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Implementation of Advanced Technology in the Shipbuilding Industry - Pilot Workshop Report

U.S. DEPARTMENT OF TRANSPORTATION
Maritime Administration and
U.S. Navy

in cooperation with
Newport News Shipbuilding

IMPLEMENTATION OF ADVANCED TECHNOLOGY IN THE SHIPBUILDING INDUSTRY--PILOT WORKSHOP REPORT

A Project of

The National Shipbuilding Research Program

by

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

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16. Abstract

This report outlines the development of a pilot workshop on the dynamics of organizational response to advanced technology implementation for the U.S. Shipbuilding industry, the tools that were utilized in executing the workshop design, and the lessons learned.

The purpose of the workshop was to provide the process for management to gain a better understanding of the consequences of implementing advanced shipbuilding methods into the shipyard.

The process for implementing advanced technology was based on industrial engineering and management science relevant to organizational change. This information was presented to the workshop attendees in a series of tutorial lectures that are outlined in the report. Lecture topics included: "Organizations are Systems: Traditional Management vs. Open Systems Management," "The Socio-Technical Systems Model," and "Implementing Change and Managing Resistance to Change." In addition to the tutorial lectures, a series of working sessions is outlined. Recommendations are made for future workshops.

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Appreciation is expressed to the shipbuilders of Bath Iron Works Corporation and National Steel and Shipbuilding Company for their participation in the project. A special appreciation to those individuals of the workshop staff who developed the design and content of the workshop from which the authors compiled this report: Randall Albert, Daniel Denison, John Garvey, Stuart Hart, Jeffrey Liker, and Charles Starkenburg.

EXECUTIVE SUMMARY

In February of 1986, the Design/Production Integration Panel of the Ship Production Committee contracted with the Marine Systems Division of the University of Michigan Transportation Research Institute to develop a pilot workshop on the dynamics of organizational response to advanced technology implementation. This report outlines the development of the workshop, the tools that were utilized in executing the workshop design, and the lessons learned.

The pilot workshop, entitled *Implementation of Advanced Technology in the Shipbuilding Industry,* was held in August, 1986. It was attended by Bath Iron Works Corporation and National Steel and Shipbuilding Company. The workshop was based on the premise that the technology gap between U.S. shipyards and their overseas competitors is one that is caused primarily by software technologies. The purpose of the workshop was to provide the process for management to gain a better understanding of the consequences of implementing advanced shipbuilding methods into the shipyard.

The process for implementing advanced technology was based on industrial engineering and management science relevant to organizational change. This information was presented to the workshop attendees in a series of tutorial lectures that are outlined in the report. Lecture topics included: "Organizations as Systems: Traditional Management vs. Open Systems Management," "The Socio-Technical Systems Model," and "Implementing Change and Managing Resistance to Change." In addition to the tutorial lectures, a series of working sessions is outlined. These working sessions provided the shipyards with the opportunity to deal with the lecture material as it related to the specific challenges facing their shipyard. Included in the appendices of the report is a Delphi survey on the U.S. shipbuilding industry, forecasting change for the period 1986-1995.

The pilot workshop outlined in this report was intended to provide a foundation for further workshops within the shipbuilding industry. The success of the pilot workshop gave impetus for holding a second workshop sponsored by the Education and Training Panel in November, 1986. This second workshop was attended by five shipyards and provided additional lessons to the workshop design.

Recommendations are made for future workshops. These recommendations include: (1) utilizing the workshop design for a single organization, in addition to the multi-shipyard approach, (2) compression of the pilot workshop content/format, and (3) development of additional technical content beyond the change process: specifically, a model that "rationalizes" the shipbuilding process.

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1.0 THE PROJECT

The development of a pilot workshop, entitled *Implementation of Advanced Technology in the Shipbuilding Industry*, was the result of a task set forth by the Design / Production Integration Panel (SP-4) of the Ship Production Committee--a part of the National Shipbuilding Research Program. This task recognized that the dynamics of organizational response to advanced technology implementation were not well understood by the shipbuilding industry.

In February of 1986, the SP-4 panel contracted with the Marine Systems Division of the University of Michigan Transportation Research Institute to develop the pilot workshop. The project thrust was to design a workshop and hold a pilot session (attended by two pre-selected shipyards) that would provide a foundation for further workshops within the shipbuilding industry.

This report outlines the development of the workshop, the tools that were utilized in executing the workshop design, and the lessons learned. The pilot workshop was held during the first week of August 1986, in Ann Arbor, Michigan. It was attended by selected personnel from Bath Iron Works Corporation (BIW) and National Steel and Shipbuilding Company (NASSCO).

1.1 Pilot Workshop Background

The National Shipbuilding Research Program (NSRP) technology transfer initiative has introduced many advances in ship production techniques. As these technological advances have been absorbed, changes have occurred in the shipyard organizational structure, communication patterns, reporting relationships, etc.; however, it has not often been clear what changed and to what degree. Any impediment to full and rapid implementation has delayed the benefit flow expected from the investment.

In addition to working with the NSRP, many shipyards sent teams of personnel to Japan to view advanced ship construction techniques. The teams returned with the acknowledgement that there was a superior method of building ships. However, after their return, project(s) for transfer of the new technologies

often failed. It has been contended that, in the cases of failure, the transfer did not occur because of an inability to develop inertia within the shipyard for such fundamental change.

