through if you are transferring wordprocessing information or ifyou are transferring 3-D CAD product models or whatever.

What NIDDESC as an industry Navy cooperative effort has done is the contents standard and the format standard for all types of definition information and all a, b, c stages of design and construction. What we have essentially prearranged through the SSN21 subprogram and the DDG 1st flight to A program is that they will be picking up the translator costs of those major systems and then through the CAD 2 contract and NAVSEA’s Intergraph will pick up the translation to and from the new standards through Intergraph. We project that in a year or two we will be able to transfer from any product modeling system at any shipyard in the U.S. to another product modeling system, either in the shipyard or back at NAVSEA. We are feeling like we have that problem somewhat under control, at least it’s heading along to hit at the same time as the others.

I don’t want to overstate my comments on this number 16 initiative. What I want to say is that the pattern has been established. To make the pattern work you have to have a leading activity that is developing the information. A capability to transfer information to the leading activity to the following activity. The follow activity has to have the ability to pull up and use that information. To broadly characterize where we are is that at NAVSEA’s headquarters we are developing the capability and capacity to do all our ship design work in the 3-D product model basis beginning in the early parts of calendar 93. Through NIDDESC we expect to be able to transfer back and forth to any shipyard in approximately two years. Shipyards themselves are individually building up a product model capability that they will expect to apply during the detailed design construction process. Of course Sea Wolf and DDG being examples that are

pretty far along with that. We have other efforts that are working to get the planning yards and various other field activities as this product model is developed in the course of ship design; and when it starts coming to them, they will have the different elements that it takes to make them operable.

In the late stages of this paper, for us federal guys, that old formula for what we need to do to have a coin operation we have to have hard ware, soft ware, willing and trained users, management support and communications. Programmatically we have to have money, a contract vehicle, an information technology (IT)budget allocation and life cycle management documentation. What needs to happen is that the recipient organizations receive all this information from the shipbuilders and they need to have all those things needed in the data transfer world. You have to have the content standard, format standard, a translation software, a requirement by the government to deliver the information and on the Navy side you have to have the money to contract the vehicle, the IT budget allocation and the life cycle management documentation If you miss in any one of those, it is a fatal flaw.

We must organize to make sure fatal flaws don't happen. Since we need to get organized to make sure all actions happen and to start basically making sure all the buttons are punched.

With respect to the federal activities and their ability within, the outline of the organization is painted and it is painted in the NAVSEA information resources strategic plan and it is painted within the responsibilities within that plan for the business unit managers to integrate software, but yet for the functional codes, the existing line organizations to deal with the resource and personnel and staffing implications of putting that infrastructure together. The IRSP is a relatively recent document that has been out about a year. The business unit manager in the design and engineering case I can tell you has been so busy with dealing with the headquarters design and engineering implementation that I haven't really pushed very hard in trying to get an integrated philosophy and approach that carries this vision out to all people. I have a sense that that is wanted at the planning yards and at the various other activities. One of the reason I wrote this paper and have been passing it out like business cards is to start sowing the seeds of that vision. At the commercial shipyards it is another problem. They have to hit all the same buttons, except that they are free from the LCM vehicle and of course their contract vehicles are a little to arrange. They need to hit the other buttons as well and they need to have the internal capabilities to receive information centrally. (I think they need to describe better for this thing in more detail so that they will have a road map they need to follow.) One of the calls I recently received was from Electric Boat. They took this paper, I think from being at the same symposium, and a young lady from there called me up and either asked me for some reference or asked me for a copy or something. She said they had circulated around and made a start. That might be a good case to see what impact this overall philosophy has, taking it as a cold start — a place like Electric Boat which has had a lot of computer activities, but is just now coming to grips with the real product model concept. They have used the physical model as their control model in the past. You have the need for each

organization internally to do its thing, to be able to operate on a product model basis internally. You also have the necessity for them to be able to inter-operate and swap information with Navy activities and the visional issue of your supplier base.

We are trying to create an environment within NAVSEA so each of the life cycle managers that are responsible for a piece of equipment and at the same time that he goes to buy the equipment is also buying an information package which has the product model information as well as the more traditional forms. Likewise the companies that are buying better supply and equipment will have to do the same thing. The word around is that if you don't have that, if you can't get it from your vendor or you forgot to order itfrom your vendor, or your vendor wants too much for it, you have yourself developed a catalog parts libraries that have that tiormation in it. I think there is precedence set for requiring that information and sharing it, rather than each company acquiring or developing it on their own.

That certainly is one area where there should be some cooperation going on. It certainly is an excellent opportunity for us to save big money as an industry. It is a funny thing on convincing management to go for a CAD or product model approach. The information on cost savings is very soft and tends to be antidotal and very rarely any opportunity to conduct a control experiment where you do it this way, you do that way and see what the difference is. What I have found is that if management believes, there is plenty enough information to support their belief. If management doesn't believe, then all the information you develop won't be enough to convince them it will work. Management belief and support is a key issue as we defined earlier.

The last thing I can feel somewhat personally, since there are probably slot these managers, *is* that despite the fact of working around this technology everyday and promoting this technology everyday, I am rapidly losing my hands-on touch for it. I am rapidly losing my grip on the technology. It raises some social issues of how do we change our culture to make it acceptable for people who basically popped out of the top of the technology to culturally, acceptably recycle themselves into technology and work up through the organization again without losing all their position, status, self-esteem, clout, etc. in the process. That is something we ought to solve. How to make that work. A real human relations issue. All the issues to mind in this are human relations issues, sociological issues and organizational managementinformation organization type issues. The technology at this point is not cut and dry, not star wars. The technology is there, but it is hard to fathom if you don't believe it. We found that even when some of design people who resisted getting a computer and start using CAD, we got a CAD workstation and gave it to them for awhile and then said, if it is not saving you any man-hours we will take it away, they didn't want it taken away and we knew we had done something good.

Carl Bryant:

Some things are near and dear to my heart. I was the one who put this initiative in there, You should be able to go from the very earliest facets of design information parameters that you have all the way through into production and

there are those in the CALS community who look at the broad support afterwards. So the documentation needs to be "seamless." You should be able to go step by step through that process without having to spend a lot of time converting from one system to another. An example in my work with Bird-Johnson: we start on a propeller design based on hydro dynamic data which would come from a towing tank or from a commercial propeller tank. Sometimes it would be just a computer model, speed, power, weight, that sort of thing. From that we had a software system that would then determine what the propeller should look like.

From there you would go to a different evolution to make sure that the thing is strong enough in the hydro dynamic form. You go through each specific, which would be a separate software package. Every time you went through this you take all this data. Put it all together, all kinds of opportunities to lose it, misstate it, lose something in the translation. Then from there you would have a requirement to come forward with a set of drawings which were an actual requirement, Which meant sitting down and drafting them by hand based upon various data. We had to design patterns for the castings which would go off to the foundries. We would cast molds from that. You would then get the casts back. There would be dealing with an extremely sophisticated machining process. More so for Navy customers, but we found that you could please commercial customers cheaper with a machine finish. Boltit on so each would be treated as a separate assembly. There was a full process where again you had to define numerically and perform the processing and post processing and come up with a set of machining data which then would be read into a machine and then following that you had to check the blade width.

It was a hand process and it would go today set up on a laser type of device which would check all the points to make sure they are to the described tolerance and ultimately back to the ship. Each time through this whole process you were taking all of that information and moving it probably one system or another half a dozen or ten times and the goal we were striving for and we met it halfway down the road and hopefully is started and still working on LTD was not that you had a wonderful computer system that would do all this necessarily but that you could take the modules and have them all using the same set of data or the next one using the data as the predecessor.

The same thing would apply to shipbuilding. You tend to focus on the structural side of things even thoughit's a small percentage of your cost. The other example I tried to use was years ago from whatever is going to set the volume to what is going to go through the piping whether it's for a heat exchanger or something. There is a computer program that is going to tell you that. That should then feed into something that sizes the pipe, that should then access the whole data base whatever it is that describes where everything is inside the vessel so you can route the piping in the appropriate way. That should then lead to something that should go to your pipe vendor and materials people to call out systems: we need this fittings these places and there is probably a by-product from a set of drawings you give to your customer. Again, this happens to some extent in the aircraft industry, but I don't think they're all the way down the road either. I think there is tremendous

emphasis on that common data base.

Mike Connery:

This initiative means a lot of things to different people. I attack the seamlessness from data. On the aspect of designing a product, one should ask themselves the following question and I do this to my people. If I go aboard a hull and I pull open the door of any of the SQ Q89 cabinets and I point to a module down there and I have my contract person with me, and this by the way happened to me from a Captain from the Navy, he pulled out this module, held it in front of me and said, now you prove to me that I ordered this. Specification-wize, build-wize and everything. I want the integrity track. Take me back to the contractor's "shelI" to perform this function and walk me through this. Five years ago I couldn't do that for you. Today I can almost do that for you. It all deals with how a corporation treats its data. Its data is an asset, the information. One invests in assets for pay off and I submit that one should invest in data for payoffs. It is not a very expensive investment.

The architecture is thereto do this seamless integration and our approach was using relational technology. Relational technology is nothing more than saying I have given you a big flexible spreadsheet. You can do all your calculations, you can do things in a spreadsheet vision that people like to do, but in the background we have linked all these knowledge pieces together so that you don't lose anything. The basis for seamlessness to me, in conceptual design, follows: if there is a functional aspect to give this thing a functional name or number in which we are trying to assemble all design attributes, initial parts lists things, geometry, stress analysis, all the results and or tests associated with that are all attributed to this part number and stored that way. Is it transitions into manufacturing that takes on a bill of materials number, it never loses; its stores and all you do is reference the new bill of materials number to the old function number and keep this relationship as it goes all the way through. Tome that is the idea of seamlessness, it's connected data.

The seamlessness of tools, I don't think a corporation will ever get to. My example is that the Lotus spreadsheets again. They are good at doing number crunching and they also have a capability to do databasing, but you would not want it to do databasing and although it can, you want stool specifically designed to do databasing. Will there be a different mode of operation between the tools? Of course there will. You best have an educated work force that understands that. Seamlessness to me is data. Data integrity, data validity. I don't want to reinvent the wheel. If the data and the information is out there in engineering, why do I want to go and recreate it in manufacturing or support. It just doesn't make any sense.

One of my pet theories is that I call it "tollgateism" and these tollgates are expensive. You can do an experiment with a piece of data, especially in what we call a design release unit. That is where the widget, or whatever it is, transitions fron engineering to manufacturing and or assembly. If you were to take and give everyone that was associated with this product a dollar bill on a Monday morning and then you started from where that widget ended manufacturing, and you go back and keep asking

may I, may I, may I, what did I do - you'd be arich individual because you would be collecting all that widget went through so many peoples' hands that each time it went over the wall, if your wall is a tollgate, you paid something for that. You paid in cycle time loss is what you paid and that is what you have to get rid of. Some of it is automation, but most of it is common sense. You see what the process is doing.

Jim Hutto:

My interpretation of seamless integration is the information that is required for each step in the process thatis dependent on being generated by some prior process so that the information is captured in some form, that it is made available to the user of that information in a form that is transparent as to its origin. So if fits into his process with an interface that he is accustomed to and uses terminology he is accustomed with, he continues his work without significant retraining or hindrances into being fully productive for his entire work day.

It is different for different systems or different users. It requires certainly integration of information and the first step in that is for a company to come through and analyze what is their business or what are they doing in each step of the process and it requires them to understand what data is necessary to do it and then what mechanics they want to use. Certainly our first thought is always computer based, but that is not necessarily the optimum solution. Sometimes it is still paper based, it depends on the step or process. The key is first for a given process, what is the information and what is the format that is needed for the information to be brought to that user. If it is paper based it could be a check off list. We think of voting cards, magnetic strips, bar codes so if you come down to a place where you need to give and operator a check list of what he needs to do it doesn't necessarily have to be in computer format. It could have been generated by computer upstream and when it comes to that user, once he is finished with his process, then you need to sit and analyze and define how you want to capture what he has completed.

Our best technology for capturing, of course, is to get the information back into some sort of electronic format. Whether we use the computers continually in the process or whether we convert information to different fonnats, whether converting from different computer systems or computing different media - screens, videos, drawings, computer plots, cards to be marked off if steps are completed and scanned back into the system in a downstream process. But I think the key in doing that is first to define what is the process and the information that is needed. The next step in implementing that is to decide where are your investments and pay backs. Whether you want to replace your computer systems you currently have or whether you want to integrate them into your entire architecture, the computers and programs you already have in place. The next step is in prepare the tools that move information from one step to the next and change the formats as necessary.

In terms of progress toward electronic capture I think we are being very successful in isolated areas. I think we have islands or automation that are being very productive in that. If we look at what has happened the last few days and

ask have we automated the entire process, do we have a completely automated seamless society and the answer of course is no. When we look at local areas we do have computer systems in place that are taking advantage of new tools being used for interfaces that can look at data in different perspectives. They have been prepared based on working targeted user groups and the information is coming up in that local user's vernacular.

The next step in seamless automation has already begun in some areas is to study the processes. You first need to decompose the entire work process into what the objectives of the process are. Who is the user community, what is the experience level, what is the educationlevel, what is the standard language that they use, what do you anticipate would be the primary method of communication? Everybody doesn't want to learn computers and so we shouldn't force that, but we have check offlists that we have done with some Army projects and Air Force projects where if you are into diagnostic type situations you can decompose the entire schema of data to strictly yes or no questions. You have to first understand who the audience for the information is and how they want to relay.

We are talking production process, build repair process, diagnostics in combat areas where you have a question: is it possible for that tank operator, is possible for that gunnery sergeant to sit there and do some repairs or identify what is the problem. We have done systems like that before, to sit and walk through building: who's the user, what is the process, what is the information, what kind of interface do they need to deal with. Do you want to teach them computers or do you just want to communicate with them as if you were on a telephone with them? Which becomes some sort of dialog with yes or no. This is the technique or process of eliminating the 'seam."

The first step has to be understanding what your process and objective are and what information is necessary. From that, then you can begin making decisions on what is cost effective and define the areas where you can truly come in and provide automation. Always for any of this to work it is critical that all the information be captured and be brought back into a global system and until we have that commitment we will always end up with the cliffs that we have to fall off from and we won't have the solution yet. But I do see that we are moving in the right direction.

Douglas Martin:

I would lump that with one further down the list, Develop an information technology plan featuring data and function integration. Both deal with the idea that you want to have available to you a system that has the characteristics of capturing data once and leveraging that data in a subsequent function so that the guy receiving it or making use of it in the subsequent function has no hoops to jump through. It is just his normal single focus function from sit down and do his job and the data is there (comes as an input to him) and comes as a by-product. No special hoops. That is really a key.

If you look around the industry now, that is where everybody is trying to go. Some people are further down the road than others, but they are all reacting to the general problem of having to do a lot of non-value added things to data

created in the prior stage before it can be useful in the next stage. Whether that data is electronic or paper or what have you. A lot of non-value added stuff, a lot of errors introduced in transforming from one to another. I am trying to eliminate all those interfaces to make it a nicely integrated system. Most effort is in the design data, graphical information and some text information, the production engineering effort, and procurement. I think Ingalls is probably as far along in that area as anybody. They still have interfaces between distinct systems but they have consciously set about to make those interfaces as transparent as they can.

To achieve this integration from design through implementation that we are not now doing is difficult, because everybody has their own set of systems that they are trying to make integrated and it is characterized as a custom effort to do that obviously. Everybody has their little piece of software that they are trying to knit together or databases they are trying to knit together. We can functionally describe the databases that are needed rather than their exact configuration thanks to the results of the NIDDESC effort. Yes it is all about a standard which describes the data to be delivered to the Navy by the contractor, but when you sit down and look at what you have to do in order to support that objective, what you end up doing is saying well what is a design database for a Navy ship to look like? What is in it? How are the pieces inter-related? That is what those specifications coming out of that operation really are. So, to the shipyard if a guy sits down and looks at it in that context here is someone who is taking the time to write down what ought to be in an ship in general design database, there is some production ensuring stuffin there as well: There is at least a real good cut at it. And I had the advantage of working the program and seeing that early on and I just sat back when I finally realized what this thing was becoming because that then is a key piece which helps a guy like myself see what interfaces or integration has to happen in terms of the applications, developing and using this data.

Now we have 15 different pieces spread all over the place. It in and of itselfis an aid to the shipyard, to sit down and answer the question, What do I have to do to really come up with an integrated product definition and downstream the system to eliminate a lot of these interfaces we are talking about, the time and cost of getting between function a and function b. So what to do there. Maybe somebody in Dan Billingsley's shop or NAVSEA code 07 I think would be a good place to put together a dog and pony show. Some type which brings this to the attention of design managers and their related CAD people in different yards if they don't already know it. Of course, a lot of people don't know what a NIDDESC is and could stand to hear of the Tampas and Trinitys.

In terms of seamless business through total implementation, it sounds to me from my ignorant position that most of the effort has been related to design areas and transmitting design information back and forth. I don't know where we are in that in terms of incorporating some of the production engineering type of requirements or the procurement type. That whole CALS business, identifying ultimately spare parts and maintenance type information. In terms of implementation, we are not very far. Going back to Ingalls they area reason-

able benchmark as to how far we are as an industry; and where they are is that their CAD system is feeding the material requisitioning system and material ordering system. As a natural by-product of the design function, they have some touch labor on that design definition to create shop paper, shop construction packages for things like the pipe spools, ventilation assemblies and other fabrications. But, nevertheless the point is in their case the data that is creating those shop products is the design definition or the definition that originated there, sourced there. It is not somebody else's interpretation of what some guy expressed on a drawing. Shop sketches are falling out of the process.

I think I have seen where we need to be though in a visit to Odensee, Denmark, last fall. They make us all look like pipers. They have a system that is highly integrated both in their materials system, their planning system, and that integration is real tight, real impressive. From their design database they are getting work package budgets automatically. Certainly a high degree ofintegration with production control, automated process control data, robotics all over the place. That is the model. I think it would be a good model for the U.S. It would take time to convert to that model from where we are. Time of people to sit down and think through the process. Obviously if you can buy direct from suppliers you are stilI going to have to do something in training. We can succeed IF we can solve the money problem.

Lets back up for a second. First of all, you have to have an understanding on the management team that you have a problem that needs solving. It is not obvious. I don't think to a lot of those guys that there is a problem. They know there is a problem, but they don't know there is a potential solution. The problem is that the process of shipbuilding has a lot of problems associated with it. But that is like the sun comes up in the morning, but what all of them don't have an appreciation for is that somebody has solved a lot of those and it looks like an integrated computer system. We spend a lot of time searching out solutions to problems that we deal with based on the old paradigm, the traditional paradigm. I have this organization that does this function and I have this organization over here that does this function and this guy needs to beat this guy. He needs to do it on time, he needs to do it accurately. It would be nice if there weren't political confrontation between them. So I am going to get a facilitator in and do some team building between these two. Maybe you don't need to do that. Maybe you could eliminate one of those processes through the application of automation. The reason the idea didn't sell very well is that it was like a 1970s idea. Automation was the thing in 1970 and was going to save us, turn over jigs and automatic panel lines and what have you and everybody said in 1980, that isn't going to work. But, you have to be willing to go back and look at that subject again and that is why I said I think alot of guys who are in executive positions may not realize there is actually an answer out there and it looks like an integrated computer system. Getting them to the point that they realize that is a potential is the first thing. Then you have a lot of work to do to get them to spend some money. Maybe there is something the government can do there in terms of accelerated appreciation or seed money or something like that. Having conveyed that thought, convinced them they have

to do that, then you are just really starting. You have a lot of training indoctrination to do to talk to all the affected functionaries in that organization to paint a picture for what this new process will look like. Actually have them paint it. Again, just like a guy sitting in front of the 3-D CAD system and say oh, yeah I see what you are talking about. We can do this and this and this and it starts to flow. They need to go through that process, they need to internalize that. They need to translate that into direction to their organization. There needs to be a lot of how you use the system kind of training, low level.

One of the ways you can think about an integrated computer system like we are talking about, define the definition system as a revolution for a company is that it rolls in from X,Y,Z company in Japan, Korea, Denmark, Germany or where ever and its architecture, its function, set offunctions is based on a system, based on their system. Their system grew up in the fashion you were discussing a few minutes ago in the absence of the computer system and it was highly efficient at that, but here is a computer system which reflects, which mirrors that system they use, so if one were to acquire or implement that system in a completely foreign setting, completely different setting, National Steel and Shipbuilding where every it is, something interesting happens. That is, everybody is walking around kind of adapting to this other model. It is like it is a little bit of a clone operation actually. Use this thing as the flagpole everybody walks around and in some cases it is pragmatic to do that because you don't want to spend a huge amount of money customizing that to do every little sketch and report that you used to be looking at. In some sense it is a whole lot more practical to say, well this thing does this, lets take it on face value, lets do it. So it is a Trojan horse kind of thing. The advantage of buying an Odensee system is this: The computer system is already dependent on a process and if you get the computer system it will force you into the same process. It sounds unconventional. Look, we have to get along way in a very, very short amount of time and it is a tactic that you can use to do that. Maybe the government can become involved in fostering that adaptation of something like that so that they can turn this thing around in a short amount of time. At the very least they have to be receptive to wanting to do that. It is important their wanting to do that.

17 Put all that is known about a ship in an integrated model

Paul Friedman:

My thinking there is that, particularly from a technical perspective as opposed to a business or financial perspective and also something of a historical perspective, that we want to initiate what I'll call a product model. What we are thinking these days is the product model essentially, the CAD graphics that carries at a minimum the function in geometry of the design, linking that to the intelligence that describes the ship as a product and we want to do that down to the either the object level or the raw material level. And what that all amounts to is being able to link the planning systems, define how and in what sequence you are going to build it, when, who. To the material systems, define what we are going to purchase. To the design, essentially the CAD system. To

the engineering system, to the logistics system for product support in the long run pricing. That's where, personally I get a little hazy. I can extend the analogy, I am convinced of the ones I mentioned as the right way to go, and I can extend it to say that it probably makes sense to do the others to, but that is where in my job I am going to have to take a long time sitting down with the users of those systems and telI them this is why I supposeitis good for you, you tell me whether it is or not. I won't be suprised if they say yes. However, I don't know that.

The historical perspective I mentioned is vitally important for us in a product model to be able to recall relationships after they have been established. This is particularly true of Navy ships and probably of commercial as well. For example, in the original design of DDG51, it was vitally important that we use a resilient hanger on a particular pipe run for any number of possible reasons. Now, what we are finding today is, because of our peculiar drawing structure - beyond all that - it is extremely difficult, when we change (which we do constantly) to know that that resilient hanger is in the backup structure that supported that resilient hanger and in a number of other things are all functionally significant. They are all there together for a valid reason. We have great difficulty today in recalling that reason or that there is any relationship, any fictional relationship at all. Today we tend to be production based and if the same trade installed that piece of pipe and that resilient hanger then we would be gold, no problem, because the planning system notes that and it is part of the work package and everybody is ok. If you move one, you have to move the other. But in fact they are two entirely different trades, items are installed at two entirely different times. We need to be able to carry that knowledge, that engineering knowledge with us. That is the historical function. They have to be able to talk function together. Specifically we are looking at relational data bases. Even though this is in essence an expanded engineering bill of material, a literal project that we are doing this under - an engineering bill of material project, we are consciously avoiding the standard bill of material processing system, because we want to be a lot more flexibility. We want a relational database to do this as there are so many different cuts at the data.

18 Make user interfaces more intuitive and simplify them for non-professionals

Marion Nichols

That really for me speaks to some of our own direct experiences. Our inclination is we want to have these wonderful systems that require interaction from the user base because you want things like your as-built condition and you want to understand that somebody makes a decision to make something differently, you want shop control systems to tell you where today you are at this hour. The issue with all of that, the risk with all of that is you can create a highly transaction dependent system. Now, whether you are moving into bar coding or other innovative ways, don't design it so you've got to have slap top computer on ever lap out in the shipyard. It's not going to make sense or be successful or cost effective even if in ten years it will be the size of a wristwatch.

The issues illbethe same in terms of the training environment concerns. Smaller and more convenient is still doing the transactions. So how do you get very creative about your feedback mechanisms. Do you really focus on exception type recording exception feedback that you assume the process is flowing smoothly except when somebody intervenes and gives us a new piece of information for the data base. That for me is what that's getting at. So think it all the way through. Think the vision right down to the person and what they are going to be doing.

19 Implement concurrent engineering in shipyards

Dan Billingsley

The CAD technology is one that really isn't an enabler of concepts like concurrent engineering, affordability through commonality, design for producibility - but all these things can really cook if the environment is there, that you are doing a design in 3D CAD product model. Of all the yards, it seems tome that Ingalls made the most progress in actually doing concurrent engineering. They have developed a view-only workstation allowing the production planner to come in and sit down with designers and engineers. They jointly work through the design and an assembly sequence in advance. The folks sitting at the tube have some real world conversations like, "I can't build that like that," "what do you expect me to do?" I think Jim Vander Schaaf mentioned, surely ten years ago, "Yes, the concept is to build it in the computer before you build it in real life."

Because of the relative labor and overhead rates involved with a couple of people working around the computer termina1 versus 10 or 12 people helping up on an assembly platten, problems are a lot cheaper to detect and resolve. Litton recently put out a paper on their SAR 5 experiences and one of the questions that I asked them in this paper, this was for the ASE symposium, what impact has this made on changes, etc. They gave me soft answers on the paper, but the soft answers were extremely favorable. They really cut down on changes and rework. They also had a lot of absolute definitions about the equipment they were observing. They also told me on the side that it took them longer to do design than they expected, but they do feel that they are really reaping the results even on the lead ship to savings.

Jim Wilkins

When people say that concurrent engineering is something the shipyards need to start doing, I take a lot of exception to that because we did that at Avondale and we did it manually as it didn't have to be computerized. The approach does not require computers aids. Like all of production engineering doesn't require computers, it helps. They make it simpler, but I have always taken exception to some of the presentations that almost made it sound that if you didn't have magnificent computer capability you couldn't do these things. That is the wrong mentality, but it does make it easier to see what you have. Our engineering guys were in meetings with the production people and would plan on how the ship was going to be put to gether with module breakups and the whole arrangement before the design was being done so that the designers did do it,

they had all that knowledge of how the ship was going to be built and when they developed a drawing they would have the production people in and sit down with them and went over all their drawings. Tome that may not be the classical definition of concurrent engineering, but that is what it was. Functional. Engineers knew how the ship was going to be built and when they put out a drawing the production people critiqued it before they got the drawing to build. This was ten years ago. Nothing new. The current tools are making it easier, nobody has any excuses anymore.

Joe Wudyka:

Digital has been doing concurrent engineering for many years. Before it had the name of concurrent engineering. In fact, we have done CALS for many years before it had a name either. I was interested in the subject because through the NSRP we put a proposal together, with the help of Barry Schram who runs a small consulting firm and Tom Lamb from Textron Marine, to actually implement concurrent engineering in one of the shipyards. Not to study it, we don't do studies, we implement. I would like to participate in whatever this organization does in that area.

But concurrent engineering is a subject in our company that actually goes beyond concurrent engineering. We are doing concurrency in as many things as we can. We overlap operations. Concurrent engineering, I think I can accurately say, originally was the engineering organization learning how to work in parallel with the manufacturing organizations, so instead of doing things serially, they did things in parallel in the spirit of cooperation. Our products have such very short product life cycles that we can't afford to miss a beat and everything, as much as possible, has to be done at the same time. It is more than concurrent engineering, it is concurrency. There are similarities to continuous flow, but I think to make it simple I would have to say that is different.

20 Integrate business operations with ship data models, e.g. planning and cost

Dan Billingsley

I talked about integrating the business environment with the data that is required for the ship. My philosophy here is that it is all one string. That the requirements on one side being primarily from a performance and cost side work on "whatisit we are going to build." The same requirements on a cost and schedule side, "how are we going to build it." I believe that these are intertwined cycles and that the requirements drive both what you are going to do and how you are going to do itbyrecognizing that. By recognizing concurrent engineering, your information string, which is yet on a planning side we haven't done from an information modeling point of view, although there are certainly considerable databases in existence for the production planning stuff. I think that is how those things need to come together, with an information engineering flow. A diagram is shown in the SNAME/ASE paper *opus citera. Since* this is a great problem, somebody ought to work on it.

Jim Hutto:

This is an area that I think we have omitted in a lot of our standards

discussions. So much of our standards, integration studies, have been driven this far by the design organizations and the manufacturing organizations. Logistics has been involved in how they are going to support the thing at the end, but thus far we have given very little attention to looking upstream and to getting first the competing, the strategic planning, the business planning in this modeling and that is where we have identified that some of our foreign competition is doing a better job because they have built their system so that they can come in and do what-if studies early on.