Since considerable money, time, and effort had been expended, the delay in realizing benefits from a project (or the actual failure of a program) has lead to management frustration with unrealized goals and objectives. There has not been enough appreciation of the extent to which a new production concept affects the structure of the firm. The resulting disruption from technology emplacement has often produced a "backlash" reaction against further endeavors at technology implementation.

The SP-4 panel proposed to address the challenge of implementation of advanced technology through the development of a workshop that would:

(1) draw heavily on the state of knowledge rapidly being developed in industrial engineering and management science relevant to organizational change;

(2) utilize industrial and academic experts with intimate knowledge of the technology now being applied within the shipbuilding industry; and

(3) organize the workshop format in such a way that an effective and unique learning experience occurred.

1.2 The Pilot Workshop Purpose

The purpose of the workshop was to respond to industry's recognition that implementation of advanced shipbuilding methods and procedures requires a special understanding by management of the unique consequences such concepts have on the organizational effectiveness of the enterprise.

The workshop was based on the premise that the technology gap between U.S. shipyards and their overseas competitors is one that is caused primarily by the software technologies: quality control, planning, production control, design for production, production engineering, product work breakdown at the design stage, standardization of the product, and progressive management techniques.

In the early stages of technology implementation, management has often viewed advanced technology as hardware-oriented (e.g., a highly-automated plasma-arc cutting system, a large-capacity building basin, a robotic assembly operation, etc.). As work continues, however, most management (not all) become convinced that "advanced technology" is, in fact, most appropriately applied to the area of social systems.

The purpose of the workshop, as presented to the attendees, was:

1. To enhance the shipyard's ability to implement technology by:
    * exploring the organizational complexities of technological change,
    * broadening the vision of how to manage those complexities, and
    * providing time to develop and share some new approaches to challenges faced by each shipyard.
2. To help the representatives of each shipyard become a more effective management team by:
    * practicing participative management and other social innovations,
    * encouraging appropriately open communication, and
    * examining the process of how people work together.

2.0 THE WORKSHOP PARTICIPANTS

2.1. The Shipyards

The two shipyards selected to participate in the pilot workshop were Bath Iron Works Corporation (BIW) and National Steel and Shipbuilding Company (NASSCO). These two shipyards were chosen for the following reasons:

* each shipyard had, in the last five years, undergone extensive changes in its approach to shipbuilding;

* each shipyard had technology transfer programs with Japan;

* the shipyards were not a threat to one another in the market place (BIW being primarily a builder of surface combatants and NASSCO being primarily a builder of commercial merchant ships); and

* the types of ships built by the two shipyards presented similar types of construction challenges.

The participants from each of the shipyards were also carefully chosen. The shipyards were asked to send personnel from each functional area within the shipyard. The criteria given was that each person selected should be directly involved in the implementation of change and in a position within the company to influence and design future change. Prior to the workshop date, each shipyard reviewed the other's proposed attendee list to ensure that a close counterpart from each yard was attending.

Listed below are those persons that attended from each shipyard:

Bath Iron Works Corporation

James M. Blenkhorn	Senior Vice President, Business & Technical Development
Royce A. Young	Senior Vice President, Bath & Portland Operations
William D. Potter	Vice President Engineering
Denis K. Dugan	Vice President Management Systems
Peter L. MacDonald	Director, Production Planning and Control
Jan E. Erikson	Director, Technical Business Development
Bruce K. London	Assistant Director, Structural Design
Harold K. Benner	Assistant Foreman, Electric Shop
James R. Vander Schaaf	Director, CAD/CAM Development

National Steel and Shipbuilding Company

Donald Spanninga	Senior. Vice President, Operations
John Tucker	Director, Engineering
Ian Robertson	Manager, Outfitting Engineering
Jim Scott	Director, Materials
Janice Shanklin	Director, Information Systems
Erwin Struss	Director, Outfitting Production
Dave Hetherington	Ship Manager, Hospital Ship Program
Len Schneider	Assistant Superintendent, Hull Assembly
Andy Parikh	Manager Planning

2.2 The Workshop Staff

The workshop staff was comprised of the following personnel:

Howard M. Bunch - Project Director
NAVSEA Professor of Ship Production - University of Michigan
Chairman, Ship Production Committee Education & Training Panel

John J. Garvey - Project Manager
Marine Consultant
Former Director MARAD Office of Advanced Ship Development

Charles Starkenburg - Industry Consultant
Former Vice President of Planning - Avondale Shipyards, Inc.

Jeffrey Liker - Academic Consultant
Assistant Professor of Industrial Operations Engineering - University of Michigan

Daniel Denison - Academic Consultant
Institute for Social Research - University of Michigan

Stuart Hart - Academic Consultant
Visiting Assistant Professor, School of Business Administration - University of Michigan

Randall Albert - Consultant
Organization Development Consultant - Dannemiller Tyson Associates Inc.

John Jessup - Workshop Coordinator
Senior Engineering Research Associate - University of Michigan

3.0 WORKSHOP DESIGN

The goal of the workshop was for the attendees to return to their shipyards with: (1) an exposure to the processes required to effectively implement change, and (2) a working outline (developed by the attendees) of a plan for implementing change that could then be developed by each individual shipyard. To achieve this goal, the workshop design was broken down into two parts: a combination of tutorial type lectures and hands-on working sessions.

The lectures were to provide up-to-date information relevant to organizational change from the sciences of management and industrial operations engineering.

The hands-on working sessions were to provide an opportunity for the participants to deal with the lecture material as it related to the specific challenges facing their shipyard. Each working session was designed to build upon previous sessions, culminating in a final presentation at the close of the workshop. This presentation was to consist of each shipyard's plan for how it could better implement change within its own organization. The agenda for the workshop is contained in Appendix A.

4.0 TUTORIAL LECTURES AND WORKING SESSIONS

The following is an overview of each workshop activity: the tutorial lectures, the audio/visual presentations, and the working sessions. Lecture notes and overheads are contained in a separate appendix referenced under each title.

4.1 Tutorial Lecture I:

Implementation of Advanced Technology: Strategies for Change, Models for Success and Failure

The purpose of this lecture was to provide a stage setting for the workshop: outlining the purpose, format, and goals. Appendix B contains the lecture notes. A brief overview of the material presented follows.

The premise for the workshop (recognizing that the technology gap between U.S. shipyards and their competitors is based on something other than capital facilities) was developed from past studies comparing U.S. and Japanese shipyards. The implementation of advanced technology (as defined in the context of the social systems: organization of work, design/production integration, production planning, and human resource optimization) was presented along with the purpose statement outlined in section 1.2 of this report.

The following precepts were given:

* Advanced technology is any existing process not commonly utilized that improves production.

* Transfer of advanced technology has four distinct stages:

    1. Initial Awareness
    2. Evaluation
    3. Adoption
    4. Implementation (including follow-up)

* Technology transfer must occur within a dynamic organization to survive in today's market.

* The implementation of advanced technology into the system results in:

    * dislocation of organizational practice
    * change in work rules and job definitions
    * power shifts
    * new attitudes and positions

4.2 Tutorial Lecture II:

U.S. Shipbuilding Delphi Report: Assessment of Technology Now in Use and Potential for Change.

The purpose of this lecture was to promote thinking on the current environment for change in the shipbuilding industry. The lecture material was based on a Delphi survey of the U.S. shipbuilding industry that was undertaken as part of the workshop project. (Appendix C contains the summarized results of the survey.)

Subject areas covered by the Delphi survey results included:

* Identification of important areas of change in shipbuilding in the next ten years:

    Implementation of Revised Construction Techniques
    Market Conditions
    Government Issues
    High Technology
    Computer Utilization

* Functional areas of internal change that can be expected in shipyards:

  Production/Manufacturing
  Design/Engineering
  Marketing
  Purchasing/Material Management
  Production Planning, and Control
  Industrial Human Relations
  Technology Development
  Finance

* Personnel changes likely in the next ten years.

  Total Work Force
  Layers of Management
  Skilled vs. Unskilled
  Craft Mix
  Cross Trading
  Ratio of Workers in Fabrication vs. Assembly vs. Erection
  Ratio of First Line Supervisors to Workers
  Ratio of Degreed vs. Non-degreed Personnel
  Ratio of Design Engineers vs. Production Engineers
  Ratio of Technical vs. Non-technical Management

* Identification of the accelerators of change.

* Identification of the inhibitors of change.

4.3 Tutorial Lecture III:

Organizations as Systems: Traditional Management vs. Open-Systems Management

The purpose of this lecture was to provide an understanding of how to define and view organizations as systems: to explore the implications of "system thinking" for the management of change. Appendix D contains the lecture notes. Following is a summary of the key points in the lecture.

A system is defined as an interrelation of parts. The key to system thinking is the sense of integration: altering the arrangement of the parts alters the system. In viewing organizations as systems, two distinct types emerge: (1) organizations with closed-system thinking, and (2) organizations with open-systems thinking.

Organizations with closed-system thinking have the following characteristics:

1. The organization has distinct parts performing clearly defined functions.

2. Challenges to the organization are viewed and approached as a linear chain of cause and effect.

3. Change in the environment is considered to be slow and predictable.

4. People are viewed as extensions of machines (i.e., expendable spare parts).

The closed-system or "machine" model of the organization is a result of management theorists of the late 1800s and early 1900s. The above characteristics are the extreme view, but they do describe the traditional management that has evolved in U.S. manufacturing.

Organizations with open-system thinking have the following characteristics:

1. The organization is considered to be a dynamic entity composed of interacting parts with changing functions.

2. Challenges to the organization are viewed and approached as a joint causation of interdependent and interacting systems.

3. Changes in the environment in the foreseeable future are turbulent and uncertain.

4. People are viewed as complementary to machines, and as resources to be developed.

Open-systems management is based on "organic" or living-system models of organizations. The need to manage in the turbulent times of today and tomorrow is pushing U.S. manufacturing toward this fundamentally different type of organization.

4.4 Videotape Presentation:

"Meetings: Isn't There a Better Way?"

The videotape, "Meetings: Isn't There a Better Way?,"[1] was shown to promote efficiency in the working sessions that were to follow. The tape describes the meeting process, individual roles and responsibilities, and the decision process.