They are capturing what is the implied cost and what has been called implied planning and what is their manufacturing limitations. So is it the business case or do they need to decompose it to a different solution. Here we get into the up front planning that tends to use historical data for comparison, but then as that planning shakes out to bid strategies, business commitments, now that becomes part of your information system and can drive the rest of your design project, because in the end you have access to why did you decide to do this, what were the trade offs that were considered up front. Certainly my company is one supplier to do that. It makes us aware that there has been very little focus on that.

We don't see that being done in the shipyards necessarily in the same way my business entity has attempted to address its market. And again, we recognize it as a process that each business is going through and you choose to go after in your contract, your construction. So the thing we are identifying here is that we need to focus earlier in the process, not just focus starting when the design engineer gets started. We need to look forward of that and think of it as a total business operation, not just a design operation. You have to do that differently if you are waiting for someone else to impose their requirements upon you as if you are deciding what the requirements ought to be. The supplier never really decides what the requirements should be. A supplier is always going to look at the market and what has been and extrapolate how do I decompose those requirements into management units and then build a solution or a business. They can solve that. Whether we talk about the Europeans or the middle East or the U.S., we still look at what can we accomplish, and it is just when we look at commercial operations we realize that we always have to give the customer some flexibility in putting his unit together.

When we go purchase a car we have a list of options and the car manufacturer in the commercial area says no these are your option sheets to choose from, but sure we have a division in all the major automobile manufacturers if you want to customize a race car, yeah-we can go do custom things, may cost you a million and a half for wheels, but it is a different division, different setup. You have to understand who your user is or your customer is. To turn out a standard model with options or whether you are doing a completely custom job is an entirely different business world.

Douglas Martin:

We talked about the idea of the system used in design containing for example work content parameters associated with each of the types of thing that that the system can't represent. Pumps, pipe, whatever. So it goes back to those

process factors that have to be incorporated into a database, and then you know that you have X-number of feet of some kind of pipe and that will automatically give *you an* estimate for some unit of work for fab or installation. Cost is sort of like a whole new area. One of the things that is an impediment in getting back onto the integration idea to making improvements is that you don't know what the costs are so you can't prove to anybody that you are going to reduce them. You can't convince them to develop a perception on their part that their costs will go down because there is nothing to grab onto. Other than going out and doing i.e. time studies. That really lets you convince this guy that lets you spend money The current cost collection system is not defined enough to identity that.

I think it is a basic problem in the industry and I think some of it is deliberate. A deliberately created system, be*cause they* don't want other people to know all of the details and yet what it does is mask from the companies the tiormation they need to know. I guess having worked in a shipyard for 11 years I don't see it as really a premeditated thing. I see it as a more everyday sort of problem that to really overhaul your cost collection machinery and systems so that you can know the things to make judgments about how to improve, it is very disruptive. It costs a lot of money. You have to retrain everybody in the yard basically n different cost collecting systems and how to use them.

Whether we are talking the facts each foreman has to go over and visit with the time clock 20 more times ***a*** day than he used to have to do it .. in ways that are not going to be so intrusive. It is just a daunting thing for management to think about. Completely overhauling cost collection, because again it is a matter of what you are talking about telling me to spend a million dollars in system costs and a million in retraining costs to do this thing. What am I going to see from that. You can't express that. It is not a black and white thing. You spend A and you get B. It just doesn't work that way. Even with your verification tests, you never do it both ways, so *you* don't really have both ways to compare. The whole cost avoidance area is so hard to document. It is tough and unfortunately that is where a lot of the potential is. In order to prove the potential savings or in order to get management to adopt some of these new ideas there have to be savings in it. There has to be a cost benefit and proving that cost benefit is a difficult thing to do and one of the reasons it is difficult is that our current cost collection systems are not collecting data at the level that we need to have them collect in order to understand where the cost savings are going to be. That is very important. People don't like to get into cost systems. As soon as you talk about cost collection systems in shipyards all flags go up and all the resistance comes up.

21 Getcomputer tools into the hands of yard personnel

Joe Wudyka:

This initiative was natural for me to sign up for as we are a computer company and talking to get computer tools into the hands of those people, we have products very well suited for that. Input devices, data entry devices that can be used in very harsh environments such as with sanding grit in the***air,*** dust

and fumes, caustic chemicals-you name it, Radio frequency, devices that communicate through the airways back to the computer. It is all there and available, the interfaces for people to use. It's very easy and no problem. The thing that has amazed me in some of the shipyards I have been in, is when you step outside of the administrative buildings, the engineering environment, it is rare that you will see a computer of any kind. I don't understand it and how they can be efficient if they don't have people out on the waterfront who have some kind of rapid means of accessing data, rapid means of transmitting new data, of communicating. It just boggles my mind. In our company we have a ratio of people to input devices - if you are a digital employee, how many terminals, pcs, what not - something like 1.6 devices per employee. So no matter where you go you see all these devices, that I like to over simplify and call communication devices because the tape recorder is one. Getting back to the concept of competition, if you want to be competitive you want to be able to communicate very fast, quickly, accurately with practical devices available today.

22 Implement distributed databases

Carl Bryant:

Having listened tome so far you probably have a pretty good idea where I'm coming, from on this. But first of all, what it means to me is that you don't necessarily want to have all of the data required for the project in one spot or if you do, it's only because you pulled it out of a variety of other places and assembled it here in this one spot for this one task. So that you could perhaps share the design with several shipyards or some combination; the means to do that would be the discipline to maintain multiple databases or pieces of common database at different places. There is software out there which would allow you to do that. Again, what you are aiming to do there is to get access to information that has already been developed and not having to develop it again. And also to share a finite pool of labor in this industry and perform this task rather than every time somebody wins a job that's probably the only job around rather than having them all suddenly having to pack up and go somewhere either in or out of the industry so we don't have to go from here and lay them off or all the other disruptions and inefficiencies. And we would come out with a larger subcontractor. With this piece here and this piece there and be assured that when this comes back together whether it's simply software entities or list or fabrication of some sort that they'll all fit.

The idea to implement distributed databases almost really accepted today. For a while people said everybody's got to use one database and the answer is no, I don't think that that's a reasonable approach anymore, the investment in anyone's database is too valuable. The thought that anyone could build a database and manage it and it was powerful enough to do even two or three people's jobs doesn't make sense. The technology today for linking databases is there, in 1987 I don't think it was there.

Dan Cada

In the arena of configuration management of the data there are difficulties. A long time ago the guys who were doing the early thinking on the

SEAWOLF program and I discussed this at length, we spent a day on it, they apparently have solved it. I think Newport News knows the answer. If their answer will work everywhere...I don't know that, but at least one person has solved it and I asked them that question when I visited there recently and it was no problem; somehow somebody in there figured that out and made it work, but it's definitely a factor, the configuration of digital data is a serious matter, and when you're distributed even when all of them are wearing the same badge like Newport News' badge it's still serious. When they're different color badges or different industries it's especially serious but I think it can be solved.

23 Integrate proposal estimates, detail definitions, work accomplishment, and contract reporting

Douglas Martin:

What Dick Moore was talking about here is separate databases and in many cases there are separate bases for coming up with the dollar. Estimating looks at it one way and they may use in many cases the same productivity rate that detailed budgeting later on is using. Not always because we are dealing with bigger aggregates a lot of times and you have as a result one set of data through one mechanism and you go down to the next level of detail. Actually that is also an area where I think Jonathan Corp. is making a lot of strides. They are working in this area and different than most others partly because they are a primarily a repair yard than a construction yard and the turnaround is not a 5-year shipbuilding or how ever they are doing it. The reason for those things being separate is that they are separate computer programs in the main. There is a little bit of difference because when we talk about estimating cost engineering those guys have always looked across a little bit differently, and they have been struggling trying to make the conversion to a product base costing rather than cost number type base.

OBJECTIVE III PRODUCT MODEL EXCHANGE

24 Set up a data exchange project for the shipbuilding supplier industry

Jim VanderSchaaf:

The basic idea here is to develop the means to exchange information electronically with the supplier industry. The information to be exchanged could include purchase orders, shipping information, equipment configurations, speciallabeling requirements, catalog information, physical characteristics, and, data required to create three-dimensional (3-D) representations of the components for use in a CAD/CAM system.

Standards are available for EDI (Electronic Data Interchange) for such areas as the transfer of purchase order type information in other industries. These standards could be applied in a pilot project with the Navy, shipbuilders, and several shipbuilding vendors. The intent of the pilot project would be to install software, test, and proceduralize the exchange of such information. Similarly, IGES application protocols or variants could be used to exchange 3-D graphical information on a pilot basis. While the IGES data could not be used directly to create most CAD part librar-

ies, having the dimensional representation for physical design verification would be very desirable.

25 Make sure standards drive the architecture not the current Window technology

Carl Bryant:

It gets back to the whole notion of having a set of fairly low level standards but have a set of standards so you can migrate from system to system and operate different systems so you can have a common industy pool of software that is not restricted to any person's platform. This goes back to my comments on CAD 2 procurement.

Mike Connery:

I firmly believe in this and the perfect example is happening with us with the US Navy right now and the wonderful world of documentation. The Navy has generated Military Standards and in the area of documentation, namely SGML, are the two standards to transition data. The Navy has a hard time with their own standards, and the example has to do with customer having Norfolk VA write into the contract that I deliver them documentation in a vendod's format. I just went ballistic when I heard this. I said, ok - for 1- I don't have that product and it is going to cost you a contract to get it to me, and 2- if that is the game you want to play, let's do away with mil standards, and 3- I don't think the federal government will like you endorsing a commercial vendor. That is a captured market. That is the attitude. They got a good buy on x-amount of computer equipment and workstations and tried to force the industry to fit that mold. We can never let that happen, because you will never see platforms into it.

The risk they run is that in five years when the new GSA contract comes up they have got it and they have lost a lot. Standards are there for a reason. Standards are to keep you architecturally independent and there are basic standards today. I can call them down. Tome in data transfer there is SGML. Standard graphic mark up language for text and there is IGES for graphics. There are many flavors in each of those. If one thinks they are going to buy an off the shelf product that will give them an exact presentation of IGES of SGML, one is crazy. You will invest in what we call filters or twitters between us. The point I want to bring up here is BIW or any other company should take a close look at their customer base right now in the Navy. I know for a fact that we have built these filters for the Navy time and time again. They are GFI, government furnished information. Get with your customer, tell them to take an inventory of what GFI is out there in these other contracts, and you would be surprised at how much free software will be coming your way. I have satin on too many DOD CALS committees where you want to say, "physician heal thy self and then come and talk tome about your issues." There is a big diversity.

26 Develop good interchange standards

Jim VanderSchaaf:

Presumably what was intended here was "Quickly" develop "and use" good "data" interchange standards.

Viewed from the perspective of time, development and implementation of the PDES (Product Definition Exchange using STEP) standard has taken far too long, and the end is not in sight. Regardless of the acknowledged complexity in developing such a standard, policy could have been set to create interim standard(s). In addition, it must be understood that the development of standards only addresses a portion of the problem. Beyond vendor implementation (software development and testing), there are several complex implementation issues regarding application, transfer procedures, data sources, configuration control, data accuracy, and other policy issues to be addressed prior to full usage of these standards. As an alternative approach, on the DDG 51 Program, an intetrim capability was defined, software was developed and tested, all the implementation issues were addressed and actual transfers are being accomplished today for major portions of the ship. This was accomplished in far less time. Complexity is one dimension of the problem associated with standards development and implementation. There must be perceived benefit and/or incentives for the use of standards. Beyond executing flawlessly, accessing data at the source of its generation, and, the related issue of configuration control of the data must be addressed to support achieving the promised benefits.

27 Fund prototype development of applications running on the NIDDESC information model

Douglas Martin:

The result of NIDDESC work is not just a specification for exchange of data. It is a specification for an integrated product definition database. This item talks about demonstrating that fact by wrapping some applications around the top of it with whatever system and showing the value of this integration. I want to spend a second and talk about the integration aspects that" we didn't talk about when we were talking about this seamless integration earlier. There is an integration between tools and data. Pipe stress analysis and the representation of the piping system, that is one kind of integration. Another kind of integration we are talking about is the stage integration where we are talking about a piping diagram and a detailed piping arrangement being based on the same definition of the piping system. Just different presentations of it.

Those are really the key and of course we have the interdisciplinary integration expressed by the fact that you can sit down and look at a pipe, piping arrangement within the context of a compartment within the context of a structural design. Documentation of the integrated database idea through putting applications on top of that NIDDESC database is what the initiative to fired prototype development of applications running on NIDDESC information models (#27) defies it. We need to make it happen?. Spend some money, give it to the guy who is probably the furthest along in terms of needing to do the least to document this thing, and I don't think we are talking about a huge effort here.

We are talking about something which is a demonstration offeasibility. A demonstration of concept kind of thing. You might want to do something like take a fresh water cooling system going to some electronic boxes, show that in a system diagram type representation, flip

to the 3-D arrangement type implementation, ask some questions about components in the system and make some modifications, show that the diagram and the 3-D arrangement standards, go through the process of defining the spools, fabrications, zone for that system. VIVID has not done the diagram part. That is new. The other thing that might be new would be demonstrating the ability to take off work content rather than just material from that product definition. Ingalls has done a little bit of that.

If we are talking about cutting sheet metal for example I think they have done some of that. They don't do things that are work content or more complex assembly kinds of things. That is a little bit tougher problem. And again, this is to demonstrate really two things. One to the guy who is unfamiliar with the potential for integrated system, just in general what it can do. Two is to demonstrate that the product the Navy has paid for, this NIDDESC distribution, can be the model for that database: Leverage. Finally and hopefully there needs to be some way to demonstrate the cost impact. That would make it worthwhile. We keep having this uphill battle.

Jon Matthews:

NIDDESC, I think everybody, certainly everybody who is going to hear this message, knows what NIDDESC is. I think that NIDDESC, which has been Carefullydeveloping specs and standards and a method. NIDDESC has now a very comprehensive specification and a pretty good handle on what a consortium of Navy and commercial shipbuilders and ship designers feel a product model is. This is not a Navy initiative, this is basically made up of shipbuilders big and small to prepare new construction that has been in place and working very well for the past five years. It's now time to separately fund, and this is going to have to be funded, a test case, a real test case that can be used.

SEALIFT might be an opportunity, but I don't think it's going to happen fast enough. You certainly could design a piece of a ship or maybe a whole ship using this approach, but I think that's going to be too expensive. I think **it** should be something that exists now and can be back loaded, because, for two reasons: one, it can be done quicker, and second, it will give a comparison, there'll be some opportunity to compare the value, the validity of the modeling vis a vis what was done historically, whether it was done on the computer or not is really not the issue. I don't think something like a destroyer is the right program, I think it should be a commercial ship, because it will simplify the model. See, the model is a very comprehensive model that picked up every attribute that you could dream of that was important in the process.

This model is held by the NIDDESC organization but NIDDESC is made up of six or seven major shipyards, major and minor shipyards involved, a couple of design agents, maybe new construction and repair, so it's really been a disseminated model. There's been some publications made to it,there's a data dictionary.

The master really resides with Billingslet's organization in the Navy. But we've got Ingalls and NASSCO and Bath and Newport News, Jonathan Corporation, and Electric Boat; so it's kind of structured toward the Navy mentality I suppose, but the model itself is very valuable in that it is forming the basis of contract design and detail design devel-

ent in the future.

To be practical about it the Navy's going to have to fired it. I'm not sure whether we're talking a quarter of a million dollars or a million dollars butit's going to be in that order of magnitude. It probably should be funded through the NIDDESC organization in some way, shape or form; and it needs to deal with a commercial ship environment. The reason is that the contractual and business mechanism is already set up. It's a cost sharing program so we get more bang for our buck as an industry because the companies that are supporting NIDDESC are in fact putting money into it. This is not 100% government funded. All of the members of NIDDESC are contributing by virtue of cost sharing.

28 Implement the Product Data Exchange Standard (PDES)

Dan Billingsley:

When we worked through the IGES PDES organization with this NIDDESC effort, it became clear a couple of years ago that PDES was really slow coming along. We were using the PDES core entities, but the NIDDESC application protocols were actually driving. We were using PDES core entities, certain entities in PDES so well stabilized and so well mutually agreed by everyone that they are recognizedas core entities. These include things like a surface, a surface definition is something that everybody agrees exists, and they are actually very basic and fundamental geometric building blocks of a very limited extent.

After a number of iterations they decided they would go for an application protocol approach which would describe how each particular industry or discipline would work using these, and it happened that out of the first twelve of these that were set forward by the U.S. to the International Standards Organization (IS0), six of them were produced by NIDDESC. Of a world population of information modelers, the group that consisted of less than 3% of the population and who was working on a budget of perhaps $600,000 or $800,000 was outperforming all the rest put together, including folks like PDES, Inc. who was operating a $30,000,000/year budget and just knocking our socks off because they have real technical experts working cooperatively on this thing for a number of years with consistency and purpose. We are leading the charge in PDES' implementation and in many ways are going to get there before most of the participants of PDES can transfer their products. The trick is to be sure we don't get cast as being nonstandard because we are doing everything PDES will allow you to do and doing all the other things you have to do in order to transfer information. So in a sense implementing PDES as an objective or as an element of an objective.

Essentially I don't believe anything needs to be done. I think we are well on track between the NIDDESC efforts and the different translator efforts that will come out of the different programs that will be coming along in the next several years. In terms of feasibility grading used for the group as a whole, that particular item has to be up there as a 9 or 10: however, there was a discussion of that when we got to that point in the grade cycle and I first graded it fairly high and some status said it is on its way, but hasn't proved itself, that was about a 7. We backed down from that basically to the point of view that while NIDDESC has this area pretty well

locked up, definition area, and has worked some into the requirements, a little bit into the analysis results and fairly substantially into the product structure configuration management.

It hasn't touched these other areas and it hasn't touched the planning, the how-to area at all. Whereas it is fairly strong in definition at maybe a 7 level, it is back down to perhaps a 3 and I think we netted out at about a 5. It has set a pattern of development and a pattern of advancement that one of the things we definitely should follow through is made in the marine industry and expanding that work with that organizational foundation and skill base that those guys have built up to continue until we get a complete conceptual scheme for all ship information. We have already seen cases where that shared conceptional scheme has been applied by shipyards in reconciling how they do their internal information bases as being used by NAVSEA to figure out how we are going to transfer model information to the builders. At the same time we are worrying about how we are going to transfer the model information up to analysis programs. It is a continual building process and the NIAM technique and the information models that come out of the NIAM technique really allow ratchet actions.

Guys can work on it, capture their value added, lay it down, others can come along and pick it up who have little of the specialized knowledge that those people have to get a complete comprehension to a 90-95% level of all the constraints and all the things they knew they invested in that model with somebody who never had physical contact with them, pick that up and read it right in the model. It is an incredible tool for communication and documentation. It allows you to work on some piece of the problem without losing the overall context. Everybody in the marine industry is using the NIAM technique. In the broader U.S. and International scene people are using either NIAM or a technique called IDEF IX, which is also an information modeling approach. Of the two, NIAM is stronger but a know ledge able person can translate between them. Another aspect is that you can read NIAM diagrams with very little training. It takes really more to write good NIAM. Just like anyone can listen to music and appreciate it. Almost any manager, engineer, infoormation person can read NIAM very quickly.

Mike Connery:

Any time someone says to me to implement PDES my obvious question is, why? Why do I want to do that? And I guess I tried to bring up this point in a meeting yesterday and in understanding your industry, there are certain things that are competitive advantages tome as a corporation. Although PDES is intuitively correct, you would like to set a set of standards across the industry, you would like to share a product model, you would like to share design libraries and the more realistic thing is it is for the benefit of the whole industry. Where PDES will fall apart, and this is only my belief not the corporation's belief. I believe via PDES we have had the opportunity to sink hundreds of thousands of dollars into a mutual admiration society. They mean well. Their hearts are in the right place, but they are up against the fact that no one committee of eight or nine people are speaking for companies. PDES' bigthing was its visibility of PDES. Everybody asked, what is this thing. It was an educational tool. If PDES served

that, as an educational tool, then fine. What I believe PDES should be is a clearinghouse for standards, that is what it should really do. So much for PDES.

OBJECTIVE IV PRODUCT/PROCESS MODEL

29 Establish a shipbuilding data dictionary

Dan Billingsley:

The data dictionary ends up being a flat 2 dimensional subset of the information model. It is the definition for each of the information items. Whereas the information model tells you what their relationships are and what the cross constraints between relationships are. It's almost a passe' term. When you have several databases, keeping a data dictionary helps you out. When you get into very complex databases of network relationships, it is no more helpful for understanding than a regular dictionary is for a book if you had to look up every word. Something other than a data dictionary ought to be developed it is an automatic fallout subset of an information model. If you are doing your information model, which you have to do, you defacto have the data dictionary.

Jim Hutto:

This is one I think the Navy has really taken the lead on, especially with the NIDDESC community. I think they have done some really fantastic ground work there with the support and involvement of all the commercial ship community. I think they are on the right path to building the data dictionary. The concerns there is to make sure that that continues as its focus and gets both the pat on the back and the reinforcement when you are finished. (We need to keep going and we need to keep supporting that effort.) That data dictionary, that effort has been ongoing, has been feeding into the marine industry's experience, into the global standards community so again, excluding very specific processes we find that physical engineering sciences are very common whether ships, cars, planes, electric motors, whatever. You end up talking about things (That is one of the neat things about ships.

Ships are really a mobile city. So everything you have in a city also goes into a ship. The environment is a little worse than almost anywhere else so if you can put a motor into a ship, you can use it for a city or whatever. Plus, it introduces the mechanical design and manufacturing processes which you don't get into when you look at a city as such. It brings a lot of sciences together in one place. The standard will be to have information definitions and relations of information very common across all the industries so we can make use of different suppliers. As we get this ship data dictionary richer, we will have a better opportunity to go to some of the component suppliers, like pumps, motors and that kind of stuff. This means providing electronic descriptions because they are used across lots of industries, not just because the Navy wants it that way. So we are back into a cost basis.

30 Develop an information technology plan featuring data and fumction integration

Jim VanderSchaaf:

Efforts in this area are probably

best accomplished within each organization. In order to accomplish data and function integration, process analysis and improvement must take a dominant role. Once processes and well defined,in-place and being used effectively, then the discipline of information engineering can be used to effectively integrate software applications with data across functions.

31 Specification for information independence

Jim VanderSchaaf:

Presumably this refers to interoperabibiity of software on multiple hardware platforms, and, accessibility of data across hardware platforms. There are a host of issues involved with achieving "information independence" in even a moderately complex corporate computer system environment. This is no reason to not proceed, and, the place to start is by specifying the overall systems architecture and setting policy for achievement of the target architecture.

32 Pin down shared conceptual schema for ship data modelling

Dan Billingsley:

The shared conceptual schema for ships information and the sort of things we have been talking about in connection with data transfer end up being the specification for integration/independence. It really relieves you in large measures of worrying about what system the guy used to develop the information, what procedures he used to develop the information and even who developed the information because when the information comes to you in a known format, a known content, a known relationship between elements, to a large extent that is all you need to how.

NIDDESC is doing this. This conceptual schema of this is the context standard for the information and we talked before about what areas it covers and what it doesn't. There is a trade off here. When you are working on relatively long term occasional data transfer like relationships such as between NAVSEA and the shipbuilder, you can say, "we are going to transfer information via standards" and that basically frees up each organization to make their own business decision on what systems they are going to use. On the other hand with this local support contractors or information exchanges are frequent. Smaller, but much more frequently.

We can't afford the inefficiency dealing through a neutral binary interface it necessarily requires. There, by in large, we are encouraging, in some cases requiring them, to equip themselves with the same mark and model consistent with what we do so that they become part of our team and can deal in the same information and development cycles we do. We are, I hate to say ambivalent or two-faced about it, but you have to consider how tight your working relationship is with an organization as to whether in fact you need the equivalent or you can afford to transfer through standards with the greater national policy and business goals that satisfies.

33 Document the information required to manage

Carl Bryant:

That is how the job is done and what it takes to make the job happen.

Documentation being done to get that task underway should be a collaborative effort between people on the waterfront and people in design to give full understanding of what the leading man needs to keep his crew going along all the way up to the program manager or the person who is talking to a board of directors. Here is not only the feedback of where of where we are but also the projections of where we are going. Generic documentation or very specific documentation by contract and work station and the company may be needed. I think it will be a little different from yard to yard, given personalities of different shipyards. And I think to try to force that at least at the outset to force that through common format or common approach will create all sorts of resistance. Their physical plants are different their climates are different which will make the work to be done a little bit different.

Dan Thompson:

I can tell you a story on that. I had some IHI people people at Bath Iron Works share with the structural world their documentation on managing their processes in a structural fabrication area and assembly. And it was amazing how intricate a process it is; but we did succeed in getting it all documented. To an extraordinarily large extent that was a waste of time; not all because certainly people were empowered by it and some various things were changed. But the documentation effort was quite high. Very intense. But the payoff that we got immediately was very low. Other than the people investment, other than the people collaborating. Then it came along as something which could be used later. Now, I don't know where that is today, but it could be, you know, gold today. So I guess my other question here is what is the payoff of such documentation?

Carl Bryant:

I think what you would probably find is that there is a need for some amount of information flowing down the lines. I don't know to what extent people are really acquainted to where things stand in the schema of things. It gets back to the notion of empowerment. If you don't know the relevance of what it is you are doing you probably aren't going to put your best efforts into it. The other thing which would probably come out of that is you will find a lot of information out there that is not required that is being produced for whatever reason or what you will find, you and I 20 years ago when we sat on tasks like this to get rid of X number of reports there *always* was somebody who used apiece of that report therefore you couldn't get rid of it. In this day and age you shoudn't have to be worrying about printing reports. If there is data available then down there in the shop office or where ever it might be, he should be able to tailor his report to come up with that data whatever way he wants to off of a data base in realtime. This has happened in other areas. I like to show the example of the blade pitch actuator shop at Bird-Johnson: you knew everyday where you were.. where things were in production, it was all right there. It was a garden variety off the shelf fairly well used around the country. Nothing fancy. Bird-Johnson used the same system for government and commercial customers. The toughest part of it, and there were enough options within the system to meet the requirement of keeping track of government owned invento-

ries. This is the item and go to the specific item you bought. This is where the government owns it and this is the one you paid for. That is where the government had some trouble with some of the MRP systems. I know people at Boeing have systems that comply with that. But that is just a small part of it. You could go in as soon as labor was reported which was daily, credit card types of things, and it was done at shop level, as soon as that went in you could say where am I in any job. You worked with standards so you knew the standards and it did you did work with standards so you knew the standard in the sense the standard time to do a job. Because we were working with fairly explicit route sheets you knew what operation you were on. You knew where you were. This was monitored daily certainly in the shop when we took it over. We were well over one month behind on all of our shipments. So we had vendors or customers screaming, "where is my widget?"

OBJECTIVEV CALS IMPLIEMENTATION

34 Replace drawing with product modeling

Dan Billingsley:

As we discussed in the paper, we are about to replace the drawing with the product model and we will do that for new ships. There will come some time when it is quite clear that drawing in the traditional format as the conveyor of graphical and nongraphical technical information of these different categories, that that drawing impasse'. Probably for some time we will be using drawings as basically hard copy, as snapshots of product model information and of tailored product model information showing perhaps assembly sequences. But increasingly those will be used the way we do, say, printouts from wordprocessors. You get the information, you use and toss it away and don't worry about saving the original so much. Rather than being the media by which we convey design information. I personally get uptight with people who talk about nonpaper wills as I think paper is a very inexpensive way to handle and use this information which we generate, but it isn't the best way to keep it for awhile. We are a long way away form having people with computers in their hands to do work on the waterfront, so therefore we have to use paper.

What we have to watch for, and I think that is in a number of these other ones we are not talking about right now, is to watch for the inertia of the fact that we have always required that form and format, driving us into making that form and format just to satisfy the action. The Air Force and Northrop were doing (maybe not Northrop, but some aerospace company) slot of process modeling and it is very interesting because they discovered that there were some dead ends in the information flows, certain forms and reports even, substantial size reports that were produced that they could not identify who was consuming and they would have taken immediate action just not to produce those reports anymore. There is considerable potential for wrinkles. Too much paper is not needed in is discarded.

We did this with weight reports coming from Ingalls back on the DDG contract design in 1984. We started

getting weight reports on tape and could go through those with a lot more facility then with a hard copy of weight reports. There is lots of opportunity there.