4.5 Working Session I:

The External Environment

The workshop participants were directed to break-out rooms where each shipyard was to study and define the external environment. After the subgroup discussion (directed by the task statement and process outlined below) each shipyard returned to give a group report.

Task Statement: The last ten years have seen many changes in the nature of the business environment. International competition, technological innovation, changing values and other forces or trends have rendered business strategies based on stability inappropriate. Through a process called nominal group technique, this session seeks to foster discussion and consensus about the nature of the external environment facing your shipyard.

Process:

1. Working alone, silently generate ideas about what factors in the external environment are prominent (e.g., competition, stakeholders, trends). (10 mins.)

2. With the aid of the facilitators, list your task groups' ideas in round-robin fashion. Facilitators will record the results on flip charts. (20 mins.)

3. Discuss and clarify each of the ideas suggested by team members, item by item. (30 mins.)

4. Arrive at a group sense of which factors characterize the external environment of your shipyard: consolidate and reconcile. (30 mins.)

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[1]Available through the AVMAST Library, Ship Production Committee Education and Training Panel, Transportation Research Institute, University of Michigan, Ann Arbor MI 48109.

5. Volunteer to give a short (5 min.) report on group deliberations to the other company representatives and the workshop staff.

6. Reconvene the larger group to hear the reports and discuss their implications. (30 mins.)

Expected Outcomes:

1. A deeper and shared "snapshot" of the external environment which impacts all internal processes.

2. A written list of environmental characteristics.

4.6 Working Session II:

Present Corporate Product/Market Position

Each shipyard was directed to a break-out room to develop a picture of its organization's present corporate position. The following steps were followed in this working session:

Task Statement: Discuss the position of your shipyard relative to the external environment. What are your products and who is the target market? In what direction are your systems and people taking you? What goals or "targets" are implied by your current direction?

Process:

1. Individually, jot down notes to yourself or write a statement of your product/market position. (10 mins.)

2. Group discussion. (60 mins.)

3. Facilitator summarizes notes for approval. (15 mins.)

4. Meet together in large room to discuss the day and evening plans. (15 mins.)

Expected Outcomes:

1. A shared picture of your organization's current product/market position and momentum.

2. Written summary.

4.7 Tutorial Lecture IV:

The Socio-technical Systems Model

The purpose of this lecture was to provide an understanding of the socio-technical systems approach to manufacturing. Following is a summary of the key points of the lecture. (Appendix D contains the lecture slides).

The term "socio-technical systems" is used to describe the systems approach to the organization, based on the theory that the technological system works only within the context of the workers' social system. When an organization uses this systems approach, analysis of the productivity of both the social system and the technical system must take place with a recognition of the interdependence of the two.

The social system is examined to determine and improve organizational roles and their interrelationships. The technical system is analyzed to obtain maximum benefit from the machines, tools, materials, techniques, procedures, and skills used by the workers.

The need to develop the socio-technical approach is, again, a response to the manufacturing systems that grew out of the management theory espoused and implemented in the early 1900s. The over-simplification of work, and vertical orientation of departments, left workers alienated from the organization. Productivity improvements traditionally focused on the technical system without regard for necessary changes in the social system (e.g., in job roles or organization design).

There are five social system factors critical to motivating work in the socio-technical-oriented organization:

1. ***Autonomy*** : Workers are given responsibility for a range of work. Many decisions are left to groups of workers for decision by consensus. Peer review is a result.

2. ***Task Identity*** : Work groups are given an understanding of how their tasks fit into the whole picture.

3. ***Task Variety*** : Workers are cross-trained with new skills. Job rotation and skill-based pay systems are a result.

4. ***Feedback*** : Workers have a capability of changing the system through feedback. Work groups monitor their own activities in relation to the whole organization.

5. ***Task Significance*** : Provision of the above critical factors gives workers an understanding of the importance of their work and the significance of their duties.

There is an increasing use of the socio-technical system approach to organizations in the U.S. manufacturing industry. The fundamental change required by the traditional organization is a long, complex, and expensive procedure. The two major roadblocks to such change are the incongruous managerial system already in place, and the basic human tendency to resist change. The benefits of overcoming these roadblocks and implementing the change result in an organization that is flexible, and highly motivated, and one which provides satisfaction to its work force.

4.8 Working Session III

The Internal Environment

Shipyard personnel were directed to respective break-out rooms to analyze the internal environment of their shipyard. The listing of the prouds and sorries (strengths and weaknesses) of each organization, developed by the subgroups following the outline below, were then presented to the entire group--the focus being on the implementation of advanced technology.

Task Statement: Looking over the past year in your company, what are the social and technical issues about which you are proud and what are the issues about which you are sorry?

Process:

1. Split into two groups of approximately equal size. Choose the people in your organization with whom you interact the least.
2. Take a couple of minutes to think individually.
3. Choose a recorder for your group.
4. Brainstorm your strengths and weaknesses using newsprint divided in half. Discuss lists. (20 mins.)
5. Be prepared to summarize your lists for the other group from your company. (20 mins.)
6. Come back together to discuss the interactions and implications of the social and technical issues. (60 mins.)
7. Meet with larger group for summaries by facilitator.