Paul Friedman:

We won't be replacing drawings with product models but what it does for us is redefine what the significance of a drawing is. I think we would still have drawings. That just may be because my personal vision is still somewhat more limited than some of the others. I heard people talking about hand held computers and things like that, and I can see that is a possibility. As far as I can really see the yard going, I think that we will have a system that will allow us to plot out a drawing in the shop so that a mechanic can grab it and go on the ship, roll it up and put it in his pocket. The significance for me of a product model in relationship to drawings is not so much replacing it, but redefining it. It is surprising how much difficulty I had in getting the notion across and we are starting to have some success now.

What the difference of having a product model today and what we had before was that the drawings were the documentation of the design and in the selective minds of the engineering department is this notion, this design of the ship - because there was no other useful media we have - confused the document with the idea. What CAD, a product model, gives us the opportunity to do now is to have a vehicle to define, explore, and change the design, to define the design without having to worry about how we are going to deliver that information to everybody else. We now can split this, to not worry about the document. It is so ingrained in our way of doing things that even today, after years and years of working with CAD and having a fair amount of success with CAD, we still have managers and designers who don't understand how you can design without a drawing. The hard copy is God. Doing everything you did was to produce the drawing, that is how they see it, and it is easy to see why. That is not the case anymore and now the point is that you design in the computer and then take the appropriate slice of that information and at the appropriate time, deliver that document or working structure, material list, to the people who need it - better yet, when you are fully networking and much of the work force is trained, allow them the ability to pull it when they need it. I have been struck by how difficult it is to get the notion across that there is a difference between design and drawing. We are getting there.

Jim Hutto:

That is occurring in a lot of places right ***now. As we*** saw in the last few days, it is not industry wide and certainly we don't have the data dictionaries and all the exchange tools to where we can bring all the information from every contributor for the entire vessel into one system and totally do away with drawings. We are seeing individual shipyards who are seeing in the computer industry the technologies and tools are available to deal with what we call the virtual ship and the ship that is electronically defined in the computer system and then depending on information that the user needs we'll be able to pose that question and have the information displayed or output on any kind of display mechanism whether it's a paper drawing or a video screen.

The tools are in place now, the technology is in place, to do walk throughs; animation, if I want to do a walk through part of the ship and then look around, that type of technology is here today. We get back to the cost .... each business unit has to assess the cost and benefits to them of going and purchasing and installing the technology. It depends on who is your customer, what problems you're trying to save, what your mechanism is, because realistically in business we do encounter some situations that the customer does not pay us to be efficient. We constantly have to look at what their coordinates are and what's being asked of us. The technology is here, it is continuing to improve, implementing the technology into a production system is expensive both in buying the computer horsepower, the specialized software that's going to drive it as well as reorienting the culture of the people. There is a big difference in looking at the computer screen versus plottingit out on a drawing and putting it up on the wall and sighting the lines to see if they're reasonable.

Just being feasible to do it doesn't make it desirable to do it. We alluded to training. It may not be cost effective for people or when you get into the areas of training and retraining costs you get a different assessment. I don't know if you then want to install a number of systems. The data has to be available, the information has to be available. Next you choose where you want to use it.

Jon Matthews:

I think that if we're serious about automating the processes and getting the gains we believe we can get out of automation we've got to get away from the drawing environment. I think we need to have a test case.

35 Provide customers with on-line access to product data

Carl Bryant:

The first one gets back to the discussion we were just having where you substitute the people in the shop office for people in the customer's office rather than going through all the gyrations that you go through to provide access to a data base. The best way to do it is use the same data base that the yard is using with password control to keep them out of places they don't want them into. All of the data that winds up in those reports comes out of a common set of data within the shipyard. And rather than spending all kinds of overhead preparing whatever, ask the question what other types of data you want access to and let them have it. The other thing called for at this point in time is some sense of responsibility on the part of customers to not drive the yard crazy by this data coming out of six different places. The first thing the implicit message in this is that there is nothing to hide. Second is that this is information required to manage issued from a different perspective. There is a need to know to assure you that we are doing what we said we were going to do.

Mike Connery:

I truly believe in this and working corporations will come back to you and say, I don't want to show them all my data. There are competitive things in there they don't need to see, proprietary things and that is the right statement to make. I pose to you, especially in the

military world, the statement and the statement can only be from the government, is show me electronically what you would give me anyway. That is what they want to see. They don't want to get into your detailed financials or your master production schedules although they may think they want to. They wouldn't understand what is in there. I think the essence of this message is, especially in the way of CDRL's, and an example we are working on right now in the Sea Wolf program is negotiating with the Navy in dealing with SPCC, their supply and support center.

We generate paper, which are parts listings that we send to SPCC, which they enter into their computer and use to do provisioning. I pose to you that that is a bit ironic. What we are saying to them is that we can do a lot of good here. We will do away with these CDRL's and we will give you an account on our provisioning system and give you a view, an SPCC view into the database, which automatically tells the management and corporation is that all that they will see is what they would normally see anyway. I'm using relational technology again to create these views and it is working. We have done away with the CDRL's which mean I have done away with the writers of the CDRL's and the production people of the CDRL's and the time associated with the delivery of them and we transfer the data back and forth.

They are on line to the data. The thing that I have not come up with an answer to is what do they call up periodically? The thing is that they call the information up, we don't give them the raw data, data is dangerous to give to people because data can be interpreted in different ways and it may not be the way you wanted them to do. Actually having the customer linked into your systems tome is that they view data and they don't have an inter-active relationship with your data. They are just pockets of information that they view. They can down the line load that data to their processors to add value to it, and if need be return it back to you, but return it to you in a way that there is a buffer between you and your corporate databases. You can analyze what is coming back in or else you lose the integrity of the thing. Again it is not rocket science, it is just a logic of how you want to protect yourself in having it. I pose to you, only give them what they normally would get.

Provide customer with on-line access to product data. He is talking about product data and you are trying to look at information rather than all the data. And you have to define what information is going to be made available. I suggest the starting point to do that is the contractual deliverables you have already signed up for. Build the confidence with the customer to let them see that electronically and manipulate it. We are doing it with SPCC and we also do it with the LSAR, the logistic support analysis records, that one puts together. When you take a combat system the size of (Busy II?), you are talking about 2-4 million records of this data. The sheer bulk of paper going through is ridiculous. You can't do it. It can't be done. We do deliver them electronically, this data on tape right now. They want to get on line with us and it is just the communication thing we are trying to get together right now. The technology is there, the systems are there. It is a culture that has to grow. By the way, it is very tough to get traditional, for lack of better words, civil servants or bureaucrats away from their green eye shades and rolled up sleeves in

paper. That is their security blanket. That goes away and they feel a bit uncomfortable.

Paul Friedman:

That goes very closely with what I was just talking about. I tend to think in terms of the customer as being not just the shop's and some of the other people around me, but of course the Navy. We are attempting to do this. We are lucky that the PMS 400 is our customer. On the Aegis program there is, relatively speaking, a lot of money around and a great deal of interest by this part of the Navy in CALS and CAD and all that, so we are actively discussing how we can provide on-line access to our data, to the Navy, to our competitors, the Ingalls program; and all that is moving along pretty nicely.

There really are no fundamental disagreements about the notion There are plenty of standards to be worked out, although actually we are further ahead than industry-wide groups like NIDDESC for example and certainly PDES. By necessity we just went ahead of them. We just said we think we understand what it is your doing, now we are going to go do our version of it and those two groups I think I understand why that happened. We just couldn't wait. We are lucky in that regard. We are moving along pretty well there. The difficulty for us, interestingly, is bridging the new construction versus the life-cycle support world, both in the industry of the shipyard and more specifically in the Navy.

The life-cycle support people, they like everybody else salute CALS, probably because they have to, but they either don't have the willingness or they don't have the money, that's a possibility too, to really do anything about it at all. That's the real challenge for us, is trying to make sure these models have the life-cycle data that is needed and make sure the users of that information will in fact use it. There is reluctance on all sides to do that.

36 Require CDRL'S to be written to pass product model information

Dan Billingsley

That is something we are sort of working on, particularly with Jim Murphy-the guy in my group. But we do this pretty much ad hoc for each project. We don't haveas yet a stock set of CDRL's to require the delivery of information.

CALS implementation is requiring CDRLs to be written to pass product model information. A concern there is that CDRLs (as most recently brought to me as anissue byBIW)is that the CDRLs don't seem to be designed to pass information of value to customers. You look at the makeup of a CDRL, a particular one, it's a real strange mixture. It's apples and oranges and table manners, it's funny that anybody could possibly use this, and I think the conclusion is something we'll talk about in a minute, and that is that some CDRLs are designed to do nothing more that checkup on the preparer to see if they know what they're doing and that the ultimate user probably really sorts through that information, throws away the Q A features of it as it doesn't make sense to me, but I can get what I need out of this report, I only need half of what's there.

Aside from the issue of moving data digitally rather than on paper, which is by itself worth it in every way we can

imagine, we just need to say let the customer draw from the database what they need and find some other way to make it high quality other than distributing multiple copies of either paper or digital products to people who probably use it as a sampling technique at best for Q A. We need to get away from the thinking of what a CDRL is for and get down to find the guy who uses the data more than once, more that a Q A test and have them set what I need, and we could probably work toward direct access in the CITIS concepts that are now being more than explored in some cases, actually. We just need to re-think what a CDRL is good for.

Dan Cada:

My sense is that in certain cases we have attempted at a technical level to pass product model information which nobody asked for or nobody knew what to do with when they got it. We've got to find out what the customer wants and by the way, that might be somebody right across the hall, that might not just be SPCC or somebody like that. I've had a couple of short discussions just to get people thinking about when you've got a 3-D model that you use in new construction how much of that really needs to be passed on for lifetime support. Certainly not all of it. You're not going to rebuild the entire ship in any of its maintenance availabilities, so you don't need necessarily the complexity, but what is the subset, what aspects of it can you pull off a model and leave the others behind or do you just break the model when you do that, because you've lost your ability to re-configure the space, to identity the bills of material, those actions that you're contemplating.

So the answer might be it's not a part of a light bulb, you've got a whole lightbulb here, and what you do with the light bulb is your business but you can't just ask for the light part. You've got to get the envelope and the socket and everything else that's in it. That understanding of what the product model integrity is and what the customer wants from the model, each customer down the line, has to be established. You've got to go off and build that. I think it's going to be a data manager's job as well as a technician's job to do that. The person who does an LSAR probably isn't the only person we need in the room to have that discussion. We need somebody who understands how data is assembled.

We need a joint team to work on this as hard as we're working on standards. We need to look at our customer and what does he/she want. Until we know what the customer wants how can we write standards. Academically we can write standards about quality of data and formats and things like that, but we're back to the issue which says, until I know what I want to move how can I write a standard for it.

That takes us back to the product model. The 3-D model has to be moved in whole to a planning yard or an overhauling yard, so be it the CAD model enables us to do that today...I don't know, but if that's the answerit better be able to do it, or we better find out what else has to go with the CAD model to do that; or is a part of the model adequate.

37 Encourage vendors to supply product data with their products

Dan Billingsley:

That has been areal problem, long

lead times providing these contracts. The contract for DDG51, for example. The maximum extent we were willing to stretch in 1984 was to require that the builder give us selective record drawings back in IGES Version 2.0. By the time the builder was to the point of giving us selective record drawings, IGES itself was up to Version 5, and since then probably what we wanted back from them was slot of 3-D product information that at that time we got from them in DDGT (digital data transfer) format instead.

It is very difficult to look forward and see this predicament. There are some very powerful clauses that dictate the technical data clause that is invoked routinely on every contract. As the builder develops this information, the government has rights to it for cost of reproduction. In the worse case, the government can take it in the native format and at the government's expense, translate it into a neutral format. It is a problem of sequencing and timing.

As the NIDDESC standard becomes more stabilized and implemented, it will be relatively straight forward to have bids that say you have to give me information on the following data items, which will be identified as data items, and the format will be specified, etc. That is a problem that is working along, and I think at a roughly acceptable rate. It probably could use some more emphasis.

Other than theNavy few are making that happen. For product model stuff it is essentially the Navy. Essentially NAVSEA code 05 and code 507 act as a consultant to the SHAPMS of the ship design managers for digital traditional stuffthere area number offolks working all over - CALS related projects to require that sort of thing. Our policy is to depend on them to do it right. Drawings are drawings are drawings. Make fast drawings and we can read. We just have to get them on our screens. I encourage the vendor to supply product data with their products and increasingly we are going to be requiring the vendor, both component vendors and major combat system shipyard vendors to pass that stuff. That will be for Government Furnished Equipment.

Our whole future policy is that weapon systems will be managed from a product model basis beginning with the ones that are coming into the pipeline now and going on. We are at this stage still going on a program by program basis and for each we are going to have all our shipbuilders require this of their vendors. This is an excellent opportunity to standardize that. A logical ongoing project again of NIDDESC type efforts.

Carl Bryant:

That can generate a lot of energy in some places. I'm pretty sure it came frlm the logistics support people and it's a double edge sword. The customer particularly the Navy wants to have enough data with its purchased items so that it can support those items 30 years from now when the vendor may be out of business or no longer makes that model or whatever, which means in many cases getting right down to drawings and piece or part definition of something that is highly proprietary at least fromavendor's point of view critical: to their fiture. They don't want to have information going out once the government takes possession of something like that; and, if you don't put restrictions on it, the government is free to give that information

to anybody else in the world, really.

Vendors are not generally confident that if they have put proprietary restrictions on it it will be honored There is a matter of trust in all of this. I don't think there are any examples out there where that has been violated. But, on the other hand, what we'll find is the vendors will make sure that the proprietary legends are there and watch visually or prevent escape of the sensitive data. We're dealing in this case with perceptual reality. My advice on that is I think you have to develop trust; it can be worked on successfully, but I think this requires a lot more dialogue between the vendors and the government.

Maybe standardization of information or cleaner contract language and again just things that would generate trust. Even more of an issue is in the computer software business. It's invisible; an intellectual property as opposed to hardware or an engineering database. on the other hand is the half life of the computer software with less of a worry about the need 30 years from now. Keep your competitors away from it for two years, you're safe. Building a valve or a pump is not the same.

More importantly, I think that that demonstrates the vendors' commitment to work the way we say it has to happen; that is you've got to have your process described and your ability to produce the product model information. That's as important as producing the product. We all know that a piece of equipment going out without adequate data to go with it is really...it's a burden, it's almost worse than nothing at all.

Dan Cada

I am not aware of any steps being taken within the Navy community or the industry that you're aware of to require vendor data as suggested here. There are many many aspects to this and one is the contractual aspect, another is the state of technology, another is people's familiarity, there are a lot of hoops that need to be gotten through. That's probably going to be a big challenge. If you take a look at where most of us probably spend our time re-iterating things, the most is dealing with vendors, verifying and planning what that latest drawing revision really meant, where is the data. Why can't I find out what this guy is thinking, why is the redline mark the best I get out of some places, why do I deal with these people? All they do, contract after contract, is frustrate me, stymie my design process, and burden my managers who have to squeeze information out of them like toothpaste out of a tube. We ought to get a package; we ought to build a contract that requires that, and then we ought to help them go get good at it, so we don't leave them staggering from the blow out there that says I have to deliver my product model one year before I deliver my product, I don't even know what he's talking about.

We've got to start within the AEGIS program to improve the quality and timeliness of design. There's an effort ongoing. Perhaps a related effort could be established in this area. I don't know if the vendors are ready for it.

I suspect some of them are, or you may find that some percentage of them are ready and we've never asked them, or they didn't think we wanted them, and that's because we don't ask them. We tend to ask in more traditional ways, as in six months before you deliver the radar deliver the foundation for the design requirements or the electrical power, or

needs of this equipment, so we get a stack of 8-1./2" by 11" paper with handwritten figures in some of the blocks. We may not have encouraged them enough and in some cases they might be ready and all we have to do is ask the right question.

This is an area that's worthy of a project of some sort. Looking back on just one aspect ofthe program, not justin the acquisition of the equipment but in the configuration management activity that goes on with vendors, it's substantial, it probably comprises a third of the effortin Configuration Management, and it's the hardest and all that CM is reflecting is that oscillating and dithering as the design converges and how we're able to convey those changes in the form of ECPs.

When you have a diffused acquisition process or you have another code supplying the equipment to AEGIS or any other program you've got layer after layer of configuration control that it goes through, each one of them working with a unique process and a unique vendor approach. You end up being a master of many kinds of approaches to just change control and really successful at only a few of them at fairly high expense.

38 Provide contract awards only to reliable suppliers

Joe Wudyka:

That is one of my many,many "hot buttons." When we go off and deal with the government, try to sell to government, we go to government with products and organizations that are of the highest quality. We meet or exceed every quality. Now there is a new thing the Europeans have put together called **IS09000** which is a certification process for quality. We meet that and teach other companies how to do that, and, yet, when we go out to sell our products, government buys from the lowest bidder. So why did we do all this stuff Here we are talking, in this session, buy only from quality manufacturers. I am now projecting our experience into the rest of the US market place. And I am saying to myself, are they serious when they say they want to buy from quality vendors. You should buy from quality vendors, because in the long run you pay less - it costs you less when you buy quality. A little frustration there I guess.

39 Establish relationships that support the entire life cycle

Dan Cada:

This initiative speaks to relationships that support the entire life cycle. My concern on that was with the contractual part. It's been suggested that if we can come to standards on the way we acquire and use the models, the data and the processes, that coming and going, the inevitable coming and going of contractors will have a lot less impact. I think probably that's the solution that might come to us other than saying, well, Raytheon, we're going to buy these tubes from you for the next hundred years, that's not realistic for social, economic, and just plain business reasons.

We have not conducted any workshops in general with vendors where we've had Navy and industry representatives to talk about this issue. It's certainly an area that has a lot of potential. People tend to have a vision only as long as a contract lasts and we've got to get out of the sinking feeling that gives

you at the end of the contract, everything sinks to the bottom of a file cabinet, nobody wants to talk about it because there's no job order to talk to.

It should be noted that CALS is not a program, and it ought to stay that way; because, when something takes on the identity of a program, then people tend to want to set up special offices and special programs and special funding lines and all that to go do it. I suspect that the thinking is that CALS tools, the initiatives that come out of CALS activity, the value of them is that they come from a single idea of how to go about doing business and what's a good, acceptable way to approach that.

I'm hoping that while, yes, there's probably some infrastructure cost up front, that people are going to find that doing business in a CALS way doesn't cost us anything overt; they have to think about it and they have to go to the CALS shelf in their bookcase to find out what does CALS want us to do instead of some other shelf, or their own shelf, or no shelf at all. I'm not willing to say CALS is expensive and we're going to have to go fund a lot of CALS activity; the people who are taking steps in the area of CALS have found out that it pays them, it's an internal improvement. They're delivering faster and cheaper and realizing the payoff themselves. So making CALS a way of life is more in thinking than it is in doing, although the doing has to be focused on. Why don't we use the standards the CALS initiatives are suggesting, why don't we introduce the programs the way other people are saying this is how CALS is strategically changing acquisition and logistics efforts. More thinking, not a lot more money. I don't see a lot of money there, in fact the expectation from DOD is that we're going to get money back; that's hanging over a lot of people's heads, and that scares them, and it probably should, because it means there's a commitment there not to give it a try and throw it aside if it wasn't easy.

I have no specific examples that would allow us to see how some other companies have implemented this. I'm too new to seeing a broad part of the industry. I've been exposed to SSN-21, and to the Portsmouth, New Hampshire, 688 class overaIl thinking they've given mea day's drink from their fire hose and it looks good, both of those look really good. Other people are anxious to do it. I'm not smart enough to tell you what Boeing or Lockheed or General Motors has done because I haven't been there, and I haven't had an opportunity to go to any symposia or other of those professional approaches or societies that really other people set their booth up and say we in the Air Force or we in the Army or we in the automobile production industry have done thus and such and we'd like to brag on it. My exposure is limited right now catch me in a year and I may know much more.

There are paradigm shifts involved in this whole process that we need examples of what others have done, not from a technical point of view but from dealing with the other aspects of it to say we've got some successes. Even when you listen to the folks who have the booths and give the papers at whatever expo you go to, remember that they're speaking to their product and their environment and maybe even talking a little vision in some cases; by that I'm saying this is what they're going to go do, not what they're been doing for two years, therefore they've found bugs and fixed them and demonstrated success.

We're going to have to keep our eyes open and when we see one that's attractive, get the guy's card and drop in on him, and spend a day with them and find out what they're really doing, sort out the enthusiasm and good intent. Look for a few guys with a few scars then we'll know. Other than that I don't know how to build a library of success stories. Just keep checking skeptically on everyone we hear and everybody's got to do it, and let's come back together again and say well, yeah, there's this little group out here in Illinois, and doggone if a 150 man plant hasn't changed throughput by 700% and driven their cost down by 30%. Maybe we'll figure out what they did, as long as they're willing to share it. They may be making wheel bearings, but nevertheless they're doing something that we want to go do.

Lorna Estep:

We kind of touched a little bit on the fact that if you're talking about what your productis and your productis something that is not only designed and built but also support, you fast get into the complexities of inter-relationships not only with your customer but with your vendor base. When you're trying to improve your whole process, you really need to have relationships with suppliers, with your customer, with your vendor base, and it needs to be in light of that whole product support, not just building the product but supporting the product, because, if you measure your cycle or restrict your measurements or your activity only to the building process, then you'll be establishing relationships specifically with one area, but if you look at the full support area you're broadening your opportunities for really providing value, and of course value is profit.

So when we look at the full support cycle we're not only talking about deployment issues and training issues for deployment we're talking about repairs, overhauls, processes, what do we want to do in terms of improving the technology sets, not building anew ship necessarily but improving the existing ones out there by some major technology refreshments or insertions within existing hulls. How do you support that process and is there a way within your industry that you can improve that whole support so that your customers are going to comeback to you. I used tobe involved in foreign military sales and we used to say that one of the differences between buying a weapons system from the United States and buying it from the Soviet Union is the United States agreed to support it whereas the Soviet Union only agreed to support it with some contingencies as long as you were my friend, and kind of used that as a real difference in our approach. It strikes me in the same way in the shipbuilding industry, we're not just in the business of the easy part, if you will, building the ship, we're in the whole support area, and there's a lot of value and money to be made in that area.

40 Create systems that reduce the costs of gathering cost data

Lorna Estep:

One of the whole barriers to really making improvements in the process is we try and overlay on some processes activities that are not related to the process. That can be as simple as time and material information that we want the engineers to support, job order informa-

tion, all kinds of things that we have to do. We have stacks of paper following the product that really have nothing to do with the product itself but have to do with when did you get it, how much time did you spend on it, what did you do with it, did you do it right, capturing all the quality information and those sorts of things that under today's environment can efficiently be done as a by-product of the process itself.

You can capture it as part of the process rather than have to spend valuable time of the engineer or the artisan community to collect that data. When we're looking at process information tools that necessarily are supporting directly to the process. If those tools are smartly developed, we can get all the information we need or any financial people need in terms of the data. I've seen figures that say that 40 to 60 percent of an engineer's time is actually spent on these miscellaneous activities and not on real engineering so you can get far greater productivity in terms of real value added if you can design your systems to alleviate those basic processes and not require them to occur in a manual sense.

Jim Wilkins:

This is cost collection technique. When we go down to lower levels of cost collection, which I'm saying we need to do, the first thing most people do is make it so complicated that people start "gun decking," and they are not reporting accurately. The point is that we have to collect costs using techniques that reduce the costs of collecting the data. One is cost, but number 2 is making it simple. I don't know if that is in here per se, but I just use a personal approach. If I have to try and figure out my time in less than two hour increments, I really find that very diflicult and more effort than it is worth. In a day I can allocate my time to 1 or 2 hour increments and I am thinking of it as shipyard environment, where a normal shipyard worker is not working on more than 2 or 3 jobs in a given day anyway and a white collar situation addressee might work on 1 or 2 drawings. So it isn't that hard. But we are not even doing that.

Timekeeping is somewhat automated, but we are not doing it in shipyards like they are doing it in various other manufacturing industries, and in some ways you can't do it quite that way. There is a bar code thing used in Aerospace, used in GE, and there is a lot of application where that could be perfectly suitable in a shipyard. That is, facility costs, buying all the wands and again you have to demonstrate how it is going to pay off if you don't think cost data is important to you.

I always think that if I were running a shipyard, what would I want. I have been at the group tice president level which is one level below the president so I think like I'm running the shipyard. I always say that if it were my shipyard, if I were running it, I would want to know more about the cost, what it is costing me to do business. That's is the most important thing I need to know. I can't even bid intelligently if I don't know what it is going to cost me. I don't mind if I bid below the cost, above the cost - that is my management prerogative; but the very minimum data that I have to know is the cost. And if I don't have cost that is accurate, I don't know how I know. That is why I am interested in cost. That's basic, basic management. I can't improve if I don't know what I'm improving from.

41 Involve the customer inreview of configuration and reporting requirements as cost drivers

Jim Wilkins:

This initiative comes from a need to say from the shipyard viewpoint:this is the owner, Navy, in the case of the government. We have to go back to that guy and involve him in the review of the configuration reporting requirements and identifying the cost of doing what he is asking you to do, all these other things we are talking about. My response to that initiative is: I don't know who is not doing it, but maybe other shipyards are not doing that, but every ship we did with the Navy within six weeks after contract award, we were in a conference going through the CDRL list and identifying unnecessary CDRLs and other things we could simplify and eliminate some cost from. So I would assume that this at least superficial. Maybe we really need to do it a lot more significantly, I think it is part of a normal acquisition process.

CDRLs really mean that these are the reports which you must give to me and then behind every CDRL is what is called a DID (Data Item Description), a detailed description of all the data that must be reported and sometimes format and other information. There is a CDRL out as to how you report your schedule requirements and a CDRL for identify ing what is your schedule. Give me a milestone schedule that must be delivered by such and such a date. It must be updated every X number of days, give it to these people - here is the distribution list for it. That's what a CDRL is. And so to go through those and scrub these reporting requirements can indeed save a lot of time.

The biggest complaint that people who do government work, who work on military specifications, have is the reporting requirements. CDRLs are the technique for identifying reporting requirements. We are really saying don't make me turn out all this paper work and report to you all the time. That is what we mean by reducing CDRLs and obviously that is an overhead cost saver. It won't necessarily help you on the production line at all, but it is sure is a cost when doing business with the government which you would not normally have doing business with an Exxon.

At Avondale shipyard we did work with Exxon. We were doing commercial and navy work when I got here. So it is not like it is all that difficult that you can't do it. We did tend to keep both kinds of people, because production managers did not want to be doing the same kind of welding on commercial ships as we were required to do on navy ships, because probably the requirements on navy ships are excessive. You don't need to have such perfectly pure wells as navy ships will require that you have. Their argument is that they may have a bomb attack or something like that. So they do in fact have a little different environment that they have to be ready for.

42 Establish customer capability to produce product models required by CDRL

Lorna Estep:

At first we were talking about looking at ways the customer could use the product models that were delivered. The fact is that in the CALS environment it's very nice if the industry itself provides information in an electronic for-

mat. However, if the customer can't use it for anything and it doesn't contribute to the entire process, I think we've lost a big opportunity and it goes into a relationship between the customer and the industry that says here's what I need to do in order to use the product and what kind of tools could be developed that will aksist me in using that information. If I want to buy spare parts, for instance, can you provide me tools as part of your product that will let me buy spare parts easier and reduce my cycle times as well.

If what we do contractually is prior to contract award, we work on the interfaces between the customer and the suppliers so that we can define just what the infrastructure is in terms of architecture of information that we need to pass back and forth. The contracting people don't define the specifics of the contract that is required to deliver the information. It's not known what the receiving information format should be or even whether there are computers and systems to support that kind Of thing.

It's a changing environment, those infrastructures are rapidly changing, and that needs to be readdressed not only before contract award but constantly throughout the process on what can be done. Everyone's migrating towards a more efficient electronic way of doing business, and we need to insure that we migrate together in those environments, that our infrastructures as customers can support it as you grow and change the way you are doing business within the industry as well.

Jim Wilkins:

That idea is just logic, absolutely logic. It just says, don't ask a guy to do what you don't know he can do. Not unusual for the government to put in a requirement to report back to me under PDES for instance. I don't know details about PDES, but I am using that as an example. It is a Floridian baseline at this point and time and shipyards do not know what that means necessarily, but they will sign up to it just because if they don't sign up to it they won't get the contract. That shouldn't happen.

43 Make CALS a way of life

Lorna Estep:

There's been a lot of conversation between the industry and the government on this issue of CALS and standards; the government wants to require electronic data and electronic data interface exchanges really for an opportunity to reduce costs in the acquisition life cycle. But if you look at a lot of the initiatives that we're talking about even within this environment here, most of them have to do with establishing relationships, doing a better job of integrating and a by product of all that process ends up to be an easy way that we can get at CALS. I guess the plea that I have in the whole environment is establish relationships between the customers needs and the need for your industry to improve its process as a by-product or an electronic data format that everyone can find useful.

Joe Wudyka:

CALS for some reason seems to have a bad reputation I think, in this industry. As I said earlier, people seem to talk about it as if it is just a pain in the neck thing they have to do. Somebody told them to do it. (That's literally what

happened. The Navy told them to do it, in the typical Navy way I suspect.) It is the manner in which it was done, but if you try to be objective about it, it makes sense. It is a new brand that companies should operate under the principles of CALS. I don't know how you can see your way through that any other way.

Maybe what we need is more education in the industry about what CALS really is and not have it come from the government - those guys who try to jam it down our throats - but go out and see the companies who are successful in the CALS arena, how they do CALS. Intergraph was there today and they do CALS. A lot of the companies do it and it works. I think, and here I'm not a shipbuilding industry mate - a facilitator, but I have heard a lot, and I'm going to stick my neck out and say I think, at least two years ago, senior executives in shipbuilding companies might have said something like CALS is great, but not for something this complex as a ship. All the more reason to do it. That makes sense to you and me because we have that computer kind of background, but I can't help think somehow what's failing to happen is that people are not stepping into the shoes of the shipbuilders first and then talking CALS from inside that set of shoes, as if they don't really have the authority and I think it is very hard to step into that set of shoes, because it is so complex and so incestuous, because you practically have to be born into it to be considered a shipbuilder in the blood.

44 Substitute process reliability for granularity of data collection

Dan Billingsley:

This initiative goes back to my let's make sure CDRLS aren't just being generated for a QA function and thrown away; if it really doesn't fill any customers needs but a checker or validator of a contract performance, we'll find another way to do that rather that a really unnecessary report with apples, bananas and table linens.

James Crocker:

This is one of the things I find happens frequently in the United States. We are down at the lowest level, and I like to collect granular data, very elemental analysis of granular data as required rather than continuously. This is a personal thing. If I go out and do the elemental analysis of a process, and make that process extremely reliable, and it is a product that is capable of being assessed metrically when capable of definition as good quality product, then what I like to do is cycle-reduce the process and to heighten the reliability of that process so that there is no need to spend a lot of time and lot of effort and collect tremendous volumes of data that nobody ever uses at great cost or at least great annoyance.

The issue is if the processes that went into here and if the process is a balanced flow such that I can go from point A, from point start to point finish, in an extremely quick and highly reliable, near perfect product, and I don't care what happens in the interim. The deal was it was engineered to work and it works. I don't need to do six hundred bar code slots. I don't have to put out 650 pages of out of sequence operations. I don't have to send it to 35 different rework codes. The fact is that the process was engineered, it was designed and it works. And it works damn quick. If I've

got a process today it goes through eight operations and takes 16 weeks, then I need a computer system and all kinds of bar coding and tracking to know where this thing is. If I built a process that is perfect and it takes six hours all Ineed to know is that it started. There **is a** major difference there.

It's a management information system "fine grainness" we are talking about here. The example I like to use is General Electric's circuit board shop in Florida where they make circuit cards for very exotic equipment. And the old way was large batches, imperfect processing, long cycles, and lots of matetial in batches all over the factory. As a result, there was an information system that was put in place to keep in keep track of the batches, keep track of the lots of the genealogy inside of the batches and to report each step along the way Top ten prepared for order, top 20 stay for order, top 30 automatic insert material, top 40, actual insert, etc.. The thing would go out and these boards would be projected to the factory at a very granular level of production information, and it would take them 12 weeks to get through the process.

By focusing on that process, by not releasing the material to production without complete kits, by making the process extremely reliable, and by balancing the flow through that process, that plant went from 12 weeks to about three shifts of elapsed time from start to finish. So we could go for reliability rather than fine-grain data; we went from 12 weeks to more like 30 hours in elapsed time on one floor. When we did that we turned to the customer and said look, from a quality perspective we have two or three bench marks that we are going to inspect this process through on the way through the process so about every ten hours we are going to get a snapshot of the quality of the product. But, from a material tracking and material logistics point of view, the only thing that we are going to track is at 6 am Monday morning this thing started.

OBJECTIVE VI HUMAN RESOURCE INNOVATION

45 Introduce employee empowermentphilosophy to the shipbuilding industry

Mike Connery:

This is the whole idea of empowerment. I think we discussed that in our workout program. I can't say enough about it. As a matter of fact I am sending Mike Kelly a couple of packets on it on how we do this so he can see how it relates. It is similar to what we have been through in the past 2 l/2 days, although this has been more detailed than the general town meetings and the general town meetings it is your "storyboarding." By the way, here is a way to know when workout is working Call a meeting and the people all show up with 3x5 index cards, because they are ready to do process mapping or something.

Brainstorming is the greatest thing to the work force. No stupid ideas. Right down on this card anything you want to and throw it on the wall. Then everyone goes with their little sticky dots, just like we did, except we limit the number of dots you get and you prioritize what it is you want to talk about and those five topics that come up, we discuss for the day. It works, try it. I have some documentation on this techniques, and I am going to send Michael some of it. It is

a GE Corporate-wide philosophy, a lot of nice sayers at the beginning saying I want to participate in this thing. Jack Welch (CEO, GE) handled that correctly and said well, ok there are certain things that are corporate values you will use for this kind of thing. It has caught on. When I see general managers and vice presidents with their sleeves rolled up, going toe to toe with metal bangers outin the factory, it is stimulating.

Marion Nichols:

We've talked a lot about that. It can't be focused on enough in terms of prerequisite activity. Get right out there front and center. You've got to do it all the time.

Joe Wudyka:

I spoke about that one very early in the interview also. About me coming to this meeting empowered, and what it meant from a competitiveness point of view and a time point of view. I came here empowered and ready to roll. That's, I think, a great example of empowerment and what it does for your competitive position. Also, another point - what it does for your employees. I feel good when I go out into this industry and I sit in meetings, and I know that my company will support what I decide to do. I am empowered to do my job and if I do something stupid they will tell me I did something stupid, but they will continue to support me. I just can't do stupid things all the time. I am empowered to do my job.

Despite criticism of Digital, anybody who wants to be empowered can be empowered. We have 116,000 employees so everybody won't be the same. A lot of different personalities, a lot of different approaches to empowerment. I'll say I think that the vast, vast majority of employees in their own way all feel empowered. The amount of empowerment you take on is a function of you personally, your ability as a risk taker, your confidence. The system is really supporting healthy people who discover just how empowered they can be and enable them. I have done things in my job that I'm really surprised I ever got away with. I tested the boundaries and today I keep testing those boundaries and boundaries keep moving.

We are looking at a majority of the company, not just a select rate. There is no elite group that has empowerment. People on the shop floor, and we talked about computer input devices. They all have their own computer terminals, know how to use them and electronic mail to communicate with one another, friends in other plants, they all have telephones, they are treated like people and made to feel good, do feel good, and they are empowered to make decisions. The lowest person on that floor can say, hey look, there is something going wrong here,lets go change it. Not lets elevate it. Lets wait three weeks to get the answer back fromtheplant manager. We have plants designed by the employees.

46 Thoroughly expose management and workers to best processes for process improvement

James Crocker:

Once we've created the vision of the commercial yard or the military/commercial yard and once we've identified the best practices and how they are integrated to execute that vision, then we

deal in market awareness. The way to do that is for this group to take the ideas back into the yards with executive management overviews that demonstrate that this is how the game plays, this is how the players execute with the current technologies, this is the way we produce. This is the way we would produce commercial ships viably in this country.

This is the training program to get the both the senior management who have been into the visioning and those who have been (to a much smaller degree) into the technology, to get them aware of how this thing plays, much the way the GE company did. But the executive overviews must say this is where we are, this is where we need to go, this is the technology that gets us there. This is the road map. Get senior management to understand that and stick with senior management until they are brought into the process. Once they are brought into the process thoroughly expose it to the troops. It is both training and education.

Marion Nichols

I don't think you can over estimate the value of people seeing and triggering the creative thought process. For example, we used extensively some of the Wantauk and Schoenberger tapes to help stimulate people who had a sense of what this thing called problem solving and best processes means. We struggle as does the Ironworks with massive set up times for operations and break down the products. Once you've seen the half hour run on a tape of taking a massive sheet metal press machine that was taking 24 hours to be reset up reduced down to something under two minutes, you see the actual mechanics of how they did that. Using video cameras with text that are employed when you want people to do that type of process improvement. What is recommended is that people with video cameras that are aimed at their particular work station or the datamation machine that they are using so you can study over and over the steps that are wasting time: what are the steps wasting time, what are the steps that are not valued. What could you have done differently in this picture.

The whole notion: It's not just an education, it's a feedback, it's an inspiration. It's a belief that it can be done. You get back to that, taking something at face value as outrageous; people would throw up their arms and not even think about then showing them that it's not so outrageous and it can be done. If it can be done there it can be done here.

There was something for me particularly impressive about that example because there was this massive press. It wasn't a little insertion machine; it was something big and cumbersome, and something you would have less expectations for; the same way you might imagine a crane set up in the shipyard, and and you can only move it so fast it's so big you can only get so much out of it. You can only move it so fast. It's so big. You can only do so much with it. You get people into those time studies. It becomes a challenge. That's the beauty of it: people get hooked on building it in half the time; then you get somebody to build it half the time. Then you want to build it half of that etc. Always attempting to beat your old standard. And being rewarded for that versus the old school, which was "if you beat the standard you know, go twiddle your thumbs or hang out somewhere."

47 Management supervision under-

standing of computer aids

Dan Billingsley:

We discussed this earlier on. That is a key cultural problem.

Paul Friedman:

The thought I had here was similar essentially to the one I mentioned awhile ago. A combination of the belief by a lot of middle management supervision is what is stated here, and I tend to take that as the way they are doing it is the way it was always intended to be, the "right way." Combined with the general aura of disbelief, the wolf crying scenario, those require you do far more than just give an understanding of computer aids or try to convince them on a technical basis that it is really a neat thing. They have seen lots of neat things that didn't do anybody any good, so the notion here is that they have to be reeducated. It is a fairly fundamental problem; just trying to sell them on the goodness of it has not been enough.

48 Implement concurrent engineering within the industry

Jim Wilkins:

Implementing concurrent engineering is abuzz word today. It is widely accepted as an important thing to do. I have a little bit of difference, which I normally do with somebody all the time, but I think there is a classic concurrent engineering cult and then there is doing it. I am not necessarily a member of the cult, and my feeling about this is that some shipyards are doing some of this.

My only question here is why everybody isn't doing it. It certainly needs to be done. My experience at Avondale is that I was surprised when I got to Avondale to find that the engineering supervisors of all the different disciplines were meeting with the production planning and the production supervisors when they were planning how they were going to break up the ship into units and what the joints were going to look like and a lot of the details of the whole process of how the ship was going to be built. The engineering people were involved in that process.

I got all there ports out and checked on it. Then they went back and did the design in accordance with that plan and before they even issued the drawings a pre-copy was sent out to production people to review and then we had meetings with those guys once a week, for piping drawings in particular and got all the production guys' comments back on the drawings before we ever issued them. That is about as much involvement as I have every seen between engineering and production andit worked verywell. It worked extremely well. Whyisn't everybody else doing it? Why do we have to have a separate guru to make this happen? This is the onlyway it ought to happen. People talk to each other. All I can say is that we need to insist that it be done. If it is not being done and we need to develop a plan to do it, then we will develop the plan to help people to do it. It is a matter of deciding to do it. Again, there is no technical development necessary in my opinion.

Joe Wudyka:

Implement concurrent engineering within the industry is really a duplication of one of the other initiatives. I

think it was purposely put under two objectives to bring out different facets. Within the human resource innovation objective, is in a cultural sense: what do we do to implement concurrent engineering. It gets you right back to what I said was the major constraint in the industry, which is headsets or mindsets, the cultural organizational barriers.

There is no sense in trying to do concurrent engineering until you begin to make some inroads with cultural organizational barriers. I'll give you an idea I had in the meeting and didn't really have a chance to bring up. One way you can help change people's attitudes, their resistance to change is by exposing them to some materials that subconsciously begin to get them to look at things differently. One of the things our company did was to begin distributing these videos - Joel Barker Videos, about paradigm shifting. This video, which is about 35 minutes or so, was played in a lot of meetings you go to and really got you to think differently about your old conceptions and what have you. Some of the other things done, all the same principles - pepper the people with these things that begin to subconsciously get them to think differently. I know it made a big impression on me with repeated reinforcement,. The shipbuilding industry is heavily unionized and Digital is not unionized. The shipbuilding industry has gone through the mental bashing, adversarial 19th century long history of anger, hostility, betrayal, the whole nasty bottom line. Union people are people just like anybody else is people and they have the same needs, same objectives, they might express them differently, but they are all people. And let me turn that the other way too.

The union people should realize that management is people just like their people and they should all work together. People will laugh when they hear that, but Ireally believe that. I think when the day comes and management and unions can get together in a room and say let's jointly figure out how to make this operation efficient before we are driven out of business, that when that day comes the world will change for the industry.

There has to be a real recognition that one of life's significant events is about to happen and that this company, whatever it may be-Bath Iron Works or whoever it may be, won't be here in three or six years unless everybody pitches in to make it efficient, and what that really means is that union and management both have to look at their own ranks and say I am going to take actions that will reduce the number of management people in this company, and the union people have to say, I'll help make decisions that will eliminate jobs in this company - they both have to trim their work forces because they both are too fat. I could go on with that one forever, but I don't want to. Just for the record, my father is an ex-union steward, and I come from a long line of union-type people. I have seen it both ways and that is my real strong belief

49 Invest to overcome organizational & cultural barriers to change

Lorna Estep:

The interesting activity that goes on in this whole process, we've kind of talked about already; as you go forward and do baselining and if you start that with an idea of what the vision to change is, you are beginning to send signals

throughout the organization that are not conflicting. I think one of the biggest barriers to changing the process is that we do not consistently apply our vision in measurements. We're sending conflicting information to the culture which obviously does not promote change, rather it promotes let's stay with the way we are because we're familiar with it. I think if there's anything that you can do to promote a consistent vision in everything that is going on with the organization then you can move toward that change, but if there's anything that's inconsistent, it is bad.

If you continue, for instance, to talk about reducing cycle time but measure people on direct labor hours, then you're obviously not going to promote a change of thought process to cycle time. You can provide all sorts of tools in terms of computer tools, but if they're not consistent in your vision in terms of empowerment of people, then you're not going to move towards that Changed environment

It is worthy of some investing of not only thought but real deep soul searching about what is the change we really want to make, and let's be consistent in everything we do towards that change. That's the only way it's going to happen. We're going through a process now on total cycle time at very high levels within the Department of Defense within our spares environment that says I do not want to look at unit cost for procuring an item anymore. I want to look at what the total cycle time is so that I can understand the efficiencies that I can get out of the process and that will really drive down my costs.

But if I continue to audit my inventory managers and my buyers on why did you select not the lowest cost bidder then I'm sending a signal that I really want thereto select the lowest bidder. So there are those sorts of things that are going on right now that say I should not require those guys to put three additional pages of documentation within their folder if they go to other than lowest cost bidder. I'm sending a signal to them that saysit's going to be harder for you to do that, and I obviously don't want you to do it because I don't trust your judgment. I want you to document that to death. So its those kind of things you've got be constant of purpose if you really want to move into the changed environment.

Joe Wudyka:

That initiative is similar to others, yet there is a different twist on this in my mind. I use the word "invest." There is too great a tendency for people to think that the way you do automation is by buying things. It is maybe hiring a consultant or two to help you install it. Our experiences that you have to invest heavily in the people side - the human systems- just as you invest in the computer system

You are being effective when spending money on consultants who come in and play an active role, they areimplementors. They are not technical consultants, people who have already facilitated the successful transitions in companies where they have made massive changes in the way they do business. They have hands-on experience to how you do it, they have not just read it in the book - they have done it. And they go out and help other companies do the same thing. It is not cheap. These people are not people who come in and give a presentation every now and then, they are in their with their sleeves rolled up and working with management and everybody in an

organization o help lead them through the change. You have to be there with them all the time. Obviously you have some really good consultants who are going to be there all the time. It will cost you a lot of money, but you have your choice - You pays me now, you pays me later.

If you don't do that, you will have some solution that is less than you hoped for. One day the pieces of information that I think interesting is, we are one of the third or fourth largest systems integrators in the world. I have talked with a lot of people in our company who have been involved in these automation projects around the world to try and find out what percentage of these projects are truly successful, where if people would be honest with you, how many of them met the objectives that were originally set? It is a faltering 20% or so. People don't ordinarily share that information with you. The customer won't share it. You have to be there kind of like peeking under the sheets to see what is going on. But, only 20%, and there is something like another roughly 40% that are really failures, but you don't see it admitted. That thing - that operation - will be changed, a failed change and they will maintain the failure.

It is too embarrassing to admit you failed so you cover it up, two years later you say, this doesn't work anymore - we need to invest in something else. So not only does it cost you, the direct costin terms of equipment, training and all that sort of stuff- the hidden cost of continuing a suboptimal situation. Now think about competition - is your end screwing up your own company, wasting your money, your energy, and the talent of your people internally. What is your competition doing to you in the market place? Consultants are expensive, you have bought the best and they have something that works even though it looked like it increased the direct expense significantly. But they still come out way ahead. That's my experience, absolutely.

50 Identify and document team building and team empowerment success stories

Joe Wudyka:

I signed up for that one because we have tons of success stories. When someone wants to see how it works, I can show them how it works. It is not the shipbuilding industry, but it is examples of how this works. It is proof. People to people: I am a resource for stories like these. Let me throw out another phrase here that should get sprinkled through the industry a little bit. And that is the whole concept of human systems: Human systems.

People are very aware of computer systems and they can picture them and warm up to what it means, they can think about their communications systems. They need to begin to think about the human systems and I think when they get that emblazoned in their minds, that there is a whole system, a very complex, valuable, probably the most valuable thing in that company, it is a system. You have to treat that system properly as you go off and change your company. You can do so much in improving your company without spending a nickel on a piece of automation. Major, major changes by things like-the use of the word "mindware" — I talk about the human systems and paying attention to those human systems-improve management techniques. As a rule, people when

they go to work want to do a good job. Give them the environment to do a good job, you will be surprised at what they can do.

51 Provide university work study programs in maritime industries

Robert Schaffran:

There are two universities which teach ship construction in the U.S.: The Univ. of Washington and the Univ. of Michigan. They both have work study programs established and their people do go into the yards. Every one of the people who take those courses seem to be hired by the shipyards and seem to stay with the shipbuilding in dustry. However, I understand the Univ. of Washington course now has been suspended because there wasn't enough of the demand by the West Coast shipyards to hire those people, and there were not a whole lot people taking the course. There are text books we have developed to support these things. There are professors out there who are pretty good. I think the problem we have is that the industry is in such a weak state that a lot of these students that normally take these courses are now opting to take other things. (The Univ. of New Orleans or Florida Institute may have some work study for similar programs; Univ. of Mississippi, Ingalls use to support. Webb Institute used to teach ship production.)

Dan Thompson:

Another approach could be modeled after the Bethlehem Steel "loop" course of years ago. They sent college students and graduates to a planned series of experiences throughout the plants they had, including shipbuilding. Perhaps other industries such as aerospace would do likewise through a new coalition or consortium. Perhaps the whole thing could be orchestrated by the University of Michigan on behalf of the NSRP.

OBJECTIVE VII FOLLOW-UP

52 Conduct additional workshops like this one with senior management

James Crocker:

This initiative is the same thing as to thoroughly expose the management team. That's part of the same philosophy. Regarding senior management. I would want to make sure that they were focused on what is the business: Is it military, is it commercial, is it botl; and once we got that straight, then I think we can get into this other area.

53 Build in follow-up to this action plan

Jim VanderSchaaf:

A critical step for the sponsors wilI be to provide continuing follow-up and specific action plans. Some ways that this could occur are:

- Follow-up workshops within a sponsoring organization (shipyard, government organization, NSRP panel, etc.)
- Assignment (on a volunteer basis) for undertaking specific objectives / initiatives.
- Assignment of specific objectives/ini tiatives to individual panels within

the NSRP, and, NIDDESC.

Identification of those objectives/initiatives that could be addressed and/ or funded the Flexible Computer Integrated Manufacturing (FCIM) Pro-

- Potential use of MANTECH funding to support the high priority objectives/ initiatives within this plan.
- Conduct an annual industry survey to assess progress to this plan.
- Presentation of results at the NSRP annual symposium.
- Formulation of a five year plan of action and milestones, addressing funding, high priority tasks, action plans, etc. that incorporates the actions described above.

54 Connect everybody in this group to a common system in order to continue to discuss these issues

Joe Wudyka:

Not too many months ago I was almost at a point of jointly bidding a piece of business with one of the shipbuilding companies. We had discussions, telephone conversations and meetings. We were getting to the point where it looked tome like I had better get ready to have our company respond to that opportunity with the shipbuilding company. The first thing that hit me right between the eyes was how difiicult it would be to communicate because I didn't have to make just phone calls anymore, I needed to send documents, receive documents, get decisions made, send graphic things back and forth. The way our company works, we have our own communication efforts - the largest private network in the world. I can send messages to the other side of the world within 20 seconds and know it was received.

I would like to pursue setting up a BBS for this group through Digital Corporation. I have a couple ofideas, and I can talk about this afterwards as there are ways to do that, and yes I would be very interestedin getting involved. I can work some speciality that maybe we can get some used equipment for almost nothing just to get it going and show people what it means. You think about the story I just told, it gets you into the competitiveness arena, into that area of discussion. Lets say Digital and that unnamed shipbuilding company were to have independently gone after that same piece of business.

If you did a study of what happened, I think the shipbuilding company would be amazed to see how fast we moved, as big a company as we are, how fast we moved. Just in the decision process. Forget about communication for a minute. We talked before about organizational structures and how very, very steep they are in shipbuilding. I made decisions for my company, and getting back to empowerment may be, in a minute that took over a week for the shipbuilding company to make because nobody could make it. They had to keep elevating, wait for the next meeting, wait for it to get on the agenda, wait for it to come back down. You are now talking about orders of magnitude. Incredible orders of magnitude. Differencein speed and decision.) Unbelievable.

55 Develop a critical experiment to prove to management that this process will work

Lorna Estep:

By the process I meant the process

that we were talking about entirely in this workshop, and that is that we can find a way to integrate thinking, the databases have clarified our processes, and agree to them even if we don't standardize them to where we can do something. We have to pick some kind of critical experiment, something that's big enough but not too big, so it delivers a punchina year or something like that, at least a clear upward trend in a year so the whole place knows that we don't just have little successes here and there; that one excellent manager in one industry has improved his lot, because he would have done it anyway, she'd have done it anyway; that's not a measure of proof of this process. The proof will be we're going to have to have a multi-discipline or multi-industry.

56 Develop anindustry wide project for reaching our goals

Jim VanderSchaaf:

This initiative is closely related to 53 (...follow-up...). Examples of such efforts include those industry wide projects sponsored by NIDDESC. Another potential project is described in 24 above.

OBJECTIVE VIIIINDUSTRY CO-OPERATION

57 Establish a national consortium for shipbuilding software development

Dan Billingsley:

The National consortium; This is one of the things that I expected to come out of this symposium, and I was surprised that there wasn't more apparent support for it. I thought, based on our success in cooperative cost sharing effort for data transfer, that the thought would be that perhaps we should pool our resources and engage in a cooperative cost sharing development of software that was needed for the process of building, detail designing, logistics, preparing ships. Others who have been involved in efforts like that before are REAPS, Jim Vander Schaaf, Doug Martin - those folks seem to feel that it is an excellent idea that is really hard to do. Hard to get people together to do it. Hard to accomplish it after you have gotten the people together. Design at different phasing, different hardware suites, different needs, different cultural problems, etc.

It needs to be addressed, and I think there is real potential there. It probably needs to have some structure laid out before people will be able to or willing to buy into it, because they don't want to get into something they don't know what it is. Hopefully the mindset of general computer illiteracy and awareness level in the 1990s is different than it was in the 1970s and it will make people more susceptible to this. We need to work out with some specifics on how to accomplish it, but I think there is potential there.

Marion Nichols:

You benefit from putting people in different places together to share ideas, particularly where so much of this stuff clearly is process oriented, is technically oriented, the specifics of the product gets to a large degree less and less important in the scheme of things, as hard as that is to accept sometimes. I participated in a number of national and international

consortiums where the common theme was we all need software, but you have the diversity of the electronics industry, heavy equipment industry, job shop type things. The value in having people see each other as resources, to see each other as keys to solutions, and collaborators. To see themselves as colleagues. The whole thing feeds upon itself.

You suddenly realize that this give and take of ideas is not bounded by competitor or not competitor; they make steam shovels and I make computers there can't possibly be anything in common. It's a little bit of the world community. I also feel very strongly that from a diversity perspective you need to leverage those differences, that the value of having people who not only do different work but who come from diverse backgrounds, who have grown-up in different settings, who have approached their work in different ways, who are part of the European community or the Asian community. I have been incredibly impressed with the different thought processes that come out of geographic areas. It's as though the brain waves, the line of thinking, is different in that part of the world and they are focused on different things. And unless you are willing to validate that and say that's something we want to leverage.. we want to participate in.

Robert Schaffran:

There are a couple of things going on right now in a variety of places that might all lead to something happening in this area. There are efforts underway to look into the possibility of establishing a National Maritime Institute which would do a lot more than just software development. It wouldn't be capable of doing anything in the face of competitiveness. We have an ongoing study right now which is looking at all of the major world class maritimein stitutes that exist. The ten top maritimes that exist and what they do, how they are funded, who their members are, how they work together, what funding levels are, what the legal ramifications of these things are and also looking at some of the domestic non-shipyard related kinds of consortia that are put together, like the Electric Power Research Institute and a couple of others: The Maritime Transportation Research Institute and how they are put together and how they are funded and work.

There is a paper we are getting ready to present at the annual symposium in the fall that will present the results of this research. A small effort, not a whole lot of money going into it, but it will document what the best in the world are doing and how they do it. Then we are going to make a recommendation on how we feel a similar institute might be formulated in the U.S. Where it goes fiomthere we are not sure, but last year there was some language in the latest manufacturing technology budget that was from Congress. In the initial markup was an item to invest some money into establishing a center of excellence for shipbuilding technology and SO with that we thought maybe we would look into how to do some of that. That language was taken out of the markup and sort of came out of the congressional language last year.

There are some people on Capitol Hill still thinking about that and so there is a possibility that there might be some funding supportor some initiatives to try to establish a maritime institute. That would be the place where a national consortium for software development

might be established.

The second idea, if that doesn't happen is that in fact we had a national consortium of shipbuilding software development at one time and it was our research program. Though, as far as I am concerned stupidity, we let that organization die. It was an institute for research and engineering for ship production, but it was strictly to coordinate the development of computer technology for shipbuilding. Shipyards pool their money, pay an annual membership fee, a corporation set up with a board of directors of industry members. They decided on things they wanted to do every year, and what was nice about it was that, because it was a corporate body, any government agency or anybody could send money to it to do work. It wasn't like we do NSRP work right now. It pooled money from individual yards. If the Navy had something they wanted to do they could automatically send money to this one corporation to do it and it was a beautiful organization.

The organization was beautiful, but some of the shipyards had problems with the management of it. It was managed out of the Illinois Institute of Technology & Research and the management there at the end people were having problems with. Rather than just fire the management and maintain the corporate infrastructure, it disbanded the whole corporate thing Like throwing the baby out of the bath water. The work itself was accomplished by the shipyards. It was sort of similar to the NSRP, strictly for computer development with a small staff of 2-3 people and they basically worked at the whims of the corporate board. The money went to this corporation and they would disperse it to the member yards to do the work. Contractually it was a beautiful set up.

The history was that when we bought AUTOKON and made it available to all the shipyards, we created this AUTOKON users group which eventually evolved into this institute for software development basically. It was to coordinate the improvements to AUTOKON. A lot of shipyards who didn't have AUTOKON wanted to be part of at least the software development of the future and tie it into their systems. So it eventually became more than just an AUTOKONusers group. It was good. In fact there are some of the key players on the strategical Planning session. It used to be run by Doug Martin and Jim VanderSchaaf. They were the outreach guys, and when they had it it was very well done. They left to go out to the shipyards and it was taken over by a new group of managers, and people didn't feel comfortable with it.

Jim Wilkins:

Dan asked me to comment on that and all I can do is support that. I think that our National Consortium for Software Development needs to have to come after the identification of what we need to have. By definition you shouldn't develop software you don't need.