Expected Outcomes:

1. An analysis of the internal production, and the individual and social processes.

2. An uncovering of the "norms" of the organization.

3. A list of issues facing the organization.

4.9 Slide/Tape Presentation

Development of Participatory Social System for Increasing Safety

This slide presentation,[2] produced by the Japan Productivity Center, describes the development of quality work groups started in the early 1970s at Mitsubishi Heavy Industries Ltd., Nagasaki Shipyard. The slide show describes the application of Performance Maintenance (PM) leadership theories and the principles of group dynamics that were used in the shipyard to address the critical safety problem. The slide presentation was intended to promote discussion on the cultural differences that exist between Japan and the United States, and how those differences impact the ability to incorporate participative management techniques in U.S. shipyards.

4.10 Working Session IV

The Preferred Organization of the Future

This working session was intended to allow the participants to develop the preferred organization of the future. Following the group process outlined below, the shipyards met separately and did not present their findings to the entire group.

Task Statement:: Where should your shipyard be going? For shipyards to proactively respond to a changing environment, they need a clear direction. A set of concrete goals must be established that are consistent with the shipyard's mission and external environment. Internal and external pressures and issues have been identified. If your shipyard were to do the best possible job it

[2]Available through the AVMAST Library, Ship Production Committee Education and Training Panel, Transportation Research Institute, University of Michigan, Ann Arbor MI 48109.

realistically can to respond to these internal and external pressures and issues, what would it look like in 1995?

Process: Think of yourself in a time balloon over your shipyard in 1995. Assume that your shipyard has done a great job of responding to internal and external pressures and issues consistent with the mission of the company, and the environment has been in your favor. Describe in detail what your *senses see* (i.e. sight and sound) in your preferred future.

1. Each participant independently thinks about his/her preferred future and writes down notes describing important aspects of the company in concrete detail. (15 mins.)

2. Volunteers present their preferred futures to the group. One facilitator summarizes, on newsprint, highlights of each person's preferred future and probes for concrete details. A second person takes detailed notes. (45 mins.)

3. The group discusses the preferred future and consolidates items, if desired. It is not necessary to achieve consensus on all aspects of the preferred future. (30 mins.)

Expected Outcomes:

1. A joint image of a preferred future achievable under ideal conditions.

2. A written description of the group's preferred future.

3. A set of goals to help identify and prioritize issues and problems in session V.

4.11 Tutorial Lectures V & VI

Implementing Change and Managing Resistance to Change

The purpose of these two lectures was to provide a model for change and to gain an understanding of the management of change. The following is a summary of the key points. (Appendix F contains material on which the lectures were based).

The process of implementing change is a difficult one to begin. The traditional organization suffers from what author Peter Drucker calls "federal decentralization." The companies are organized in a number of autonomous businesses, each with responsibility to its own results and its own contributions to the total company. These firms have reached a point of dividing up the work so that they now suffer from communication blockage--analogous to the onset of osteoarthritis in the human body.

Workers in a traditional organization are living in their own narrowly defined "arthritic boxes"--at all levels of the organization, across departments, divisions, and segments of production. It was programmed into these organizations that, if "I do my job - you do yours," the work of the company would get done. Over time, the functions and levels become so separated that they often send conflicting objectives or tasks up and down the "functional chimneys."

A model that describes the forces of fundamental change was developed by R. Beckard in the late 1960s. Paraphrasing his model, one can describe resistance to change (R) to be a function of three factors: dissatisfaction with the present (D), a vision of what is possible (V), and the first steps in reaching the vision (F). For change to occur, the product of these three factors must be greater than the resistance to change.

$$\mathbf{D \times V \times F > R}$$

Although the factor (D), dissatisfaction-with-the-present, can be of great magnitude in the traditional organization, its cause is usually not agreed upon throughout the organization. In addition, the autocratic style of management that prevails in the traditional organization does not support team vision (V) and first steps (F).

Participative management is the means for developing factors that produce change in the right proportions by allowing for a common employee data base about: (1) how everyone in the organization sees the past and why a change is needed, (2) what the future could be and what is preferred, and (3) what steps can

be agreed upon in order to effect change. Participative management style, however, is a radical change itself and requires an understanding of the group process and the selective use of decision-making by consensus.

Groups are better able to make decisions that fully utilize each person's talents and view points. Decisions from a meeting of two or more people evolve from a process that is separate from the content of the meeting. This process is made up of three distinct interactions that must be addressed: (1) *Membership* of the individual within the group, (2) *Control* and *Leadership* issues of the final decisions, and (3) *Goal Formation* stating what the group is to accomplish.

When groups neglect the membership and control issues of a meeting (e.g. the individual feeling of belonging to a group and clear definition of how conflict will be resolved) and start with Goal Formation, there will be a low level of commitment to the subject at hand. This is particularly true of committees and task groups that have strangers in them. To raise the membership and control issues to an appropriate level and deal with them is called "Trust Formation" or "Team Building."

Decisions by group consensus are not always the answer for overcoming a roadblock to change. Decision-making involves two processes: the technical process of assembling and weighing relevant data, and the social process of involving, *or not involving*, subordinates and relevant others in the process of making the decision. Participative management style requires that a manager be able to decide when to involve others in decisions. (Appendix F, page F-8, provides a decision model and a procedure.)