58 Provide knowledge transfer to spread best processes across the industry

James Crocker:

This to my view is something very similar to the GE changes in process and the continuous improvement process and a thing GE called work out. The knowledge transfer comes down to this: In-

stead of doing genetic training this is the concept with MRP and EDI, etc. once by having the shared vision of this is how a commercial freighter, whatever, gets made in the United States, in a United States yard, once that vision is firmly implanted that this is how that happens, then we have something to train a very finite and very discrete process. In my little company what I like to do is provide that knowledge transfer with an hands on basis where a yard would say here is apiece of our production or a process that is either not state of art, not best practice, terribly costly, and we put together a small team on a finite basis and make that happen instantly.

What we find both in previous experience at GE but also in smaller, private business: we can talk about it in the boardroom and we can conceptualize it to the helpers and some people buy in and some people are cautious and some people are bored to tears. When you take that processing out to the real world, to the people who touch the product or the process, and when you turn them loose with okay here is what you physically do today; you then take a look at that from a point of view of process mapping, process assessment, elemental analysis, and best practice. The interesting part is more often than not they know it's not best practice and they also know what is unreliable in the process. They are energized by focusing in on that and getting the team to get their arms around a finite set of problems and a finite process it's amazing what can happen.

It is sort of releasing the knowledge that was there all along. It's not only the knowledge but the pent up frustration. I've had examples in my little business where people show me amazing things. I had a gentlemen show me about ten years worth of a verbal orders asking to get a machine fixed about once a year he would ask, and it took nine years to get it fixed. That's just not acceptable, especially when one finds that that was the bottleneck to the process. It was not intuitively obvious unless you got down to that level of the business. There was no way to communicate that.

Robert Schaffran:

The reason I circled all of these initiatives for industry cooperation is because I think we are doing it right now in many cases. We can improve on it but as part of when we took over management of the National Ship and Research program we created a technology that we call the documentation center, which is really a technology dissemination center at the Univ. of Michigan.

As part of this effort everybody now knows that there is a wealth of information out there that is available to anybody that wants it. We send out an annual bibliography of all the reports available, all research that has been done and a library of all the video tapes that relate to shipbuilding. Just call up and they send them to you. There is a wealth of information and now that we have instituted the newsletter which takes areas, one of the areas I think is going to be computer aids, and lists all the work that has been done on computer aids. They can take a different subject every time and list all the documents that are available to support that.

So that is another thing we are doing. We just started the annual report in February and sent it out to 4,000 people. And of course we have a panel structure that allows people to share information. There is an infrastructure

in place right now. I am not saying it is the best, but we ought to be working on strengthening that infrastructure and making sure we have the right people on the panels for the shipyards to get anywhere. I think things are in place and we just have to improve on it.

59 Form customer, innovator, producer councils to project the future

Carl Bryant:

This initiative is to trying to put a mechanism or vehicle in place where you get a person who has a requirement for something, you have a person who has access or control of the direction of the technology that that person needs, and sort of a third element in there is kind of a catalyst which I refer to as innovative. You have to be careful of really either of the first two elements gaining control of the process, because you will lose it if the person with the requirement is the one who is driving all his brain work in todays environment. In today's environment therefore he's not really going to see much, never really going to see much outside of today's environment, who wants to wants to do todays better or faster or something? But he's never going to see the work in light of how to do this process. Is there another way totally in left field that I can approach this process. Conversely, if you have the Person that has the technology who drives it, he's going to drive the technology that is interesting to him. You need that other element in there, the catalyst. Perhaps as the exposure to other industries and set sort of a fresh point of view on the whole issue. The customer in a consortium or collaborative set up probably would be ready and willing to accept some innovation if it was put before them. I think a lot of it comes under how the whole management innovation issue is key. If you present it right and if you are working in a forum like this, by the time you come out you should be somewhere close to a consensus. An example might be when we brought the right NICAM system into Bird Johnson, it was simply a manual graphic shop. By in large they were very good at what they did. Like here in the shipyard.

What happened though was that the head of the drafting department was a fellow at that time who lived five years from retirement. We made him first of all part of our team for evaluation of systems looking at systems he came on with us and bought into it completely. He thought it was very interesting. And he was able to communicate that enthusiasm for the rest of the crew. So there were one or two people that were never going to buy into it and there was a requirement of manual drafting of odds and ends, we were able to keep them in both cases. But Norm was penalized for being an outsidet; for having a totally different perception which didn't call for any of their skills or manual dexterity so it can work. In most cases, as long as the people you are dealing with don't feel they are going to lose their job as a result of buying into it, they will go along with what is new and interesting.

Robert Schaffran:

My office within DTRC adopted the maritime institute as a DTRC project, not an NSRP project. This is going to be reported on at NSRP in the fall as a move in the direction intended. The intent is to share this with the whole world. We are

just doing the investigative stages right now and what does exist so we can model something like this. When I say we, I am talking about me as the head of the design manufacturing system division at David Taylor Research Center. I circled the things that my division is involved in in some way as user in regards to managing the NSRP, and we do influence a lot of competitors there and plus a lot of other work we have funded. This is something I would make available to whoever wants it.

I am not sure what we can do to form customer innovation councils *to* project the future. We have done similar things, such as this session in Maine. We have the annual strategic planning session in Ann Arbor involving owners and innovators. We brought in some of the Saturn people to show how they created a division and got their people to turn the automobile industry around. We have had guest speakers come in to get our senior managers pumped up. Their plan for the future is very similar to ours for the future. We are all talking the same game.

The only customer we have right now and constantly use is Art Haskell, President of Matson Lines. He is basically the primary customer we plugged in. We should probably bring other customers in and in fact that is probably one of the weaker points of the session in Maine. We have no commercial customers of the vision; but we do have Navy customers.

Joe Wudyka:

This one is the one that came out of my comment in the meeting about why not get the computer industry and the shipbuilding companies to talk to one another and influence the computer industry. Come in and tell us what you need, tell us what we do wrong, tell us what you wish we would do, influence it, change it. Don't just take what we give you we want to learn more from the shipbuilding industry. So we would like to do a little cross-educating here. I have favorable expedience with the approach you used in this session.

We talked about automation and a five year horizon, but we all seemed to be thinking about todays technology five years horn now. And just like the example of the antigravity machine, five years from now the computer business will look so different that the industry needs to work their future vision into its vision. It needs to begin to see where the computer industry is headed so it can do the leapfrogging.

There is such a long way to go to close the gap, technically, between US shipbuilding and foreign shipbuilding that you can't do it 10% of the time. You have to leapfrog, jump ahead somehow.

60 Create leadership forums for the industry

Dan Billingsley:

U.S. shipbuilding research activity could fulfill all the ones in this area and provide the leadership forums and all the rest of the things. It is really, I think, at an appropriate point to follow upon all of these.

61 Establish a Shipbuilding America Network

Jim VanderSchaaf

Presumably the action here is to

establish a electronic bulletin board for access by all shipbulding participants on the range of topics that are within the purview of the NSRP. This task could be assigned to the NSRP for action.

62 Implement shipbuilding shareware

Jon Matthews:

The reason I circled that one is that I happen to be chairman of a SNAME sponsored ship design panel, which is a parallel organization to the Ship Production Committee. SD2, which is the ship design panel number 2, is called Computer Aided Design. We have been funded through SNAME to develop a software standard, which now exists and has been published through SNAME. We hired J.J. McMullan to develop a softwarestandard. We have published information available, it's shareable through SNAME with this organization, this concept and this group.

63 Focus centers of excellence on the shipbuilding industry (MANTECH)

Robert Schaffran:

We are trying to do that now. I mentioned that last year there was Congressional language and we were trying to establish a center of excellence in shipbuilding. That language is partly the result of our efforts in dealing with the MANTECH office demonstrating that there ought to be a center of excellence for shipbuilding center.

We are still talking to them and they are still working at the concept of the shipbuilding center of excellence if they can get it through Congress. We are also working with the centers of excellence that do exist in metal working technology, there is a joining center that is getting ready to start up this year which is a welding group. There is a composite center of excellence in Wisconsin and so with the joining center and the metal working center of excellence we have the SP7 panel, the welding panel and NSRP actually reviewing all the work and commenting on it and keeping what is being done in money. We are trying to put the NSRP actively involved, focusing those efforts on the right things and helping what they are doing. We are getting the appropriate panels in. There is a lot of work going on right now to make sure the centers are focused.

64 Form joint technology assessment teams

Mike Connery:

The example of this in aerospace is the engineering productivity arena. With in that engineering productivity concept there was something called ASSIST (Automated Software System Integration and Tests), about how you develop software. We brought together quite a few individuals throughout aerospace to assess the current state of the technology. That doesn't necessarily mean performance. You will see state of the art processors out perform anybody's, but don't be enamored by those little things. It is not little, you need performance. Be enamored by the growth capability. The open architecture they have.

Set a plan together that says I am going to pick this certain architecture. We picked VME, a bus architecture that is based around the 68,000 computer

series that allowsyou to do technology insertion. It says you can put a 5 year plan together. The caveat is that you have to have faith and analyze the market, especially the vendor you pick, that he is on the leading edge and if you look at 68,000 that started at 68,000 and went to 10, 20, 30 40 and up to 50 nowthere is an evolution there in that product line that says it will grow with you. Pick it and stay with it, it is powerful, it is open architecture and handles C, a portable language that you can take anywhere. Mitigate your risks. Don't box yourself into a corner.

Examples abound, I don't want to slight these companies in any way, but Apollo in their design arena had to run to use that system architecture. Those companies suffered when the transitions happened. I am not saying everybody has a good crystal ball they can see, but I am saying that if you do the right market analysis, get the "tech's" together and let them dream for a week they can put this plan together. The big message being, keep management to hell out of it. Let the people who understand where the market is going discuss it and present to you a plan. Again, this is the empowerment thing, and they will be responsible for making right decisions in technology. Again, not a very difficult thing to do.

Jim Hutto:

Listening through the last few days we heard that in most industries the advance of technology or surrounding computer applications has been far faster than any single user can keep up with. This industry, by its nature and cost of products that it generates, makes it very difficult to keep up with the changes in computer technology.

So one thing we've looked at the past few days is a lot of the issues that came upon needing technology to many together the technologies that are available. One of the things we very seriously need to promote is as this steering community gets together and agrees on processes and missions and requirements that before we embark on developing new products we need to survey what's already available both in government funded as well as commercial solutions. Look at the solutions, the costs, their requirements; in looking at that that will also reconfirm we do have the proper information in the system.

Digital is one group that would like to join in this search, someone from the Computer Business Society may have some insights, but I think there has to be a representative from the user community for each phase that's exploring what technology is available. I don't think there's one static team. If you're looking at the business operations don't send the engineers. I think within each major block of the operations you sent representatives that have intuition of what their phase of operation needs. What's the user interface.

What suddenly rings bells in my head is the powerfulness of getting these different users even from the same company together to talk about their needs, the people who have techniques, they can learn from one another and see how they can work together better.

I think there will be several committees and each of those will identify data transmission interfaces between the different phases of the business process. Thinking about how to make all this happen, if you did it with three or four companies or five or six companies, it

would provide a lot of commonality and if there were some outside influence that they trusted they could have a common thread together.

The processes are very similar between the companies, how each company decides to implement it provides their competitive edge so.. You talk to some engineers who are basically doing the same job or have the same problems, and they go and look at the technology. Each one will see it from a different perspective. It makes them aware of what's available to address their community needs while they retain the autonomy to compete with each other.

It would be interesting to find out why the different shipyards developed different techniques. For instance, why did Ingalls use CALMA, and Newport News use VIVID while other people used SPADES or AUTOKON. What drove them to use dissimilar techniques.

Of course in our perspective we see that they use the same solution because in their process they chose one computer solution, it was CAD based, with the visualization to do drafting, with the ability to move information to manufacturing. That was their basic requirement of that block of the phase. What it did in turn was allow the CAD suppliers to compete: Which one could provide the best value when that company was prepared to go do the purchasing. Again, the information and objectives were all similar and you look at what's the state of the technology when you get ready to do the purchase, and you understand where you're going. That's the analogy I'm trying to move forward into the marine industry. It's the same concept that the vendors still will understand what's the objective, the user base, what provides value, but lets each one of us go and compete, competition still has to be there.

Robert Schaffran:

We are pushing for the panels to do more and more of that on the NSRP. There are giant accords doing such things right now. Part of the problem is that a lot of them are very fnctionally oriented, but I personally have been pushing, and it is sort of a hard one to crack. I don't think the NSRP is really organized properly to achieve its vision, because we are functionally oriented and pushing for reformulating some of the panel. Again that is a hard thing to do with sharp changes in the organization. People sort of rebel, but we do now have all the panel chairs get together twice a year at business meetings to sort of share what their panels are doing and identify where there are links and where they should be working together.

Technology assessment implies in at least some areas some functional orientation. One also needs to work at a broader assessment of how technology is developed and how we are using whatever has been developed. It is necessary to have functional people looking at their specific part of the world and sort out what is state-of-the art and what is going on in that area. We also have to be figuring out how it all ties into the big picture. The example is the welding panel, which is coming up with some very significant things that will improve welding that will have zero impact on reducing the time of construction. That is not where the problem is. They are optimizing things that are not the problem. They will come back, everybody is very impressed with it, but it is doing the wrong things. They should be concen-

trating on other welding areas possibly or even other areas than welding.

65 Establish electronic communications within the industry

Jon Matthews:

I happen to be chairman of a SNAME sponsored ship design panel, which is a parallel organization to the Ship Production Committee. SD2, which is the ship design panel number 2, is called computer Aided Design. We have been funded through SNAME, the Society of Naval Architects, to develop an electronic bulletin board which now exists. We hired a guy to buy a PC and bulletin board software. We now have about 120 people who are using it. Unfortunately it's not an 800 number and it's not tied in to something that's easily accessible around the country, but if you're willing to make a long distance phone call into the 703 area code it is available. We have published information available, it's shareable through SNAME with this organization, this concept and this group.

Joe Wudyka:

This item is similar to another one we discussed about linking together all the people who were in this meeting so we could continue this project and communicate very rapidly. It is easy to do the same thing for the industry. Not just the members of the industry who chose to show up at this meeting, but everybody. It is easy. With a network between companies you can do things like share software. We talked in the meeting yesterday about share software.

I mean that some companies have developed software, shipyard A has software that shipyard B can use right now and two people in this meeting talk about wishing to use that. I have this thing I'm trying to work on. Shipyard A is willing to give it to shipyard B to let them use it, just a simple transfer, but they can't do it. If you have the proper network set up, shipyard B, can with the proper rules and whatnot, get into the software that is over here at A and use it. It doesn't need to be converted.

I was in one meeting where one guy said that the software he wrote on an Apple and the other guy said I have an IBM - some equipment - I can't use it. Why did you write it on an Apple, you know most of us have what ever brand - If you have one of the Digital network setups, one fax for either brand of computer to act as a server and one simple inexpensive software package, it does the conversion for you. Lets you go in and use that guy's software. No big thing. I tried to show the guy at St. John's Shipbuilding how that works. You are able to *use* the Apple application on a DOS machine. The software package is called Path works and it is not expensive.

OBJECTIVE IX EXPERT SYSTEMS

66 Use expert systems in designing ships

Jim Hutto:

These technologies, those of initiatives 66-70, currently exist. They exist in some isolated places in the shipyards and they exist in the computer supplier industry. So here we get into what is the objective: do we want the industry as a whole to implement expert systems or are we after the Navy consor-

tium to develop an expert consortium that's a supplier to the Navy, that's what the government and the Navy would like: a single huge company so we get into some business issues with exactly what this means.

The technology has not evolved to the state of having an expert system for an entire ship. These expert applications are still very focused, they're still extremely expensive to develop and the expense is not in the computer horsepower or the software itself-the expense of an expert system is the customer business, the shipyard itself, they're going to dedicate X number of people to go off and put their information into the computer system, that's where the major expense comes from. We as a vendor have installed some expert systems for some of our applications, and we can generalize expert systems slightly between one Corporation and another; there are some levels of basics, but we also find that for an expert system to be successful it must reflect the personality of that particular company because that's how they derive their competitive edge.

They have learned how to accomplish a project using their internal corporate culture, the tools they have at hand. Even though the total techniques may be similar, you may have different resources within the yard, you may have different divisions that are a lot more efficient than other divisions. There are other things which influence what's expert. So to implement expert systems it generally requires the best people in the company to not only sit and analyze what they do but also they have to be motivated and unthreatened because there's always a fear that if they impart all their knowledge in this computer maybe the company doesn't need them any more. So there's always been a psychological barrier.

I Was talking to Douglas Martin this morning, that was one of his points, they've got numbers of people who are about to retire and it's only through expert systems or something like that they are going to be able to attempt to get that knowledge before they lose it. They're losing four out of their top five electrical engineers, for example.

67 Implement parametric design concepts in shipbuilding

Jim Hutto:

Implementation of parametric design concepts is technically available today. MRP is a very good specifications requirements document for the marine industry, they have gone through and analyzed their process and their ship design requirements, and I think it is a good document for any of the shipyards to review at the starting place. With that they do not necessarily ask for a rubber ship, but they came darn close to it. So there are a lot of tools that the Navy has asked for in looking forward so they can do parametric design not only at a component level but also to be able to come into a compartment of a ship and do reasonable modifications and expect that the computer system will do appropriate adjustments; In fact that technology is here. The computer industry has demonstrated that we have the components but not an entire "rubber" ship in existence today. We have the ability to use parametrics in the design process and use therewith the components and hardware in the marine industry.

Parametrics represent the ability to come in with an external set of mea-

sured characteristics, whether it's weight, length, piping pressures; and from that the system is able to go in and select proper components, do proper sizing, and so this gets into parametrics. Historically we've done parametrics at a component level, we've got a whole family of parts. If you had a bracket or a valve you could computerize it, put in some external characteristics, and let it change its shape based on a small set of parameters. Now we're using the same kind of technology on a larger scale, we can use it now at a distributive systems level, and also at a compartment level where you take the dimensions of a compartment and rules about spacing. If you have rules about how close the ribs need to be then as you change the parameters, the distance between the bulkheads, as the ribs space up, get too far apart, well, I'll insert another one and re-space everything. That technology exists now.

68 Capture design decisions as part of the model.

Paul Friedman:

That initiative I have already described as what I called the historical element of a product line. You have already done the work, somebody has already figured all this out and you wouldn't be building a ship if that weren't the case, but now when it comes time to change it you have to recall the history somehow. It is surprisingly difficult when you have ***some*** 1200 people working on the project.

It is one of these situations when the change occurs on the ship, that is embarrassingly obvious that you forgot something. You kick yourself, but in fact the systems just don't help you at all. There is no prompting whatsoever. That is when it is a good designer system that automatically documents the as-built configuration.

Jim Hutto:

That's part of what we're doing work with NAVSEA so in their work with NIDDESC, with database architectures, they're looking at how we can go back and capture design intent; How do we put that in the data and display that to the users. There are some systems coming about to do that, but that is still in its infancy, and I think a lot of that is, we don't understand all the processes yet to build or quantify. What is it we want to capture and what is it we're trying to get it to show.

Certainly we've learned we can capture the final result and we can go out and capture dialogs, and put it into external packets if you will, but it all needs to come back and be reviewed. We don't quite know what the needs are, but certainly the techniques both parametrics, the techniques of expert systems, the techniques of what we call associativity, an example is once you go into a compartment and you have structures in there and *you* lay in a system like piping through rules of associativity you come back and have to change the height of the deck, you have to change the bulkhead then you can cause automatic design changes to "ripple" throughout the design showing how the structures change and how you may push a pipe, and when you push a pipe it pushes a ventilation duct. That is a form of capturing design intent because of rules of associativity in distributive and structural systems.

Some of that technology is being realized. What were the conceptual de-

sign decisions, what are the trade-offs? That is still apart that we are looking at: how do we capture that intelligence, why the engineer chose one solution as opposed to another solution. What's the process, what is it we are trying to capture with this expert system. Except for isolated areas we're doing structural analysis, in structural analysis there are decisions characterizing how you generate the model based on statics or dynamics, is it heat loads, is it mechanical, is it vibrations, or statics, are you worried about contours, there's slot of this that is quantified. Same thing in shipyard production manufacturing Why am I putting the engine here, why am I putting ballast here, some of these decisions are not as well quantified yet, and that's the part we're going to have to get into.

69 Integrate Expert systems with CAD, planning and manufacturing systems

Douglas Martin:

This initiative addresses, in my mind, the problem that we have which is what we talked about up front. We have the problem of hills and valleys in manning. That is number 1. Coming back up and starting up a new program you have a lower skill base than what you would like. You also have guys who are retiring and taking a lot of knowledge with them, which was never captured anywhere because there weren't computers at that time. How can we ameliorate that problem? That is, how to capture some of that expertise in the job in a fairly straightforward way with a system of this type. You capitalize on knowledge that has been in labor for the last 35 years.

If NASSCO were to address this problem, it would put together a survey of potential applications predicated on a kind of return on investment idea. It would be a little softer than straight return on investment, because what we are talking about here are areas like maybe lofting where there are some development kinds of decisions, template kinds of decisions that have a lot more art than science that you want to get down some place.

The point is that this guy is getting ready to leave. We have a situation in electrical engineering for example where four of our top five guys are going to retire in the next two years. Electrical design. So I would look for target areas like that. So look for those kinds of areas and put together a kind of a pro *forma* on cost benefit analysis, and maybe we are talking about template: a format that some guy can fill in. Have the shipyard manager look for these areas where he is going to have a problem and that technology could help.

70 Develop expert management shipyard software

Jim Hutto:

I think there area couple of prerequisites there, the first is being able to quantify what the management objectives are and the flow and with that you begin studying the decision trees that we go through and how to bring in the business information. Our focus and exposure has been very limited in the management area. It needs to be included in these dialogs:

- Which market are we after, because certainly when we look at aerospace industries and the divi-

sions that address commercial markets are separate divisions

- What are the requirements, the measures of success are different, so I don't think you'd carry the same systems across as we begin looking at expert management systems for shipyards.
- Ž What business does the shipyard believe that it is in, especially in the context of this consortium, are we trying to combine the Navy corporation or are we providing tools out to each individual shipyard where they can compete better in the world community?

In the aerospace industry there are spin-offs from the government contracts, materials, ways of doing, that carry over into the commercial side, but the process priorities are different, the schedules, some ofthe discrete techniques may be different and just the nature of the government business and their requirements will cause that to continue.

OBJECTIVE X CONFIGURATION MANAGEMENT

71 Apply the processes of configuration management to our processes

Jim VanderSchaaf

Configuration management has been applied to our products (e.g. ships) for several years. Some parts of this process have been automated. In the Dr.Deming view, we have paid insufficient attention to improving our processes. We typically address or fix the symptoms of inferior processes. The intent of this initiative is to apply more discipline to our process changes by applying configuration management to them - and documenting not only the processes, but the effects of changes in these processes after we make them.

72 Understand the discipline and training of configuration control

Dan Billingsley:

We talked previously about configuration management, that it is intrinsic to the product model philosophy here and it needs to manage not only the configuration of the ship, but the applicability of analysis results to specific configurations and also the relationship between configurations and the requirements that cause them to be. You figure the situation where a pump has gone down and it is a 500 gallon/minute pump and you have available here either a 450 gallon/minute pump or a 700 gallon/minute - which ***one*** do you take? You need to be able to look at what the requirement was for that pump. If you find it's capacity was 408 and you pick the 500 because that was the next unit greater then it opens up more options to you. Our dream it that you will be able to touch any item in the database and extxact why it is the way it is type of information back to the diagram level of design.

73 Design a system that automatically documents the as-built product

Mike Connery:

This is one of my little pet worlds of configuration management. In our business, cmfiguration management ***is***

everything. If you don't know what you have at any given time during its life cycle, I don't understand how you can produce anything. A perfect example, a story I tell on configuration management - in my early days with aerospace I did a project on a little island called Quadulena in the Philippines and it was a missile range. We had an Air Force general who came out for a couple of test firings out of Vandenberg and lo and behold the first bird came in and blew up and he said, "no, I don't want that one." The second one came in and did the same self destruction sequence, and he said that is not the one I want. The third one came in and made it perfectly and he said, perfect, I want that one. Lo and behold it went through such a change evolution so fast that we didn't know what that one was that came in. We just couldn't keep up with the configuration of the changes from the first vehicle to the third. We couldn't tell him what it was or how it differed from the first one. That is a bad scenario to be in, but I propose to you that a lot of people are in that state.

This initiative has to do with producing an automated configuration management system. I will mention two systems that we have built for the Navy and I strongly suggest that BIW or anybody go take a look at them. One is called CSA, a configuration status accounting system. The Navy paid us a significant amount of money to build it and it is located in Norfolk, VA at the Naval Sea Systems Engineering Combat station. R handles the real time configuration account statusing of 1400 weapon systems down to the piece parts. It is a frilly relational system. The government has not used its full capability of it yet, but it is there. The genesis, the schemas of how to do it in a relational environment are all there.

Prime contractors input into it. We input our SQQ 89, VD2 50 time awards down into it. It handles small track input, a lot of time and effort is put into it. The schemas and process flows have all been documented within a CASE tool called Knowledge ware which we introduced the Navy to. Someone should take a look at it. We also have a parallel system at our facility in Syracuse, NY, called CMS for Configuration Management System. What CSA is to the Navy, CMS is to us as a prime contractor, as a prime we have a lot of subcontractors bringing data into us so we truly have the position of the Navy and we are coordinating these primes, but the critical thing that I think a corporation has to understand, at least I believe, is the serviceability of the product. That is where I believe the market will be in the future because the acquisition cycles are going down.

Even though we are a part of GE I have taken this CMS system that we have and divorced it from GE and true GE aerospace is a subcontractor to this system for the following reasons: By the same reason that I cannot dictate to a subcontractor what he should use as his designer manufacturing CM system, I can't do that to a GE division either. Let them take their current invested systems and do what they may with them. Just give me your CM in this format. That is all I ask for and then I take that into a life cycle mode that anytime anything is tweaked aboard that hull out there I am tied into the 3M system that the Navy has in their spare system so I can update these configurations. It is not rocket science, believe me it is not rocket science. They are not very expensive to

get into, they are common sense. The down fall is that there are not a lot of people around who understand the technology, but you can grow a task within an organization.

The thing you really have to be aware of is "beware of Greeks bearing gifts." Yes, these systems are out there and it is the same analogy of trying to put MRP2 into a manufacturer. You can buy a fine MRP2 system. It is not the cost. The cost is integrating it to your existing infrastructure. That is the cost. If you were to take something like CMS, the configuration status accounting system we use in Syracuse for the product, and bring it into the shipyard to pilot it in which is the right thing to do, prototyping it is the way to do these things. Don't sit back and do all this requirements definition, try it. See what happens. You can tweak it better that way. You can go ahead and do that, but listen to your information systems people. They will talk to you about how to go from the systems engineering bill of materials from this into my manufacturing bill of materials. And if they start talking about the integration linking the systems together, that's when you'd like to line them up against the wall and shoot them. You can't do that. You can do it, but it takes time and money.

I propose to you where a lot of companies go wrong is in such a drive for seamlessness; you don't need this seamlessness every time something twiddles in manufacturing. When I have to update my engineering database, It can be done on a daily basis; just take the data and refresh it back into those other systems, don't make them handshake each other all the time as there is no value added in doing that. If your update cycles today are one week, two weeks, **what** is a day? It is a million percent improvement. I guess the message there again is that it is automation for automation sake. You don't need to have this high speed data transaction stuff, not in our business. We are not in the commodities business.

My recommendation would be to get to Dan Cada or somebody in PMS 400 in the AEGIS program, have them request from Syracuse, General Electric, a copy of what is called PB&SA (Part Breakdowns Status Accounting System). That is the new name for CMS — PB&SA. If anything, just get the documentation — the schemas and the requirements — into your IT people's hands and let them look at it. Again, it is GI, runs out of X Oracle database.

I am sure we could work something out, especially through this committee; maybe this would be a good thing to do. Very cheap, economical, prototype on CM. This system takes it all the way down to the lowest piece part with a hierarchical structure to build it all the way back up in different versions. That system has over $3,000,000 invested into it. That's a lot of money and there is a lot of integrity in that system. I strongly believe in it. I think it is a safe thing for this committee to take on: it truly is.

Paul Friedman:

That is an interesting one. We had a lot of argument about whether automatic should be in there and I guess we finally left it in as we all agreed that doesn't mean the system literally does it. I guess it more or less demands it. This is very much a vital issue at our shipyard today because we are heavily into CAD and the Navy is very much a player, a major investor in what we are doing.

One of their concerns is, will they get the as designed model or the as built model.

It is interesting, so far we only agree on the semantics and that is that they are going to get the as built condition, but it is going to be as a design model. As recently as this week I think that I was told by my countert in the Navy, "I don't care what you think it is, I am calling it an as built model." One can call it anything you like, if you are the customer. I am trying to tell you that you haven't paid us to do an as built model, and with today's systemsit is very expensive to determine what the as built was. Now, on the other hand we are deeply involved in a work order system that will allow us information access through the feedback method, and it will demand that we understand what was in fact built, because you can't create the next work order unless you know that. It is all predicated on how much progressis made on the previous one. I can see in the near future that we will have the means to actually do that without paying a crew to go out and do an audit of the ship. That is what is really expensive today. I think this is completely practical, soon if not now. In other yards it could well be practical now.

OBJECTIVE XI GENERIC MODULAR SHIP

74 Build a national library of reusable design modules down to the part level

Lorna Estep:

We've done some work in this area in terms of functional descriptions of design models and in the electronic area and we found them very useful. The program code's sharp, its managed out of CRANE through NAMSEA. My suggestion is that you might want to look at that activity, how they've set it up, howthey're organized and what they're doing as something that might be useful that the Navy can assist on, because we've got functional designs, we've done electronics, battery packs, enclosures, so they've started up on a very high level, specifically in the electronic areas, and they've done cross use of these between the ships environment, submarine environment, and the aviation environment so that there's some leverage in the industry that you can get if you look at it not just within shipbuilding but look at it perhaps at more of an industry forum level.

I can provide information on that. The only other comment I have on the focus on the level of excellence in the shipbuilding industry in terms of the MANTECH, initiative item 63, I think that is something that is doable. I think that the Navy and the industry can work together on that. There are five, seven centers of excellence that the Navy's spent some money on. They're somewhat focused but I think that's an opportunity for us to get projects or programs that might be of interest to the shipbuilding industry and get these centers of excellence to start producing some product. I'd like to offer that as some opportunity that we might want to seriously investigate. The program manager is Steve Lender and his deputy is Leo Pontsky, and I will probably talk to Leo at least about what we should be doing, and perhaps there should be a separate forum to address that issue.

Jim Wilkins:

A library of reusable design mod-

ules is the sort of a concept that the Japanese have done. I have no problem with that whatsoever. If we get a good module that is easy to build and provides a functional working system, why redesign that for every ship? As a matter of fact, I have been arguing this within the Navy. We have, on Avondale built ships, the LSDs, the latest version of them, the whole lower elements of parts of all the machinery spaces were built in modules. All built off the ship, what we call machinery package units and built in the shop and just landed in the ship. The problem is that the Navy designers for the next auxiliary ship will not ever look at those as built drawings. They Will start with their last set of contract drawings or do it from their paper or something and to me modules already exist. Sure, they may not want to have them exactly the same. They have a starting point if they will just use them. But I have been arguing, I teach a course to start using as built drawings from existing ships where the producibility improvements or thoughts are already in them. The shipbuilders thoughts are in those designs to some extent, except where you said they can't do it.

Robert Schaffran:

I strongly support that and is important, but the efforts that I have tried to get these things going have failed. I got some money out NSRP to begin the developing of this library of reasonable design modules and that didn't go anywhere through a variety of contractual problems we had with these shipyards that were going to do it. The second part is that SP4 had one of those projects in the air to do, and that wasn't one of the ones selected by the control board to do. The reason being is that a lot of these shipyards, particularly some of the more progressive ones, are doing this on their own. They are developing modules on their own. They are working in some of these foreign shipyards and adopting some of these models and they don't want to share it. I think the Navy right now in affordability through commonality is going to do this. They are coming up with modules, reusable design modules. They are picking a couple of machinery space modules, pieces of machinery space for demonstration, a couple of accommodation space modules.

The problem I see with what they are doing is developing modules before they understand build strategies. They have common modules, but no concept of a build strategy, and so I feel they may come up with modules that will not fit and still haven't solved the problem. Every shipyard wants to redo designs I think. We are selling manhours, not ships, the whole concept is selling manhours. Of course by doing that NAVSEA doesn't have to do anything. I think that we were trying to push and take a couple of ships - all ships have auxiliary machinery spaces and basically contrived of very similar equipment. Lets take what the LST has done and a couple of other ships and pick the best of everything and come up with some standard modules. Take the detail design drawings and go from there. It is not being done. The problem with the ATC effort is that Corky Grahm is driving it, and he *is an* integrated electric drive guy and trying to push integrated electric drive modules. We keep saying if you are going to pick modules, the two most important criteria should be first, is it commercially viable and second is it one of the things in the ship construction

process. They are not looking at either one of those.

75 Create a consortium of Navy shipbuilders to create a joint commercial endeavor

Robert Schaffran:

I think it is a good idea, but I am not sure how to do that. Navy shipbuilders, refers to commercial yards building Navy ships. You are not talking about Navy yards. I interpret that to be yards that are currently building Navy ships joining together to come up with a commercial venture. Some people mentioned at the meeting that there are shipyards working together. I don't know who they are. I know some of the commercial U.S. yards work with foreign yards cooperatively.

The only place I see it is in this Phoenix World City project. It is phenomenal. These guys have spent millions developing the concept and have a thing they call the National Shipyard and they already have signed letters of intent and looking for more. Avondale is involved, Tampa ship is involved, Beth Steel is involved. Newport News is involved. General Dynamic Electric Boat might get involved, they are looking at it right now. They are going to give the lead contract for the construction of this monster to Newport News and the reason they are going to Newport News is that they have the corporate infrastructure of Tenaco behind them and it is a big project and maybe Electric Boat as a late comer. The lead will go to Newport News and portions to Avondale. Tampa and some of Avondale might be floated around in Tampa and they will add some things to it and it will be erected at Bethlehem Steel because they have the dock to do it and they are looking for other people. They also have a National Coalition of suppliers and people are working on it right now full-time. DuPont has people on it. ITT is involved with it. Marriott, Delta Airlines.

They have this national creativeness build America committee going around talking to all the governors of the states encouraging them to promote the concept in Congress. Which is responding positively. It is a major project; a 15 -20 million manhour effort. The work going on in that area is being pushed by the owners rather than the shipyards. It is almost too big for any yard today.

Generalizing the Navy designs to generic shipbuilding designs, I think is important, and we are working on that right now. I circled that because I promote that concept and we had it as part of the affordabilities of commonality and they had a workshop out here a couple of weeks ago for all the NAVSEA people, mostly local reps for the shipyards, and run by Chris Kay who is in charge of the Unipes (?). You should have been there. He is trying to get feedback from shipyards on the whole thing. They had a morning session, they had about 100 people in the audience and a lot were Navy types trying to get everybody up to speed on what is going on and a lot of U.S. shipyard representatives. The morning was a cross cable brief of the whole program in general with a question and answer session, and then they had three splinter groups in the afternoon who broke out in groups for two hours with each one addressing a different area. One was addressing common machinery space modules. Corkey Graham led that one trying to get the industry to buy in. The second one was accommodations,

and the third one was generic build strategy. That is the one to which most of the shipyards came.

It was a very interesting afternoon session, a lot of people in favor of it. We had about 40 people in our group. A lot of give and take and concerns. I didn't try in ply the build strategy into the affordability commonality at all. Introduced the concept of generic rules and what I thought the rules strategy consists of and a possible way to go back to developing one and then opened it up to discussion. Minutes were written, but I haven't seen them yet. One of the ideas discussed, from a Navy perspective rather than commercial, was notional, so it was non-threatening to the large ship industry. We would have all the capable yards, I think 7 were identified, develop (we would pay them to develop) and optimize, rationalize, and build ***strategy with*** concentration on the build strategy that will reduce the time of construction rather than anything else. Then we would get all 7 of those build strategies and have them presented and take the best ideas from each to come up with one total rationalized build strategy. That is being done on a very small scale right now in the midterm SEALIFT effort.

We actually have hired NASSCO and Avondale with Mike Waves, who is actually running that project, and we gave them a baseline ship with the term SEALIFT, and told them we wanted the build strategy to allow you to build that ship with the construction period from contract award to deliver in 24 months. 24 months max, if you can do it faster, do it faster. One shipyard came in with a build strategy that was like a 25 month construction process. The other came in with one of 22 l/2 months build strategy. Combine the best of both of those and you come up with a build strategy that is 18 months and they are both feeling good with it. It requires not *just* **a** shipyard problem, it requires a lot of changes on the part of the Navy also, but the build strategy is fairly interesting, and they are coming up with some pretty innovative ideas. Some of it is almost like arranging things in geo space.

We are actively working on that right now and I think the Navy plans to follow upon some of that stuff. I think the Navy is buying into the concept more than the industry is because the thing is: if you come up with a generic build strategy, then you have to agree to build it that way unless you can prove you can do it better. What we are trying to prevent with what is happening is conflict on how you prove you can do it better. If you look at the TAGOS and the SWATH ships, there was a whole producibility group working on how to build it and we ordered from a shipyard who wasn't part of it and they stepped back 20 years in the build strategy and we can take a bath in that ship. How do you prevent that from happening? Most of the shipyards felt that you just give me the design and I will give you the build strategy. They didn't like that strategy as they felt they had their own particular build strategy that was better than their competition.

If we went out and Avondale came out with their build strategy and NASSCO came out with theirs, whoever we might be able to pick the best build strategy out of all those and award you the contract. The problem is that the best build strategy in this country is not even in the ball park of world fast build strategy. What we are trying to push is world fast build strategies. We don't want to go with business as usual and just pick the best shipyard in this coun-

try. We want to combine the best ideas with all the shipyards and come up with one World Fast build strategy that we can all build to. I think we can do that and we want to push them to a new level. They have problems with that because they feel they are at great levels already.

We are getting into the details of how to build, because you are already doing it. NASSCO and Avondale did not present what they did and vice versa. *The only* way you can take advantage of those is to go out with a bid which has the encapsulated build strategy and say this is the build strategy for you to bid on. If you can do it better that is up to you. To me that is no different than to go out with a design and say this is a design and you have to construct it or build it or design it to meet these requirements. You give them some flexibility.

Most shipyards wanted a lot of flexibility, and I feel the more you give them in some cases you end up with a better product. Take the LSD 41 versus the 44. Because Avondale had the flexibility they were guidance drawings and they could do whatever they wanted and they did sometbing better than Lockheed, but you also have backlash in those things when flexibility allows people like Dermont to get into the ship. The hulls were actually designed to be built in two halves and all the equipment was located so that there's nothing mounted on that same curved surface, but that was not obvious to the non-participant.

Jim Wilkins:

Personally, I don't know why that is a good idea or necessary, but I think the shipbuilders are more likely to try to create individual commercial endeavors rather than try to go together to meet a requirement, because in fact in most cases they don't need one another perhaps. Only when they need one another will they work together. I don't think the yards need to spin off a major new shipbuilding company, I think they can do it with their present facilities inmost cases. Maybe BIW couldn't do it herewith their current work load. All I can say is we were doing it at Avondale.

If the real difference in work content and overhead and other things make anew yard worth while, then you can do it. Newport News in a sense can do that as their whole north yard was built with the idea of doing commercial work and Navy work in the south yard although they have never actually done that as the commercial work business died just about the time they got the dry dock finished. They are using that dry dock for aircraft carriers, so they are using it. That plan is perfectly valid still. It was one of their earlier plans and NASSCO has done that. NASSCO has built commnercial ships and navy ships in the same shipyard. I can't believe that they would say we would have to set up a separate company to do that. Again, it is not a necessity. Maybe desirable in some cases, and there are differences in the way you approach the work, but nevertheless that is a management decision. You can manage that.

76 Develop modular designs

Jim Wilkins:

We should have been doing that. All of the shipyards today build ships in a modular concept to some extent. Some with greater efficiency in my opinion than others, but they are all doing it. We have to continue to do that. This development of modular designs probably goes

back to modular payloads or modular portions of the ship where you can change out the engines easily by just plugging in a module or change out the weapons suite by plugging in a module. There have been efforts to do that for years. The Germans are doing it very effectively these days as I understand it. I have never seen a MEKKO, I have never been in their yards, but some of the people in that ring have been. That is the example. Again, it ***is*** something that is being done in the world today. Why are we not doing it? It is not *a* technology issue and is not a computer issue - its just you decide to build ships that way issue.

77 Find a way to build commercial and military ships in the same facility

Jim VanderSchaaf:

Several issues are linked together within this initiative. Typically military shipbuilding cycles are measured in 4-5 year periods, whereas commercial shipbuilding in the world's most progressive shipyards are measured in 10-18 month time frames. As a direct result of these differences, the change and approval process is fundamentally different. In addition, there are differences in specifications of material and equipment, and testing and QA procedures. These and other practices can cause important process differences to be used by shipyards when applied to commercial versus navy ships. The net result of all of this is for shipyard personnel to expect and anticipate a "way of doing business" that would require considerable training to do a different way. The presumed need for training assumes that sufficient similarities cannot be assimilated by both naval and commercial practice. This has been the case to date. There do not appear to be any easy answers to this issue.

78 Generalizing navy designs to generic shipbuilding designs

Jim Wilkins:

I am not sure what the discussion was that lead to that comment. I am not sure how you generalize with the requirements being so different. I would go the other way perhaps, or maybe they don't have specific designs for the navy, but more of a generic design for the navy. I'm not sure what it means SO I am a little ignorant talking about it even though I blocked it in as one I would be interested in being involved in because I think generic ship designs are usually nothing more than using the same hull.

That isn't necessarily a good pay off. A hull is not that much of an expense and you are constraining your ability to lay the ship out in the most efficient way, and that may actually work against you. These military ship hulls are optimized for higher speed than a commercial ship.

OBJECTIVE XII SERVICE LIFE SUPPORT

79 **Develop a ship repair strategy using advanced technology**

Mike Connery:

One quick scenario on this. I guess I will cover #79 and #81 concurrently here. It is a support market we are getting into right now that one has to take a look, at and in the SSN 21 program we are contractually obligated to deliver no paper on board the ship at

delivery. With the prohibition of paper aboard the hull we are driven into a new technology called IETM, Integrated Electronic Tech Manuals. The basis of an IETM right now is not a typical page turner, it is a knowledge based machine, and the basis for how it works is that you take all the documentation that it associated with a particular weapon system and you take the knowledge experts who know how to repair one of these systems and you have them build work packages. Given this condition, what is the path you would normally take through all this documentation, manuals and engineering, understand their knowledge and rules based on a system? When you are at sea and a scenario comes up, one just takes that number and clicks it into the system and you are on your way through this repair sequence. That is the genesis.

The next obvious thing is to attach the information directly into the bus structure of the weapon system so that it automatically monitors the module, and when something arises it warns you and says ok guys we have to go do this stuff. IETM is a marketable thing right now and might be another good thing for this committee to take a look at just as an aid to prove to management that this technology is really here.

We are dealing with David Taylor Research right now. Within a shipbuilding world they put a quote out, we bid on it and it says here is a standard air compressor that a lot of hulls use. It has been around a while, it has a lot of documentation associated with it. It has a pretty good life cycle maintenance to it, but we want it all automated. We want to get rid of all this paper. Ok, we take this IETM and we print all the data into it and then sit down with people who understand how to fault isolate this hybrid thing that is really not digital. It is all analog, mechanical stuff. He is using this IETM on it. It understands what he is working on, knows the manual and everything, and he is going down through these hull trees, these diagnostic things and the system knows what he is looking at in the thing and finally lo and behold something crazy like a start up capacitor on the electic motar is gone. The system knows he is at that level so I found the problem and up comes this automated two kilo form and it has all the data filled in where he is already and it kind of knows what symptoms were afoul and fills all that in and he just finds it.

The worst thing with two kilo forms is that people don't fill them out, especially the white hats. So now it is done and you take it to the next stage and say ok, now I need this part. In today's world the guy pulls out his little floppy disk and he walks to the supply shop and gives them the disk, they throw it into their supply system and ok, so and so needs something and it goes and starts to update their supply system. So the SNAP system and all is on track.

The other advantage in this main area of training for people is the basis of IETM that has the technical documentation manual, video disk capabilities so that when it is not being used as a tech manual it can be used as a training device. For the Navy, this means shortening the pipeline for training and facilities. It is refresher training and it also has the capability, if it is not being a tech manual and it is not being an interactive courseware device, to be a "test egg." It runs on a DOS machine. We picked that architecture to let the market push it. The shipbuilding industry should be looking at and incorporate it into their hulls because all the software is GFI.

Everything we develop and they pay us for is available to any other military customer. Talk about lead finding technology, you could put this thing to use immediately, but again it is to get a hold of your customer and have him request this stuff coming in. Bottom line to the whole thing I believe if anything this committee can do is to build this inventory of not so much proprietary software, government software that we have all played with. That would be a natural listing. Most of it is not rocket science, it is just there.

Jon Matthews:

The ship repair industry and the ship overhaul industry are getting the short end of the stick in the process of modernization. it's primarily because they don't have a lot of visibility in the community, as this particular community has been formed. They're kind of the low tech end of the business. There is a massive amount of technology that the repair organizations can take advantage of, primarily in the data collection and the material control side of the business. We must find a way to share the strengths of the computer technology initiatives with the repair organizations. They don't have a lot of money, they're definitely short term focused, and that's really why they're in that business. We must find a way to take the technology that exists today and make it available to them in a way that they can we.

Material is the one that is the most visible to me; consolidated bills of material and elements of efficiency for material ordering. In the repair world these things are just now starting to be considered important and are economically a major contributor to costs and **cost** savings in the repair business.

80 Extrapolate new construction methods to lifetime support

Jim VanderSchaaf

If the intent of this initiative is to apply the techniques of modern shipbuilding to the overhaul and repair industry, an answer is that this is being done in the more progressive repair and overhaul facilities. If the intent is to apply computer aids such as CAD/CAM to overhaul and repair, this also is being accomplished, but to a lessor degree. One of the issues to be resolved is the maintenance of drawings or 3-D models. Typically, prior to overhaul, a shipcheck effort is undertaken to identify differences between the latest set of drawings and the ship as it exists. This effort could be avoided if the design was well maintained throughout its life-cycle. Clearly, the benefits must outweigh the costs. This issue is being addressed on a Ship Program basis.

81 Develop automated crew training aids

Jim VanderSchaaf:

This initiative is related to number 83. In the Navy world several efforts are already under way to accomplish this. Technical Manuals are being made available on-line on workstations aboard ship for the purpose of training in operations and/or repair. Additional efforts could be directed at commercial programs by incorporating these requirements in the shipbuilding contracts.

82 Use shipboard computer appli-

cations during a shipbuilding program

Jim Wilkins:

This initiative was one I suggested and merely is recognizing that the Military Sealift Command, who is an operator of ships has developed a number of operating computer programs supporting ships where they have sensors and tend toward expert systems even. Where they have picked up vibration data or sense the temperature and pressure in distributive systems, and when those things start getting to the point that it looks like, that there may be some problems with the machinery then that information is actually sent back to shore, automatically if necessary, for them to review it. If there is a determination that the equipment needs some work, then the work needed is printed out.

The point is that they use that aboard ship, and they found the cost of developing that system paid off. In one ship overhaul when they used the same vibration monitoring technique on the engines that the shipyard had repaired during the overhaul and reinstalled, they found out it was working worse after it was installed in the shipyard and put back on the ship then it had been. They took it apart and found a bearing reversed or something like that. It saved them a failure at sea which would have been tremendously expensive. Why aren't the shipyards using these techniques for monitoring the quality of their own work?

There are some good operating systems we can use inside the shipyards. I am actually trying to put a panel together for another SNAME group of ship operators and for computer aids in ship **operations. Again,** most of the owners **have developed their own systems and they consider these proprietary and they spend** a lot of **money** on them and they are not willing to give **them** to their competitors. I am hoping to get enough of them together in the same room and get Military Sealift Command, who is a government activity, to tell them all the great things they are doing and hope that will stimulate conversation and a little sharing of information.

Where do we go from here? That can be fed back if there is anything positive out of that into shipbuilding. That is what I had in mind when I proposed that we keep that as an open item and as something to look at.

83 Add value to ships by incorporating computer aids for operation

Jim VanderSchaaf:

This initiative is intended to describe a means to increase the value of US commercial and naval ships by delivering computer software which covers all aspects of ship operations with the ship. Much of this work is being accomplished on Navy program. The presumed intent here is to have shipyards design and develop such computer aids in conjunction with ship owners and operators.

CONCLUSIONS

So let's do it! Let us implement this action plan, because it leads us to take both short term and long term steps toward industry viability. Ultimately you cannot control what you cannot produce; therefore, production of many kinds of products is needed to not only sustain

our economy but also to provide our children and grandchildren with options. Although shipbuilding represents a small part of the United States economy, it is a bell weather for complex heavy and high technology industry. Shipbuilding combines both factory line production and outdoor construction. Consequently and potentially our industry can combine the best practices of fIexible computer integrated manufacturing with the best practices of complex outdoor projects.

We are not talking about top managers alone. Middle management represents both a barrier to success and a powerful source of support in attitude and successful application of new approaches and technologies to this very old industry. Let us involve all levels of management in the process of keeping the ball rolling!

We can conclude that the participants in this initial study present the problem in a realistic manner. The message stands out clearly from the knowledge bases assembled at the workshop: change our thinking and change it fast!

RECOMMENDATIONS

So let's get funded to do it! It is not enough to have sounded this alarm and to have proposed 83 concrete steps toward improvement. The Council and the Panel must keep the momentum of this project going. Without such support the follow up to the action items will be weak or lacking altogether. With support the action plan leads to more persons committing to more effective actions.

ACKNOWLEDGEMENTS

We wish all suppliers, designs, repairers, and producers of ships in the United States and Canada had contributed to this interim report; many have, however, and we hope all are included in the near future.

The author especially thanks the David Taylor Research Center, the Panel chairs, and Newport News Shipbuilding for their crucial support and encouragement of this project. The author also thanks the innkeepers at the Captain Daniel Stone Inn for their patience and understanding: (Why does Dr. Kelly carry a bull whip?). And finally, great thanks to the participants and their bosses who worked so hard to arrange to be there amidst busy schedules and who worked so hard at the workshop itself.

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Acronyms

Compiled by D.H. Thompson for N4-91-5 May Workshop 1992

ADP Automatic Data Processing

AEGIS U.S. Navy phased array shipbuilding program

ASE The Association of Scientists and Engineers

ATC Affordability Through Commonality

AUTOKON.. lofting software from Norway imported by MARAD in the '70s for U.S. shipyards

BBS electronic Bulleting Board Service

CAD computer aided design

CALMA a CAD/CAM system marketed by Computervision

CALS Computer aided Acquisition and Logistics Systems

CAM computer aided manufacturing

CDRL Contract Deliverable Requirements List, usually used to mean the line item deliverable itself

CEO Chief Executive Officer

CMS a prime contractor companion to CSA for configuration Management System

CSA, a GE-developed and DOD-used configuration status accounting system

D-BASE 3 proprietary application database program

DID (Data Item Description), a detailed description of all the data that must be reported

DTRC David Taylor Research Center, the U.S. Navy's hydrodynamic and structural research center at Carderoc, Maryland

ECB Executive Control Board of NSRP

ECPs Engineering Change Proposals

EDI Electronic Data Interchange a series of standards for purchase orders, materials confirmations, etc.

GSA General Service Administration

IDEF information modeling technique

IELM, Integrated Electronic Tech Manuals.

IGES Initial Graphics Exchange Specification

IRSP Information Resource Strategic Plan

ISO International Standards Organization

1S09000 International Standards Organization standard for quality

IT Normation Technology

LSA/LSAR Logistics Support Analysis/ Logistics Support Analysis Record

MANTECH. . Department of Defense encouragement of manufacturing technology

MEKKO a system of weapons modules in frigates being build in Germany with coordination throughout Europe

MRP Manufacturing Resouce Planning often called (MRP II)

MSC or SEALIFT Military Sealift Command

NASSCO National Steel Shipbuilding Company

NAVSEA contract with Intergraph in April 1991 = "CADII"

NAVSEA Navy Sea Systems Command

NIAM Nijjsen Information Analysis Methodology

NICAM a sytem for computer aided manufacturing of propellers

NIDDESC Navy-Industry Digital Data Exchange Standards Committee

NSRP National Shipbuilding Research Program

PB&SA, part breakdowns status accounting system

PDES Product Data Exchange Standard, a series of six application protocols developed with NIDDESC input

PMS 400 Program Management System the procurement authority in NAVSEA for the CG51 and DDG51 classes

QA Quality Assurance or Mil Spec **9858**

R&D Research and Development

REAPS Research and Engineers for Automation and Production in Shipbuilding

SCN Ship Construction, New, formerly ship characteristics board

SGML Standard Generalized Markup Language

SNAME Society of Naval Architects and Marine Engineers

SNAP computer system for on board spares per page 100

SPCC The Ship Parts Control Center, Mechanicsburg, PA. the U.S. Navy supply and support distribution organization

SSN21 Sea Wolf submarine class

T-AGOS and the SWATH ships. . recent designs of ships in NAVSEA which consciously employ production ideas in the designs

VIVID Newport News internally developed CAD/CAM system

WITNESS a simulation tool for the Department of Defense

References

1. Ernest G. Frankel, "The Path to U.S. Shipbuilding Excellence -- Remaking the U.S. into a World-Class Competitive Shipbuilding Nation," Journal of Ship production, SNAME, volume 8, number 1, February 1992.

2. Thomas Lamb, "Organizational Theory and Shipbuilding A Brief Overview," Marine Technology volume 29, number 2, April 1992.

3. Richard Moore, "Point Paper: Which Business Model to Follow for Computer Aids in Shipbuilding? or: Does Operations Management Really Matter?" an unpublished paper forwarded privately to the author in April 1992 to prepare for the workshop on computer aids for shipyards.

4. James Rogness, "Breaking the Chains of Tradition and Fantasy - - A Revolutionary Approach to the Constraints on productivity," Journa1 of Ship Production volume 8, number 2, May 1992.

5. Ernest G. Frankel, "Management of Technological Change and Quality in Ship Production," Journal of Ship Production volume 8, number 2, May 1992.

6. Michael Wade and Zbigniew J. Karaszewski, "Infrastructure Study in Shipbuilding A Systems Analysis of U.S. Commercial Shipbuilding Practice," Journal of Ship Production, volume 8, number 2, May 1992.

7. Daniel W. Billingsley, Jeffrey D. Arthurs, Karlu Rambhala, and William R. Schmidt, "Revolution at NAVSEA, Managing Design and Engineering Information," paper #14, SNAME/ASE Naval Ship Design Symposium, 25 February 1992.

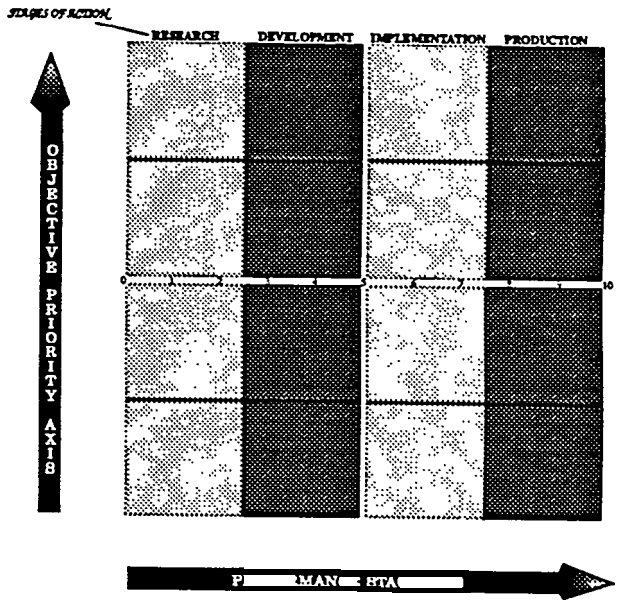
PROGRAM for MANAGING ACCOMPLISHMENT

Interpreting the AMCat Diagnostic Matrices

The matrix derives from the idea that things either grow or die. It illustrates the developmental character of growth and defines the optimum path for achievement so that growth can be managed. This path begins with the creation of a vision/goal, proceeds through the stages of performance, and ends with completion-making way for the next step on the spiral.

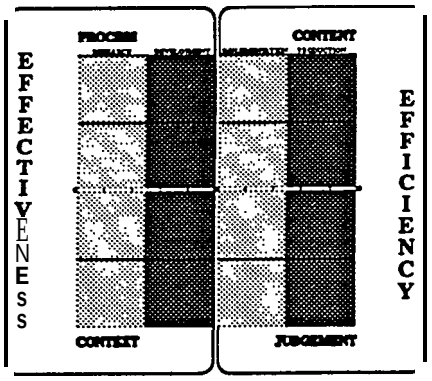
The Systematic Management of Accomplishment

The action matrix maps the optimum path for performance by graphing the priority of the objectives (vertical axis) against their current stage of performance (horizontal axis). The matrix organizes the stages of performance into four categories of action-research, development, implementation, and production-and displays them as vertical bands progressing from left to right.