4.12 Working Session V

Identifying Strategic Issues and Challenges

Each shipyard, on its own, developed the priority issues and challenges that needed to be addressed. The group process outlined below was followed.

Task Statement: What are the high priority strategic issues and problems on which you should be working?

Identification and prioritization of strategic issues should be defined by the external environment, the mission, and the internal environment of your shipyard, and should lead toward achieving your preferred future.

Process:

1. Divide into twos or threes with persons who are likely to be interested in similar issue areas or who perform similar functions. (5 mins.)

2. Each small group should discuss strategic issues and problems that are its passion and generate its own lists on newsprint with no outside facilitation. (30 mins.)

3. Small groups post their lists on the wall and each person reads all lists and selects a crayon.

4. *The Circus:* Each person chooses the issue areas and problems that are the highest priority for his/her shipyard. Each person is allowed two stars for issues he/she feels are absolutely crucial and four checks for issues he/she feels are extremely important. Check and star items on the newsprint.

5. A facilitator working with a participant from the shipyard prioritizes the list based on the checks and stars (no formal algorithm need be used).

Expected Outcomes:

1. A jointly developed, prioritized list of strategic issue areas and problems for each shipyard.

2. A basis for selecting the issues to work on for the problem-solving activities to follow.

4.13 Working Session VI

Approaches for Solving Strategic Problems

This working session required that the attendees choose the highest priority issues of the previous session, identify challenges inherent in these issues, and develop approaches toward solving the resultant problems. Results of the previous working sessions and group dynamics thus culminated in this final working session, as each shipyard presented its individualized process for change.

5.0 BEYOND THE PILOT WORKSHOP

The pilot workshop was intended to provide a basis for the development of further workshops in the industry. The positive response of the workshop attendees (over 90% of those attending indicated that the workshop was an effective use of both their own time and, more importantly, their company's time) signaled that the workshops should be offered to the rest of the shipbuilding industry. This recommendation was presented to the Education and Training Panel (SP-9) of the Ship Production Committee--the sponsor of the second phase of the project.

At the August 1986 panel meeting in Williamsburg, Virginia, approval was granted for holding a second workshop. It was proposed that, for the second phase of the project, a series of workshops geographically dispersed or a single workshop in a central location be conducted. Due to the funding strain on the NSRP program, the panel directed that a single workshop be held. It was decided that this workshop should be open to the entire industry, public and private, and plans were made for holding the second workshop in November, 1986.

5.1 Results of the Second Workshop - November 1986

It is important that the results of the second workshop be mentioned, for it was during the second workshop that the direction for final recommendations came into focus. The pilot workshop staff's reaction to the first session was that the workshop format performed beyond original expectations. However, utilizing essentially the same content/format, the second workshop was not as successful as

the pilot. The following section explores why the follow-up workshop, attended by five shipyards, was only a limited success.

The second workshop was attended by Newport News Shipbuilding, Norfolk Shipbuilding & Drydock Corporation, Peterson Builders, Inc., Pearl Harbor Naval Shipyard, and Puget Sound Naval Shipyard. The reader familiar with the relative sizes of these shipyards and the diverse spectrum of products, will recognize some of the group dynamics problems with which the workshop staff had to contend (i.e., addressing the issues from the perspective of each type of shipbuilder). Shipyard type and size, however, had been recognized as issues that would be dealt with by providing a common denominator: focusing attention on the development of individualized strategic plans, the goal and purpose of the workshop. Why then, was the second workshop not an "overwhelming success" and a green light for additional workshops using the same format and content? Two factors were identified as the primary differences between the pilot workshop and the follow-up.

The first factor impacting the effectiveness of the workshop program was the level of top management's direct participation in the workshop. In registering the shipyards for the second workshop, there was no effort made to enforce the requirement (although it was strongly recommended) that at least one person from each shipyard be at a top management level. Those groups without top management present were generally the most dissatisfied with the workshop content. These participants found themselves attending a workshop suggesting fundamental change in their organization and not having in their group a person that could effect that change.

The second factor impacting the workshop was found in the underlying quest that surfaced midway through the second workshop. Although the exercise of developing the process for approaching implementation of advanced technology was useful, a number of the yards indicated a desire for more technical "how to" tools. A *model* for implementing technology, in addition to a process, was desired. It was hoped that such a model would give precise direction for optimizing effective technology implementation.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The enthusiasm of the first workshop, coupled with the strong opinions and dialogue of the second, indicates that there is a need to have workshops that sensitize management to the dynamics of technology implementation. The following observations were made:

1) There was a general consensus from the participants of both workshops that complications of technology implementation are directly associated with organizational structure and human behavior dynamics.

2) There are significant differences between shipyards in the level of exposure and sophistication to the concepts of organizational change.

3) Top level management must be directly involved in the workshop for the results to be effectively implemented.

4) The success of the first workshop suggests that cooperative industry workshops are effective and the basic format/content framework need not be radically changed. However, shipyards are sensitive to who is attending. The ideal mix is to have yards that do not see the others as direct competition.

5) The content and format of this workshop should be considered for use in a workshop dedicated to a single shipyard.