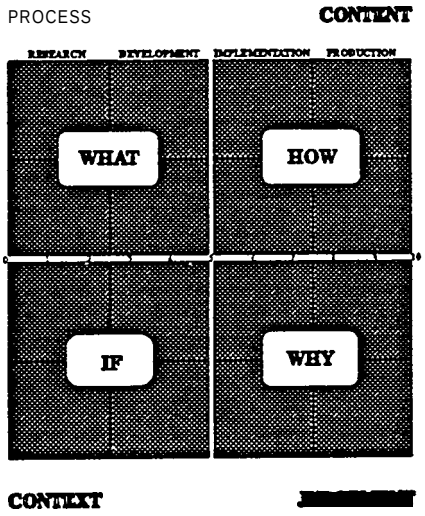


Accomplishing goals involving numbers of people, functions, skills, capital-and time requires careful deliberation on issues of effectiveness ("What actions can I take that will achieve the goal?") and issues of efficiency ("How do I carry out those actions while minimizing effort and waste?"). Considerations about effectiveness derive from theory and past experience. Considerations about efficiency derive from immediate experience.

The left half of the matrix displays objectives which need to be explored in the context of effectiveness (research and development). The right half of the matrix displays objectives which need to be tackled in the context of efficiency (implementation/production).



The matrix provides a context for initiatives taken at different stages of performance and levels of priority. Each of the four quadrants reflects a different approach Context, process, Content, Judgement. Each one defines the nature of action taken on objectives in its quadrant.



The lower left quadrant illustrates limited information and relatively low priority. It displays those objectives which need research in terms of their consequences to the goal ("IF")-the overall context created at the beginning of the AMC at which defines the endeavor.

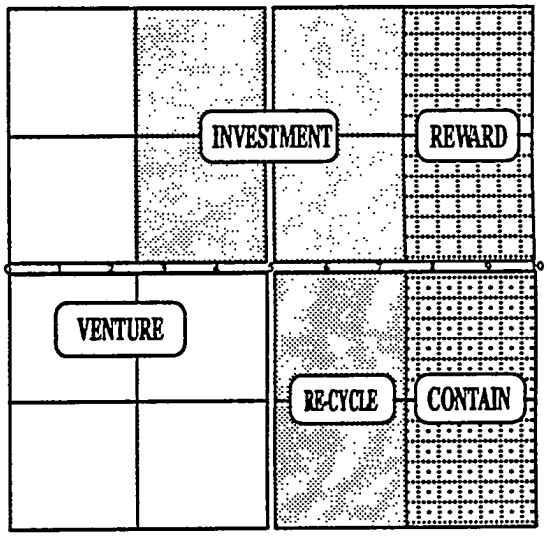
The upper left quadrant assumes limited information and high relative priority. Develop objectives in terms of the methods through which they might be accomplished-"WHAT" process will bring them to successful production so that they support fulfillment of the vision/mission.

The third quadrant, upper right, illustrates hands on, operating experience and high priority. Focus on carrying out the objectives more efficiently: "HOW" to manipulate content elements for greater productivity.

The lower right quadrant presupposes hands on, operating experience and low priority. Assess these objectives ("WHY"), reach a conclusion about their relevance/role in fulfilling the vision/mission and move forward in a way which shifts as much of available resources and energy to other parts of the cycle as possible.

Successful action depends on adequate resources. Adequate resources presumes appropriate allocation. Different stages of priority and action require specific approaches to allocation ranging from venturing through investment, reward, and recycling, to conclusion. Objectives falling into a quadrant also fall into the strategy of allocation associated with that quadrant.

Growth requires venturing. Successful



venturing requires careful risk/reward analysis. Ability to fulfill the vision represents the determining criteria for venturing.

Development and implementation require investment. Invest with the potential return spelled out clearly and mechanisms in place to tell you whether you are winning or losing.

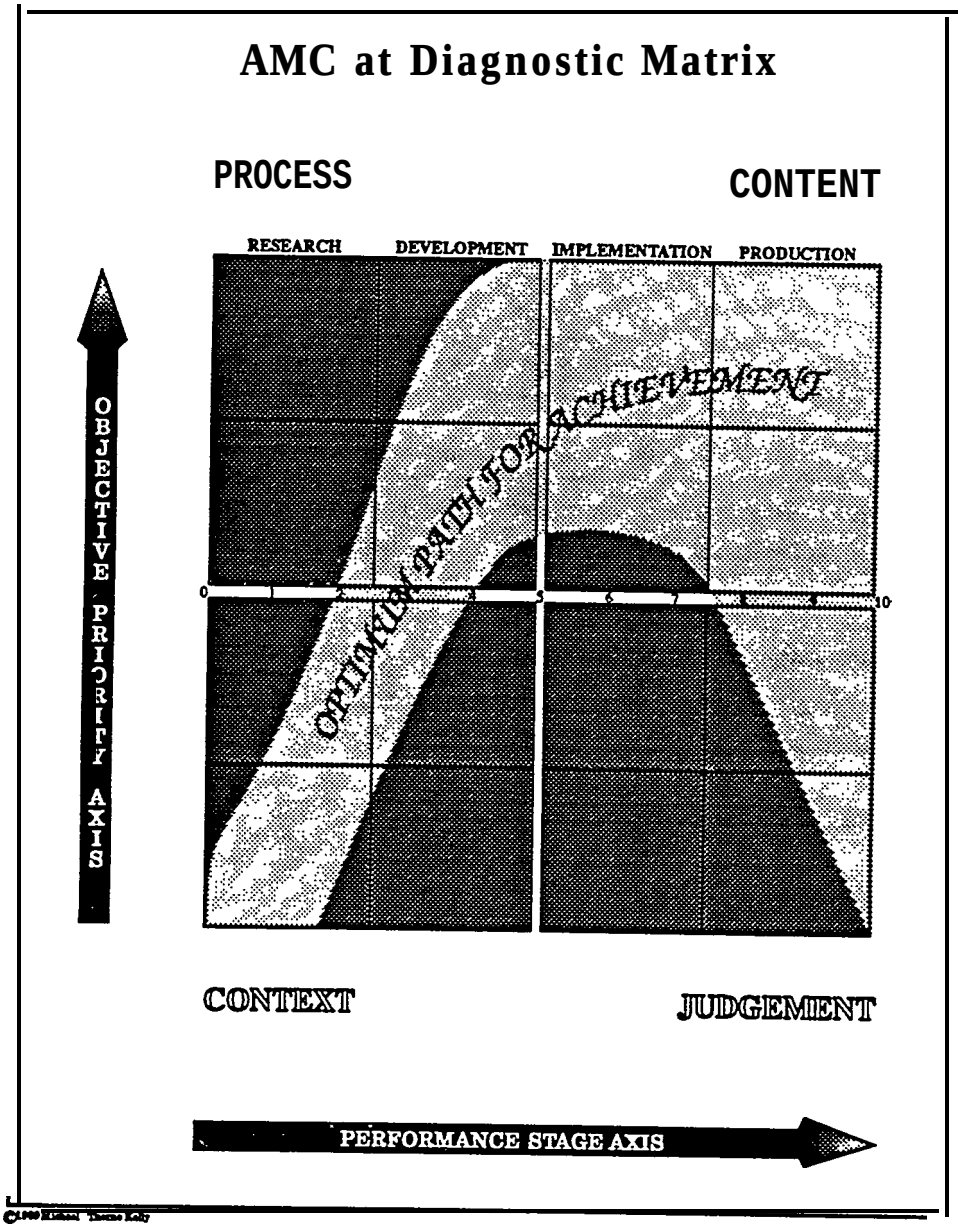
Each objective represents a battle. Con-

verting wins to successful fulfillment of the overall vision requires disciplined use of the advantages gained. Leverage Reward to facilitate growth-of the other objectives and ultimately of the vision and future endeavors.

If an objective drops in priority while still in the implementation stage, Re-cycling catches and transmutes its value. Find the baby in the bath water and send it around again.

An objective successfully in production which is low priority may be the classic cash cow or boondoggle. Best to judge and Contain it. Some things are neither: paying taxes produces no value yet has to be done. Best accomplish these with minimum involvement and ruthless precision and efficiency.

The diagnostic matrix illustrates the optimum path for accomplishment. It shows the relationships between objectives as they participate in fulfilling the vision and how well priorities are managed. See where things stand, appreciate correction where needed, get assistance if in doubt about how to proceed.



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BIBLIOGRAPHY COMPUTER AIDS FOR SHIPYARDS

N4-91-5
NSRP Panel SP-4

Billingsley,Daniel W., Jeflley D.Arthurs, Karlu Rambhala, and William R. Schmidt, "Revolution at NAVSEA, Managing Design and Engineering Information," paper #14, SNAME/ASE Naval Ship Design Symposium, 25 February 1992.

"Catalogue of Audio Visual Material Available for Shipyard Training (AVMAST) Library," U.S. Department of the Navy, David Taylor Research Center, in cooperation with The University of Michigan, Panel SP-9, February 1991.

Frankel, Ernest G., "Management of Technological Change and Quality in Ship Production," Journal of Ship Production, volume 8, number 2, May 1992.

Frankel, Ernest G., "The Path to U.S. Shipbuilding Excellence -- Remaking the U.S. into a World-Class Competitive Shipbuilding Nation," Journal of Ship Production, SNAME, volume 8, number 1, February 1992.

"Information Required From Planning Yards To Support Zone Logic," NSRP 0323, June 1991.

"Investigation of the Application of Computer Aided Recess Planning to Shipyard Modernization, Overhaul and Repair," NSRP Report 0319, May 1991.

Lamb, Thomas, "Organizational Theory and Shipbuilding A Brief Overview," Marine Technology, volume 29, number 2, April 1992.

Moore, Richard, "Point Paper: Which Business Model to Follow for Computer Aids in Shipbuilding? or: Does Operations Management Really Matter?" an unpublished paper forwarded privately to the author in April 1992 to prepare for the workshop on computer aids for shipyards.

"National Shipbuilding Research Program Bibliography of Publications" 1973-1991, especially under the key words "automation" and "computer."

Rogness, James, "Breaking the Chains of Tradition and Fantasy -- A Revolutionary Approach to the Constraints on Productivity," Journal of Ship Production volume 8, number 2, May 1992.

"Ship Maintenance - The Navy's Fleet Modernization Program," Maritime *Re*porter and Engineering News, June 1991, page 102ff.

Storch, Richard Lee; Colin P. Hammon, & Howard M. Bunch, Ship Production, Cornell Maritime Press, Centreville, Maryland, ISBN 0-87033-357-7,1988.

"The Definition of a Shipyard's Engineering Requirements to be met by a Design Agent; NSRP 0333, July 1991.

"The Shipbuilding Promotion Act of 1992," of June 1992, reported in Congressman Tom Andrew's Report to the First District, U.S. House of Representatives, Washington, D.C. 20515, and 177 Commercial Street, Portland, Maine 04101, August 1992, page 2.

Wade, Michael, and Zbigniew J. Karaszewski, "Infrastructure Study in Shipbuilding: A Systems Analysis of U.S. Commercial Shipbuilding Practices," Journal of Ship Prodution, volume 8, number 2, May 1992.

"World's Largest Passenger Liner — an International City at Sea," ASNET NEWS, The ASNE Member Network, The American Society of Naval Engineers, 1452 Duke Street, Alexandria, Virginia 22314-3458, August/September 1992, page 1.

APPENDIX B

ANALYSIS OF SYSTEMS IN USE

In response to suggestions made at the July 1992 SP-4 Panel meeting, a questionnaire was sent to several shipyards and other organizations. The questions ranged from judgement of importance of various computer systems to historical facts about systems in use. The questions were asked with the understanding that the answers would be reported in such away that the particular organizations would not be identified.

The text of the questions are included on the next two pages. The first page asks for information on functions, installations, and number of users. The next page asks for judgement of the relative importance of 27 areas of shipyard system interest. These questions are based upon knowledgeable shipyard sources and were developed with the intent that answers would be helpful in the overall assessment of the computer aids to shipyards in the United States and Canada.

Forty questionnaires were sent out on the 27th of July 1992. By 23 October 1992 six of the major yards had responded. The overall body of data from the returned questionnaires provides information on over two hundred computer programs in use in shipyards in addition to judgement of the importance of the 27 areas addressed in the second part of the questionnaire.

Trivial or widely available computer application programs were ignored in the analysis. The number of users range from 5 to 1600 per application The sizes of the shipyards returning answers ranges from 1000 to 10,000.

Analysis of the data is detailed later in this document. A summary of observations and conclusions from this analysis are as follows:

- Yards assign the highest importance to teamwork and collaboration to make computer system efforts work
- The greatest number of applications are supporting shop and material planning
- The use of mainframe systems has shrunk to 27% of the total number of applications
- Historically there was a surge of new applications in the early 1970's and a second surge of new uses in the mid 1980's
- Applications planned for upgrade exhibit no clear pattern of functions nor of user size; infact, there seems to be considerable differences between yards in their plans for upgrades of their computer systems
- If this small sample of data is indicative of the whole industry there is strong need for collaborative direction; if this sample is insufficient to evidence significant trends, more research is needed in the near future.

July 1992

Program Name	Functional Area	Installed Base (# of Users)	Hardware Platform	Purchased/ Developed In-house	Date of First Use	Date of Latest Revision	Significant Upgrade Planned/ Being Implemented
(1)	(2)	(3)		(4)			(5)
			— Examples —				
AUTOKON	Structural Design, Lofting & NC Cutting	87	IBM RS/6000	Purchased	Sep '77	Feb '92	Yearly
LMDS	Logistics Data Management	39	IBM 3090	In-House	Apr '83	Aug '91	No

Notes:

(1) Please include only those applications which have 5 or more users, and, are not widely used PC applications (e.g. LOTUS 123, Symphony, Word Perfect, Microsoft Word, etc.)

(2) Please provide a complete description of the functional areas where this program is being used (*e.g.* Logistic Data Management, Outfit Design, Configuration Management,Production Bill of Material, Procurement, Materials Management (Specific Area), Contract Administration, Accounting, General Ledger, Shop Floor Control, Engineering Bill Of Material, Management Decision Support (Specific Area), Engineering/Design Calculations,Warehouse and Material Distribution, *etc.*)

(3) Please indicate the typical number of users of this application on a regular basis. Count them if they use the application on at least a once a week basis.

(4) Please indicate if this package was purchased (even if leased), or, was developed in-house.

(5) Please provide an answer (either Yes or No) to indicate whether a significant modification is either planned (within one year), or, currently being implemented (either in-house or by the vendor). Significant changes are those performed in addition to normal maintenance.

s

SP4 Survey
Questionnaire

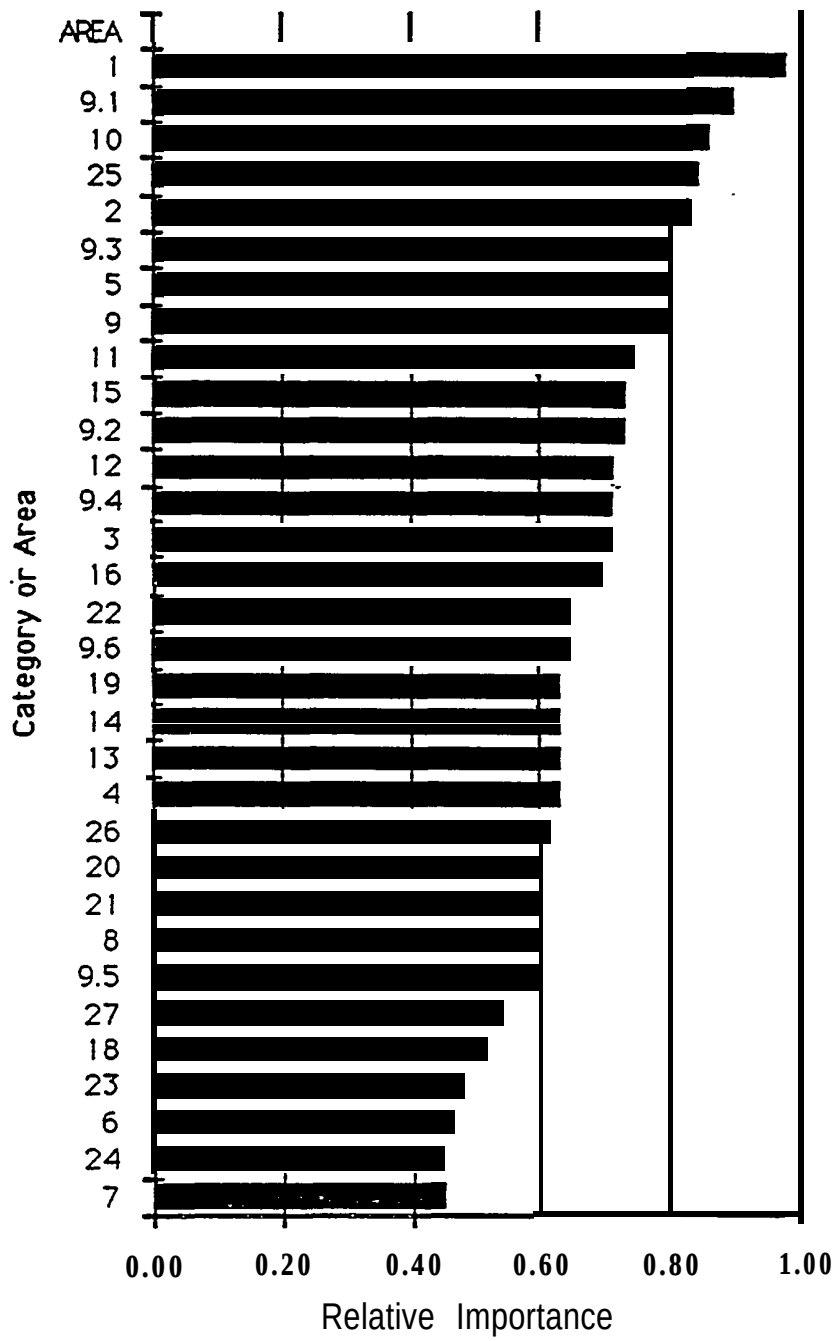
What relative level of importance are you currently applying to the following areas (use a 1-10 scale with 10 highest):

—1. Client/user involvement (business process, specification development, testing, etc.)
_ 2. Systems Architecture (hardware, software, network, standards, data, and policy)
__3. Software Development Methodology (Business Process, System Analysis, System Design, Programming, Data Conversion, Testing, Post-implementation support)
____4. CASE Computer Aided Software Engineering Methodologies (Upper CASE, Lower CASE, or both)
____5. Senior Management Involvement (regular steering committees, project sponsorship, etc.)
____6. Co-location of user/systems personnel
____7. Various techniques for Systems Re-Engineering
____8. Open Systems Standards and Practice
____9. standards for:
__9.1 Networks and Communications
__9.2 Hardware Selection
__9.3 Software Development/Selection
__9.4 Development Methodology
__9.5 Data Exchange/CALS
__9.6 Open Systems
__10. Teamwork (User/Client) for computer program development life cycle
__11. Self Directed Teams (User/Client) for computer program development life cycle
__12. Quality Measurements regularly conducted during software development/ implementation
__13. Business Process Analysis
__14. User Groups
15. Mid-level user involvement
__16. Management Decision Support Applications
__17. Expert Systems
__18. Interpersonal Skills Development and Training
__19. Technical Training
__20. Database Administration
__21. On-line Data Dictionary
__22. Relational Database Management Systems
____ 23. Object Oriented Software Development
24. Any of the Rapid Application Development Method (RAD, JAD, etc.)
__25. Networking between systems/physical locations
__26. “Store Once, Use Many" discipline
__27. Software configuration management.

DETAILED ANALYSIS OF SHIPYARD COMPUTER SYSTEMS

The above questionnaire form.and summary discussion of findings is based on compilation of data from 6 shipyards designated in this report as yards A, B, C, D, E and F. Analysis starts with answers to the second part of the questionnaire, which asked for relative levels of importance in the approaches being made toward existing and newly emerging computer technology. Analysis continues with examination of the number of applications per functional type, proportions of hardware types in use, dates of first use, and intended upgrades planned by function and yard.

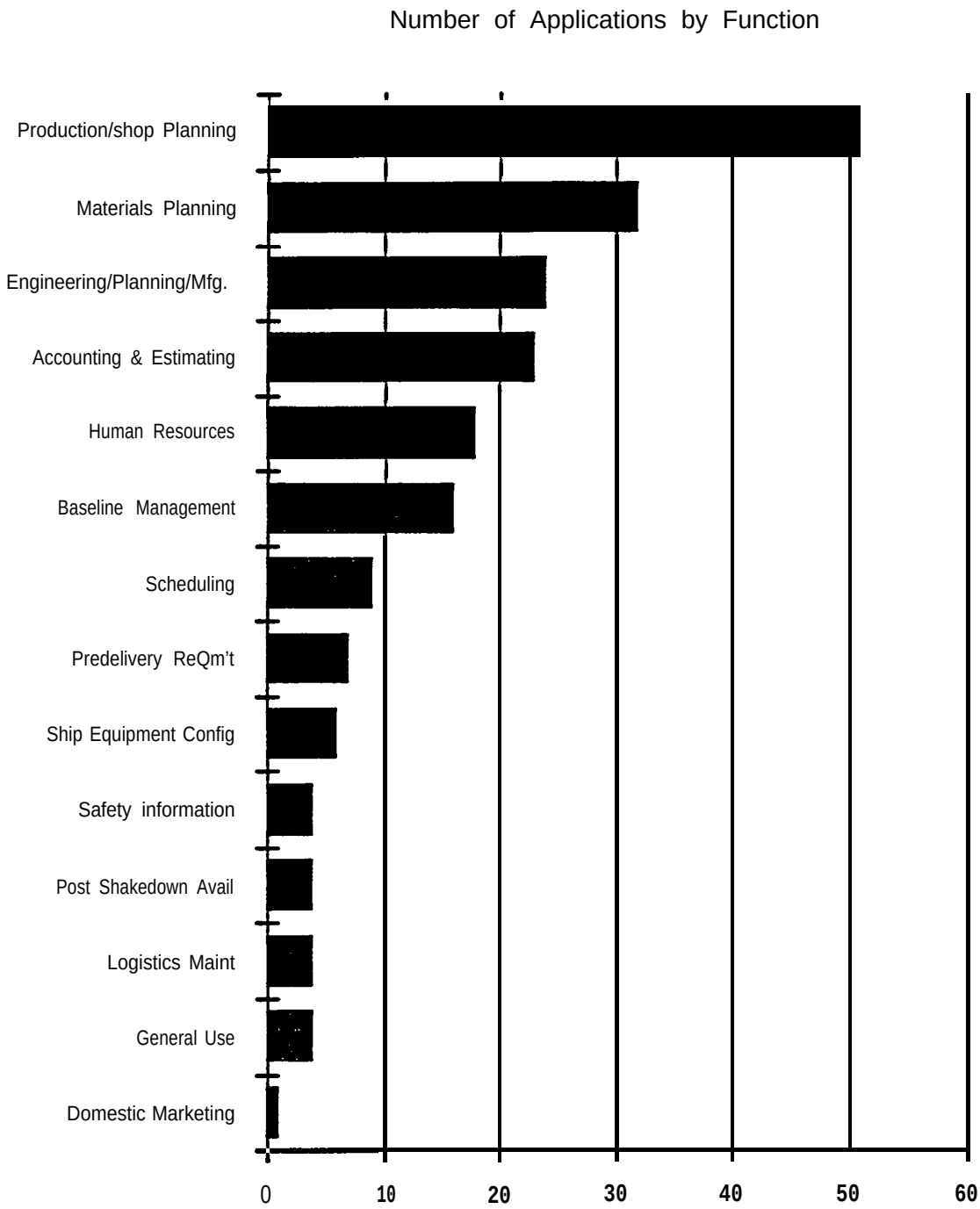
IMPORTANCE OF SYSTEM EFFORTS



Yards assign the highest importance to teamwork and collaboration to make computer system efforts work. Here are the highest seven priority items selected by the shipyards judging the importance of system efforts:

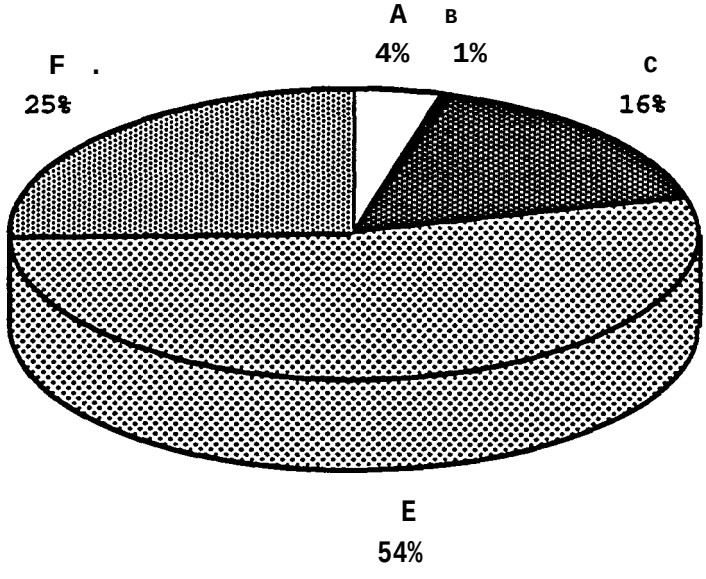
- Client/user involvement (business process, specification development, testing, etc.)
- Networks and Communications
- Teamwork (User/Client) for computer program development life cycle
- Networking between systems/physical locations
- System Architecture (hardware, software, network, standards, data, and Policy)
- Software Development/Selection
- Senior Management Involvement (regular steering committees, project sponsorship, etc.)

The survey also shows that the greatest number of applications are supporting shop and material planning as shown in the following graph



As seen in the pie chart below, the yards (designated as A, B, C, D, E, and F) are taking considerdly different views of upgrades. The chart should be interpreted as follows. The percentage shown in the chart represents comparisons between yards on the portion of the total number of employees of that yard currently using computer systems scheduled for upgrade. For example, if the proportion of the users in each yard were the same, the percentages in the chart would be the same. Clearly yard E has the greatest upgrade activity and yard B the least.

UPGRADES BY YARDS

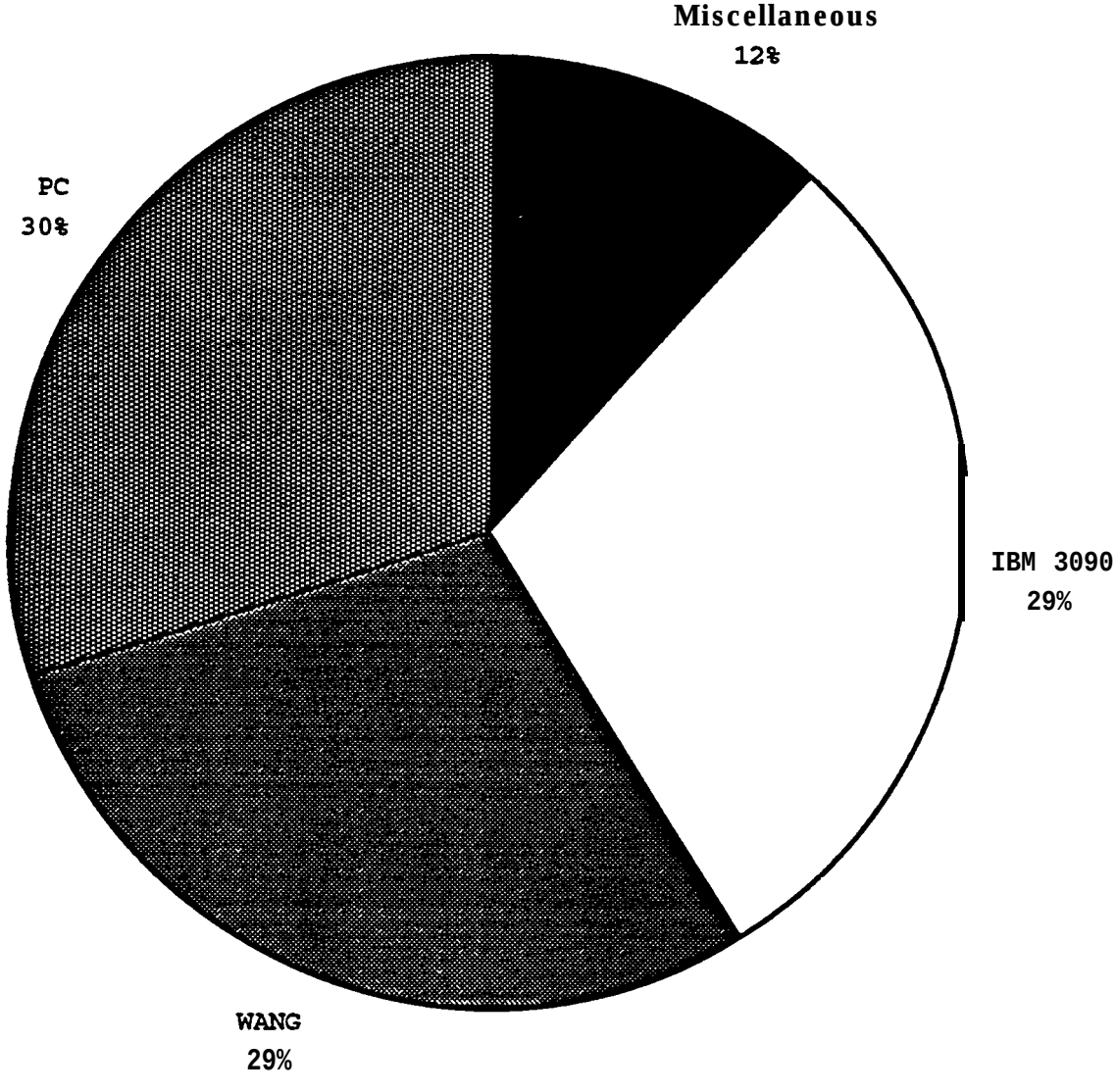


In this last chart we see the effect of having a relatively small sample of yards responding to the questionnaire. Although these data may represent the industry as a whole, greater confidence in the data would be achieved had more yards and in fact other segments of the industry responded. For example, what are the trends in computing in the design agents or subcontractors? What government trends might have a bearing on the data? What other industry trends should be examined to show the way to better upgrades? What supplier upgrades should be considered?