An understanding of the reasons for the limited success of the follow-up workshop provides directions for improvements. The following recommendations for improvement of the workshop are a result of the critical evaluation from staff and participants. For future workshops, it is suggested that: (1) the content/format of the pilot workshop be compressed, and (2) the presentation of a ship production process model be included. These recommendations are covered in more detail in the following sections.

6.1 Recommendation I

Additional Workshops

The challenges of cost and competitiveness facing the U.S. shipbuilding industry require that the entire organization undergo significant change. The struggle for effective change led the Design/Production Integration Panel to the development of the pilot workshop presented in this report. Workshops facilitate the transfer and understanding of technology needed to make fundamental changes. The cooperative workshop format that brings a number of organizations together accelerates the transfer process as managers realize that their challenges are shared by others in the industry.

The solutions to the challenges of implementing advanced technology have been recognized for American industry in general as being associated with the infrastructure of the organization. Steven Wheelwright (Stanford University, Graduate School of Business)[3] notes that:

> "...whether one is looking at production planning and materials control, human resource management, or plant supervision, the critical tasks for the future are all very similar. These functions cannot be segmented and isolated, but must be integrated. Moreover, while these functions involve many small, seemingly minor day-to-day decisions, the cumulative effect of these decisions can indeed be substantial. Finally, it appears that when competitive advantage is based on such infrastructural arrangements in production operations, it becomes extremely difficult for competitors to imitate, because there are no short cuts to putting in place the infrastructures needed to realize these results."

The infrastructure of the organization is unique, like the personality of the individual, and therefore unique solutions are required. The pilot workshop, and its successor, supported this fundamental long-term change for the U.S. shipbuilding industry by defining the processes that management must understand when implementing new technology. Workshops are needed to enhance, accelerate and reinforce this understanding.

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[3] S. Wheelwright, "Production Operations: Liability or Asset?," in G. Germane ,ed., *Executive Course,* Addison-Wesley Publishing Company, Inc., 1986, pp. 149-180.

In addition to the multi-shipyard meeting that was developed in this pilot program, it is recommended that the workshop format and content be utilized within a single shipyard. This would allow for a larger management team (top management to first line supervisors) to be exposed to the concepts. Challenges specific to the organization could be pursued to a greater depth.

6.2 Recommendation II

Compression of Pilot Workshop Material

Shipyard management is reaching an exposure level to the process concepts (such as participative management and the reorganization of work) such that they no longer need to be sold on the benefits. Future workshops need to go beyond the development of the process to meet the needs of the industry; therefore, the content of the pilot workshop related to the process for change should be compressed, and additional technical content needs to be developed.

In the future, process concepts should be considered cornerstones for further work. The level of management's sophistication to these concepts should be assessed, or assumed to be high, providing a foundation for working with a model or framework that rationalizes the shipbuilding process. The development of such a model is the final recommendation of this report.

6.3 Recommendation III

Rationalizing the Shipbuilding Process

Critiques of the workshop design have indicated that there is a need for a model that rationalizes the shipbuilding process: a measuring stick for shipyards to hold themselves up to as the change process evolves. Rationalization of the shipbuilding process refers to breaking the production processes down into unit operations, in their appropriate sequence, and justifying the work that takes place within and between each operation. Unit operations are defined as the performance of a function or practical work, a procedure, or a step in the process.

What would such a model look like? Does a modeling framework exist? Investigations would have to be made to fully answer these two questions; however, one framework for modeling the shipbuilding process was presented in January, 1987 to each of the five shipyards who attended the second workshop. The model describes the deployment of company-wide quality control (CWQC) into an organization and the integrated functions that are required to support it. The literature refers to this operating model for CWQC as **quality functional deployment** (QFD)[4].

The impact CWQC has on the productivity of an organization is well documented, both inside and outside the shipbuilding industry. Complete installation of CWQC refers to an organization that has moved from *manufacturing quality control* (inspection after production and/or statistical process control during production) to *product and process development quality control.* The result is that all operations are driven by the "voice of the customer." The impact on the organization is improved productivity and quality at reduced cost and, ultimately, competitiveness.

The concept of developing a QFD model to support shipyard management was well received by the shipyards. It was readily agreed that such a model would be very complex, crossing the many functional operations of ship production. The internal and external "voice of the customer" requires definition, modeling, and case studies. (It is important to note that quality functional deployment [QFD] concepts were first developed and utilized at Kobe Shipyard, Mitsubishi Heavy Industries, Ltd.) The model would have to recognize the roots of QFD and be appropriate to the U.S. shipbuilding industry--an industry that is typically not in complete control of the design, thus requiring unique approaches for responding to the customer.

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4 Sullivan, *Quality Functional Deployment* , Quality Progress (June, 1986) pp. 39-50.

Finally, it must be understood that a *complete* modeling of the shipbuilding process would be an individualized process for each organization. Essentially, a modeling of the infrastructure of the organization is required. The model, whether it is quality functional deployment or some other framework, provides only the tools and principles for developing the individualized understanding of the objectives.