One should also take into account the enormous changes taking place in the computer industies themselves. Hardware changes will influence future trends as well as current assessments of any industry. The next page displays the current distribution of hardware in the yards.

The use of mainframe of systems has shrunk to 29% of the total number of applications:

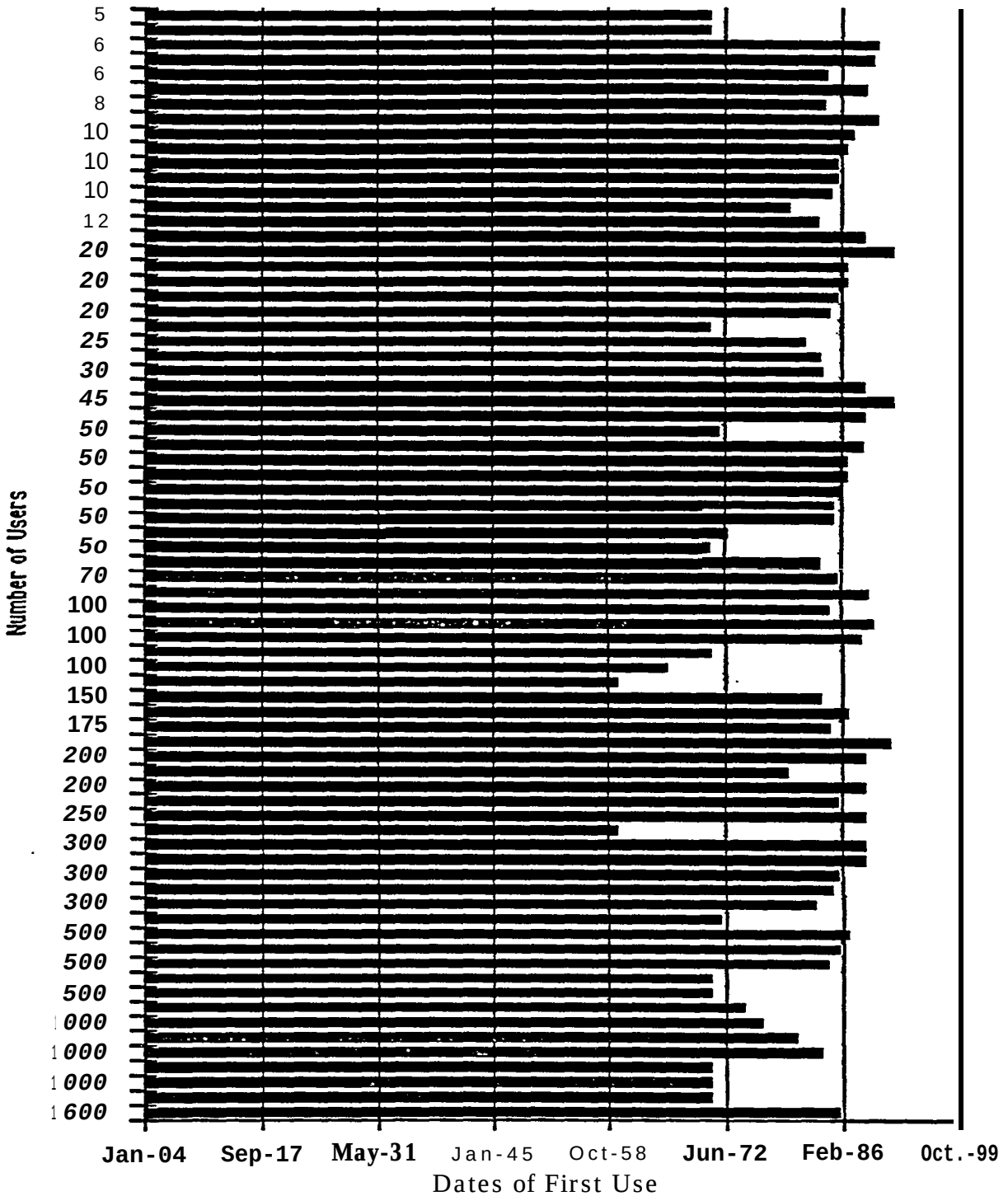
HARDWARE CATEGORIES



Notice the strong use of personal computers and high end word processors to do many tasks in the shipyard environment. We know from the analysis of functions that the big users are the shop, matetial, and production planners.

The following graph of the dates of first use shows that historically there was a surge of new applications in the early 1970's and a second surge of new uses in the mid 1980's. It is not clear exactly what these two surges of use indicati. Some of the effect may be due to the availability of the computer technology and the shift from numeric control machines to computer aided manufacturing. Some of the effect may be the impetus to upgrade yard facilities world wide. Some maybe due to the mix of work and customer opportunities and demands.

USERS versus FIRST USE



However, applications planned for upgrade exhibit no clear pattern of functions nor of user size; in fact, there seems to be considerable differences between yards in their plans for upgrades of their computer systems as seen in the following table:

	FUNCTIONS	YARD	USERS
PURCHASED	Accounting	A	8
PURCHASED	General Use		45
IN-HOUSE	Tool Inventory	B	5
PURCHASED	Claims/Data	c	20
IN-HOUSE	Genral Use	C	300
IN-HOUSE	Ping Product.	c	75
IN-HOUSE	Baseline Management	E	5
IN-HOUSE	Baseline Management	E	100
IN-HOUSE	catalog	E	50
IN-HOUSE	Human Resources	E	5
IN-HOUSE	Inventory	E	500
IN-HOUSE	Material C/SCS	E	100
PURCHASED	Outfit Design and CAM	E	300
PURCHASED	Planning BOM	E	5
IN-HOUSE	Production BOM	E	1000
IN-HOUSE	Purchasing	E	200
IN-HOUSE	Purchasing	E	1000
IN-HOUSE	Receiving	E	500
PURCHASED	Structural Design	E	50
PURCHASED	structural Design	E	50
IN-HOUSE	Warehouse/Inventory	E	500

Areas of Computer System Importance

AREA	Average	YARD A	YARD B	YARD C	YARD D	YARD E	YARD F
1	0.98	10	10	10	10	10	9
9.1	0.90	8	10	10	7	9	10
10	0.87	7	8	8	10	10	9
25	0.85	10	5	10	8	9	9
2	0.83	6	10	6	10	8	10
9.3	0.80	5	10	10	8	8	7
5	0.78	9	10	5	5	10	8
9	0.77	5	10	8	8	7	8
11	0.75	7	10	4	5	10	9
9.2	0.73	7	10	5	8	8	6
15	0.73	9	7	6	4	10	8
3	0.72	3	10	10	7	5	8
9.4	0.72	3	10	10	7	5	8
12	0.72	4	10	5	5	10	9
16	0.70	4	10	8	6	7	7
9.6	0.65	5	5	8	8	8	8
22	0.65	8	7	5	8	4	7
4	0.63	2	7	10	5	5	9
13	0.63	3	8	6	5	8	8
14	0.63	2	7	6	5	10	8
19	0.63	5	9	4	8	6	6
26	0.62	9	1	8	9	2	8
20	0.60	5	7	5	6	4	9
8	0.58	3	8	4	8	4	8
21	0.58	8	7	5	5	4	6
9.5	0.57	2	5	5	8	4	10
27	0.55	2	1	7	10	3	10
18	0.52	5	5	2	8	6	5
23	0.48	9	5	0	6	1	8
6	0.47	0	1	5	7	10	5
7	0.45	3	5	4	7	3	5
24	0.45	0	8	5	4	5	5
17	0.37	1	6	0	6	1	8

Computer Programs in Current Use

Installed Base (# of Users)	Date of First Use	Date of Latest Revision	Significant Upgrad Planned/ Being Implemented	Purchased or Developed In-house	Functional Areas	Hardware Platform
#3			#5	#4	#2	
1600	Jan-86	Jan-89	No	PURCHASED	Time System	IBM Series 1
1000	12/31/70	12/31/70	No	IN-HOUSE	Payroll	IBM 3090
1000	12/31/70	Mar-92	NO	IN-HOUSE	Labor Cost Sched Ctrl	IBM 3090
1000	12/31/70	May-92	YES	IN-HOUSE	Production BOM	IBM 3090
1000	12/31/83	12/31/83	YES	IN-HOUSE	Purchasing	WANG
500	12/31/70	12/31/70	YES	IN-HOUSE	Receiving	IBM 3090
500	12/31/70	12/31/70	YES	IN-HOUSE	Warehouse/Inventory	IBM 3090
500	10/1/84	Dec-91	NO	IN-HOUSE	Electrical Analysis	IBM 3090
500	Jan-86	Jan-86	YES	IN-HOUSE	Inventory	IBM 3090
500	12/31/86	Jul-89	NO	IN-HOUSE	Structural Shapes Fab	IBM 3090
300	Jan-72	Jan-91	YES	IN-HOUSE	General Use	IBM 3084
300	12/31/82	12/31/82	NO	IN-HOUSE	Predelivety Reqmts	PC
300	3/1/85	6/1/92	YES	PURCHASED	Outfit Design and CAM	SUN
300	Jan-86	Jan-90	NO	IN-HOUSE	General Use	IBM 3084
300	12/31/88	12/31/88	No	IN-HOUSE	Shop Floor Control	PC
300	12/31/88	12/31/88	No	IN-HOUSE	Baseline Management	PC
200	Jan-86	Jan-88	NO	PURCHASED	Inventory Sys	IBM 3090
200	12/31/88	12/31/88	YES	IN-HOUSE	Purchasing	IBM 3090
180	Jan-92	Jan-92	No	PURCHASED	General Use	IBM Token Ring/PC
150	12/31/86	Jun-92	NO	IN- HOUSE	Reliability and Main	IBM 3090
100	Jan-66	Jan-66	YES	IN-HOUSE	Cost & Payroll	IBM 3090
100	12/31/70	12/31/70	NO	IN-HOUSE	Journa/Voucher	IBM 3090
100	6/1/88	6/1/88	YES	IN-HOUSE	Material C/SCS	IBM 3090
100	12/31/89	Aug-92	YES	IN-HOUSE	Baseline Management	PC
75	Sep-89	Sep-92	YES	IN-HOUSE	Ping Product,	PCLAN/3084
50	12/31/70	12/31/70	YES	IN-HOUSE	catalog	IBM 3090
50	Mar-73	Jan-90	NO	PURCHASED	Engineering	Apolo2500/3500
50	4/30/85	4/30/85	YES	PURCHASED	Structural Design	Rs/6000

50	May-85	Mar-92	NO	IN-HOUSE	SPARES	IBM AS400
50	6/1/86	Mar-92	YES	PURCHASED	Structural Design	PC/SUN
50	12/31/86	12/31/86	NO	IN-HOUSE	Purchasing Support	IBM 3090
50	12/31/86	12/31/86	NO	PURCHASED	Electrical Analysis	IBM 3090
50	9/30/88	9/30/88	NO	PURCHASED	Accounts Payable	IBM 3090
45	Jul-92	Sep-92	YES	PURCHASED	General Use	IBM AS400
40	12/31/88	12/31/88	NO	IN-HOUSE	Overhead Budgeting	PC
30	Feb-84	Jan-91	NO	IN-HOUSE	Engr/Data Mgt	IBM 3084
25	Jan-82	12/1/92	NO	PURCHASED	Payroll	IBM 3090
20	12/31/70	12/31/70	NO	PURCHASED	Accounts Payable	IBM 3090
20	Jan-85	Jan-91	NO	PURCHASED	Planning	PC LAN
20	12/31/85	12/31/85	NO	IN-HOUSE	Ship Equipment Confi	IBM 3090
20	12/31/86	12/31/86	NO	IN-HOUSE	Ship Equipment Config	IBM 3090
20	12/31/86	12/31/86	NO	IN-HOUSE	Ship Equipment Confi	IBM 3090
20	Jun-92	Jan-92	YES	PURCHASED	Claims/Data	IBM 3084 & PC
15	12/31/88	12/31/88	NO	IN-HOUSE	Combat Sys. Analysis	IBM 3090
12	Sep-83	Mar-92	NO	PURCHASED	ENG/PLG/MFG	IBM 4381
10	Jun-80	May-91	NO	IN-HOUSE	ILS/ENG/WHS	IBM AS400
10	2/28/85	2/28/85	NO	IN-HOUSE	Information Systems	WANG
10	12/31/85	12/31/85	NO	IN-HOUSE	Fixed Assets	IBM 3090
10	12/31/85	12/31/85	NO	IN-HOUSE	ILS Provisioning	IBM 3090
10	12/31/86	12/31/86	NO	IN-HOUSE	Inventory	PC
10	8/30/87	8/30/87	NO	IN-HOUSE	Human Resources	WANG
10	Jul-90	Nov-91	NO	PURCHASED	TOOL RM/WHS	PC
8	Jun-84	Jan-90	NO	IN-HOUSE	Logistics Supp.	HP 7000
8	Jun-89	Jun-89	YES	PURCHASED	Accounting	IBM AS400
6	Oct-84	Jan-91	NO	IN-HOUSE	Engr/Data Mgt.	HP 7000
6	12/31/89	12/31/89	NO	IN-HOUSE	Change Order Pricing	PC
6	Aug-90	Aug-90	NO	PURCHASED	PLNG/I.E.	PC
5	12/31/70	12/31/70	NO	IN-HOUSE	Overhead Budgeting	IBM 3090
5	12/31/70	Jun-90	NO	IN-HOUSE	Material C/SCS	IBM 3090
5	12/31/70	Jun-91	NO	IN-HOUSE	Misc Trial Items	IBM 3090
5	12/31/80	12/31/80	NO	IN-HOUSE	Materials	WANG
5	12/31/81	12/31/81	NO	IN-HOUSE	Post Shakedown Avail	PC
5	12/31/82	12/31/82	NO	IN-HOUSE	Predelivery Reqm't	PC
5	12/31/82	12/31/82	NO	IN-HOUSE	Vent Piece/Part Fab	PRIME

5	12/31/82	12/31/82	NO	IN-HOUSE	Production Planning	PC
5	12/31/83	12/31/83	NO	IN-HOUSE	Master Data Tracking	PC
5	12/31/83	!2/31/83	N0	IN-HOUSE	Estimating	PC
5	4/30/84	4/30/84	N0	IN-HOUSE	Baseline Management	P C
5	4/30/84	4/30/84	NO	IN-HOUSE	Domestic Marketing	WANG
5	5/30/84	5/30/84	NO	IN-HOUSE	Shop Data Collection	WANG
5	5/30/84	5/30/84	NO	IN-HOUSE	Shop Planning	WANG
5	7/30/84	7/30/84	NO	IN-HOUSE	Purchasing	WANG
5	8/30/84	8/30/84	NO	IN-HOUSE	Shop Floor Control	WANG
5	8/30/84	8/30/84	NO	IN-HOUSE	Shop Data Collection	WANG
5	10/30/84	10/30/84	NO	IN-HOUSE	Inventory	WANG
5	12/31/84	12/3I/84	NO	IN-HOUSE	Baseline Management	IBM 3090
5	12/31/84	12/31/84	NO	IN-HOUSE	Shop Planning	IBM 3090
5	12/31/84	12/31/84	NO	IN-HOUSE	Ship Equipment Confi	IBM 3090
5	12/31/84	12/31/84	NO	IN-HOUSE	Material Delivery Requiremt	WANG
5	12/31/84	Dec-90	NO	IN-HOUSE	Safety Information	IBM 3090
5	2/28/85	Ju1-92	NO	IN-HOUSE	Shop Data Collection	PC
5	4/30/85	4/30/85	NO	IN-HOUSE	Baseline Management	WANG
5	4/30/85	4/30/85	NO	IN-HOUSE	Baseline Management	WANG
5	6/30/85	6/30/85	NO	IN-HOUSE	Safety Information	WANG
5	6/30/85	6/30/85	NO	IN-HOUSE	Predelivery Reqm't	WANG
5	7/30/85	7/30/85	NO	IN-HOUSE	Human Resources	WANG
5	11/30/85	11/30/85	NO	IN-HOUSE	Human Resources (D27/30)	WANG
5	12/31/85	12/31/85	NO	IN-HOUSE	Production Planning	PC
5	12/31/85	12/31/85	NO	IN-HOUSE	Predelivery Reqm't	PC
5	12/31/85	12/31/85	NO	IN-HOUSE	Spares Warehouse/ Inv	PC
5	12/31/85	12/31/85	NO	IN-HOUSE	Post Shakedown Avail	PC
5	Jan-86	Jan-86	NO	IN-HOUSE	Procurement	PC
5	Jan-86	Jan-86	NO	IN-HOUSE	Spares Warehouse/Inv	PC
5	Jan-86	Jan-86	NO	IN-HOUSE	Shop Floor Control	WANG
5	Jan-86	Jan-86	NO	IN-HOUSE	Wire Connection Lists	WANG
5	Jan-86	Jan-86	NO	IN-HOUSE	Safety Information	WANG
5	Jan-86	Jan-86	NO	IN-HOUSE	Human Resources	WANG
5	Jan-86	Jan-86	NO	IN-HOUSE	Sc Drawing Sched Status	PC
5	Jan-86	Jan-86	NO	IN-HOUSE	Spares Warehouse/Inv	PC
5	Jan-86	Jan-86	NO	IN-HOUSE	Shop Data Collection	WANG
5	Jan-86	Jan-86	NO	IN-HOUSE	Support and Test Eqpt	PS/2

5	Jan-86	Jan-86	No	IN-HOUSE	Baselln e management	WANG
5	Jan-86	Jan-86	No	IN-HOUSE	Procurement	PC
5	4/30/86	4/30/86	NO	IN-HOUSE	Shop Floor Control	WANG
5	4/30/86	4/30/86	NO	IN-HOUSE	Shop Data Collection	WANG
5	8/30/86	8/30/86	NO	IN-HOUSE	Baseline Management	WANG
5	10/31/86	10/31/86	NO	IN-HOUSE	Label Plate Fabrication	PRIME
5	11/1/86	11/1/86	NO	IN-HOUSE	Spares Warehouse/Inv	PC
5	11/30/86	11/30/86	NO	IN-HOUSE	Shop Data Collection	WANG
5	12/31/86	12/31/86	NO	IN-HOUSE	Absenteeism Reporting	IBM 3090
5	12/31/86	12/31/86	NO	IN-HOUSE	Logistics Maintenance	IBM 3090
5	12/31/86	12/31/86	NO	IN-HOUSE	Shop Floor Control	PC
5	12/31/86	12/31/86	NO	IN-HOUSE	Shop Floor Control	PC
5	12/31/86	12/31/86	NO	IN-HOUSE	Human Resources(D27/30)	PC
5	12/31/86	12/31/86	NO	IN-HOUSE	Logistics Maint	IBM 3090
5	6/30/87	6/30/87	NO	IN-HOUSE	Baseline Management	WANG
5	6/30/87	6/30/87	NO	IN-HOUSE	Shop Data Collection	WANG
5	7/31187	7/3I/87	NO	IN-HOUSE	Plate Part Fabrication	AOS/VS
5	8/30/87	8/30/87	NO	IN-HOUSE	Shop Data Collection	WANG
5	10/30/87	10/30/87	NO	IN-HOUSE	Payroll	WANG
5	10/30/87	10/30/87	NO	IN-HOUSE	Shop Planning	WANG
5	12/31/87	12/31/87	NO	IN-HOUSE	Wire Connection Lists	IBM 3090
5	12/31/87	12/31/87	NO	IN-HOUSE	Shop Data Collection	PC/PRIME
5	12/31/87	12/3{/87	NO	IN-HOUSE	Shop Planning	PC
5	12/31/87	12/31/87	NO	IN-HOUSE	Shop Planning	PC
5	12/31/87	12/31/87	NO	IN-HOUSE	Shop Data Collection	PC
5	12/31/87	12/31/87	NO	IN-HOUSE	Procurement	PC
5	12/31/87	12/31/87	NO	IN-HOUSE	Shop Planning	PC
5	12/31/87	12/31/87	NO	IN-HOUSE	General Ledger	PC
5	12/31/87	12/31/87	NO	IN-HOUSE	Manpower Planning	PC
5	12/31/87	12/31/87	NO	IN-HOUSE	Post Shakedown Avail	PC
5	12/31/87	12/31/87	NO	PURCHASED	Logistics Support	IBM 3090
5	12/31/87	12/31/87	NO	IN-HOUSE	Shop Data Collection	PC
5	12/31/87	Dec-90	NO	IN-HOUSE	Predelivery Requiremt	IBM 3090
5	12/31/87	Oct-9I	NO	IN-HOUSE	Baseline Management	IBM 3090
5	12/31/87	May-92	YES	PURCHASED	Planning BOM	IBM 3090

5	1/30/88	1/30/88	No	IN-HOUSE	Payroll	WANG
5	1/30/88	1/30/88	NO	IN-HOUSE	Payroll	WANG
5	1/31/88	1/31/88	No	IN-HOUSE	Pipe Bending & Nest	Pc
5	2/28/88	2/28/88	No	IN-HOUSE	Human Resources	WANG
5	3/30/88	JuI-92	NO	IN-HOUSE	Detail Schedulling	IBM 3090
5	4/30/88	4/30/88	NO	IN-HOUSE	Human Resources	WANG
5	4/30/88	4/30/88	No	IN-HOUSE	Human Resources	WANG
5	5/30/88	5/30/88	No	IN-HOUSE	Human Resources	WANG
5	9/30/88	9/30/88	NO	IN-HOUSE	Shop Floor Control	WANG
5	9/30/88	9/30/88	NO	IN-HOUSE	Shop Floor Control	WANG
5	9/30/88	9/30/88	No	IN-HOUSE	Human Resources	WANG
5	9/30/88	9/30/88	NO	IN-HOUSE	Human Resources	WANG
5	10/31/88	2/25/90	NO	IN-HOUSE	Label Plate Fabrication	PRIME
5	11/24/88	Jan-88	NO	IN-HOUSE	Strctural Parts Fab	VAX
5	11/30/88	11/30/88	NO	IN-HOUSE	Human Resources	wANG
5	11/30/88	11/30/88	NO	IN-HOUSE	Human Resources	WANG
5	12/31/88	12/31/88	NO	IN-HOUSE	Safety Information	PC
5	12/31/88	12/31/88	YES	IN-HOUSE	Human Resources	PC
5	12/31/88	12/31/88	NO	IN-HOUSE	Cable Inventory	PC
5	12/31/88	12/31/88	NO	IN-HOUSE	Overhaul	PC
5	12/31/88	12/31/88	NO	IN-HOUSE	Procurement	WANG
5	12/31/88	12/31/88	NO	IN-HOUSE	Procurement	WANG
5	12/31/88	12/31/88	NO	IN-HOUSE	Shop Planning	PC
5	12/31/88	12/31/88	NO	IN-HOUSE	Procurement	WANG
5	12/31/88	12/31/88	NO	IN-HOUSE	Shop Floor Control	PC
5	12/31/88	12/31/88	NO	IN-HOUSE	Purchasing	WANG
5	12/31/88	12/31/88	NO	IN-HOUSE	Production BOM	PC
5	12/31/88	12/31/88	NO	IN-HOUSE	Weight Control	PRIME
5	12/31/88	12/31/88	NO	IN-HOUSE	Human Resources	IBM 3090
5	12/31/88	12/31/88	No	IN-HOUSE	Baseline Management	PC
5	12/31/88	12/31/88	NO	IN-HOUSE	LaborC/SCS	IBM 3090
5	12/31/88	12/31/88	No	IN-HOUSE	Shop Floor Control	PC
5	12/31/88	Jun-89	NO	IN-HOUSE	Baseline Management	IBM 3090
5	12/31/88	Aug-92	NO	IN-HOUSE	Baseline Management	IBM 3090
5	5/30/89	5/30/89	No	IN-HOUSE	Payroll	WANG
5	Jun-89	Jun-89	No	IN-HOUSE	Payroll	WANG

5	8/30/89	8/30/89	NO	IN-HOUSE	Capital Planning	WANG
5	8/30/89	8/30/89	NO	IN-HOUSE	Payroll	WANG
5	10/30/89	10/30/89	NO	IN-HOUSE	Finished Goods	WANG
5	12/31/89	12/31/89	NO	IN-HOUSE	Shop Floor Control	PC
5	12/31/89	12/31/89	NO	IN-HOUSE	Technology Transfer	PC
5	12/31/89	12/31/89	NO	PURCHASED	Technical Data Manag	MAC
5	12/31/89	12/31/89	NO	IN-HOUSE	Post Shakedown Avail	PC
5	12/31/89	12/31/89	NO	IN-HOUSE	Support and Test Eqpt	IBM 3090
5	12/31/89	12/31/89	NO	IN-HOUSE	Materials Planning	PC
5	12/31/89	12/31/89	NO	IN-HOUSE	Technical Data Mgm't	IBM 3090
5	12/31/89	May-92	YES	IN-HOUSE	Baseline Management	IBM 3090
5	1/30/90	1/30/90	NO	IN-HOUSE	Human Resources	WANG
5	3/30/90	3/30/90	NO	IN-HOUSE	Inventory	WANG
5	3/30/90	May-92	NO	IN-HOUSE	Baseline Management	IBM 3090
5	4/30/90	4/30/90	NO	IN-HOUSE	Predelivery Reqm't	PC
5	5/1/90	5/1/90	NO	IN-HOUSE	Master Data Tracking	WANG
5	5/30/90	5/30/90	NO	IN-HOUSE	Predelivery Reqm't	PC
5	5/30/90	5/30/90	NO		Technology Transfer	WANG
5	Jun-90	Mar-92	NO	PURCHASED	ENG/MFG	PC
5	Aug-90	Jan-91	NO	PURCHASED	Struct. Design	PC
5	Sep-90	Sep-90	NO	PURCHASED	Hull Design	PC
5	Sep-90	Sep-90	NO	PURCHASED	Hull Design	PC
5	Sep-90	Sep-90	NO	IN-HOUSE	Reliability	IBM 3090
5	Dec-90	Jun-92	NO	PURCHASED	Loft/NC	PC
5	Dec-90	Jul-92	YES	IN-HOUSE	Tool Inventory	PC
5	12/31/90	12/31/90	NO	IN-HOUSE	Outfitting Support	PS/2
5	12/31/90	12/31/90	NO	IN-HOUSE	Human Resources	IBM 3090
5	1/1/91	1/1/91	NO	IN-HOUSE	Ship Eqpt Config	IBM 3090
5	1/1/91	1/1/91	NO	PURCHASED	Ship Eqpt Config	PC
5	1/1/91	1/1/91	NO	IN-HOUSE	Shop Data Collection	PC
5	1/1/91	1/1/91	NO	IN-HOUSE	Shop Data Collection	WANG
5	1/1/91	1/1/91	NO	IN-HOUSE	Baseline Management	WANG
5	1/1/91	1/1/91	NO	PURCHASED	Schedule Materials,	PC