APPENDIX A

PILOT WORKSHOP AGENDA

WORKSHOP -- IMPLEMENTATION OF ADVANCED TECHNOLOGY IN THE SHIPBUILDING INDUSTRY

Terrace Ballroom, Campus Inn
Ann Arbor, Michigan

AUGUST 5,6, & 7, 1986

August 5, 1986 - Day One

*** Introduction/Administrative Details
*** Implementation of Advanced Technology: Strategies for Change, Models for Success and Failure.
*** U.S. Shipbuilding Delphi Report: Assessment of Technology Now in Use and Potential for Change.
*** Bath Iron Works, Issues and Challenges
*** NASSCO, Issues and Challenges
*** Lecture: Organizations as Systems: Traditional Management vs. Open Systems Management.

*** Group Luncheon / Videotape : "Meetings"

*** Working Session "The External Environment"
*** Working Session "Present Corporate Position"

August 6, 1986 -- Day Two

*** Lecture: Socio-technical Systems Model
*** Working Session "The Internal Environment"

*** Group Luncheon/ Slide Show: "Misumi"
*** Working Session "The Preferred Future Organization"
*** Implementing Change
*** Working Session "Identifying Strategic Issues & Challenges"
*** Group Dinner
Guest Speaker--Dr. Robert Cole, "Culture as a Barrier to Borrowing"

August 7, 1986 -- Day Three

*** Lecture: Managing Resistance to Change
*** Working Session "Developing Approaches for Solving Strategic Problems"
*** Team Presentations
*** Wrap-up

APPENDIX B

LECTURE SUPPORT MATERIAL FOR "IMPLEMENTATION OF ADVANCED TECHNOLOGY: STRATEGIES FOR CHANGE MODELS FOR SUCCESS AND FAILURE"

IMPLEMENTATION OF ADVANCED TECHNOLOGY: STRATEGIES FOR CHANGE MODELS FOR SUCCESS AND FAILURE

by

Howard M. Bunch
August 1986

I. BACKGROUND ACKNOWLEDGEMENTS

A. Preaching to the Choir:

Two leading shipyards currently involved in implementing advanced technology.

1. Both have contracts in implementing Japanese technology with IHI.

2. Senior executives have both told me at various times over past five years of absolute need to implement.

   (a) "...if we don't do it, it will all be over..." (BIW Exec in 1982).
   (b) "...our future as a viable competitor is linked to success of IHI technology transfer project... (NASSCO Exec in 1985).

B. Other Acknowledgements

II. ELEMENTS OF PRESENTATION

A. Productivity/Advanced Technology Gaps.

B. Examination of Advanced Technology Transfer and Its Implication.

C. Suggestions for Focus and Action.

III. PRODUCTIVITY/ADVANCED TECHNOLOGY GAP

A. Productivity Gap

1. "The Productivity Problem in U. S. Shipbuilding", JSP, Vol. 1, #1.

a. IHI/Levingston Comparison...Table #1.

b. Exxon Study...Table #2.

2. PD214 Study

a. Avondale (1983) vs KHI-Kobe (1980).

b. Detailed Difference Vary by Function... Table 4.3.

c. Factors favoring Avondale

(1) More space
(2) Larger lift capacity (209 vs 250)
(3) More advanced CAD/CAM
(4) Automated panel line

d. Factors favoring KHI

(1) Facilities in harmony
(2) Better material flow
(3) Process rationalized
(4) Design/production integrated

e. Conclusion: The gap is something other than facilities...it is caused by soft technology (i.e., something not associated by fixed facilities).

B. Todd/Mitsubishi Relationship....Japanese Superiority in Eight Areas.

1. Paper to be presented by Len Thorell at 1986 NSRP Symposium.

2. Specific Areas

a. Welding Automation

(1) Application of robot welding techniques
(2) Other

b. Strict Quality Control

(1) Total Quality Control
(2) Statistical Quality Control

c. Production Engineering

(1) Drawings formatted to simplify construction concepts
(a) ...combining steel with outfitting
(b) ...developed only for work package

(2) Special tools and fixtures

d. Production Engineering for Advanced Outfitting

(1) Facilitate on-block and on-unit
(2) Optimize working conditions, e.g., down-hand.

e. Product-Oriented Design

(1) Implement concepts at design
(2) Standard deviation.

f. Tight Delivery and Inventory Control

g. Industry-wide Cooperation

h. Progressive Management Concepts.

(1) Management by.Objective
(2) Participative Management
(3) Closer Planning and Production Control.

IV. ADVANCED TECHNOLOGY TRANSFER --- IMPLICATIONS

A. Definition: Transfer (Deployment) of existing processes (knowledge, skills, equipment) not presently utilized...commonly interpreted as transfer of Japanese shipbuilding technology. [Could also be European. Ex.: CAD/CAM].

B. Stages

1. Initial Awareness
2. Evaluation
3. Adoption
4. Implementation

C. Most Important Stage: Implementation

1. Deployment as a Systems Problem

a. Dislocation in organizational practice

(1) Work rules
(2) Communication patterns
(3) Job definitions
(4) Power shifts

b. Ripple effects

2. Longitudinal/Strategic Aspects

a. Management focus on short term
b. Current focus on law/money

3. Socio-Technical Aspects

a. Traditional (expendable labor) vs. Advanced (Multiple-skilled information transfer)
b. High job security
c. Power shifts

3. Socio-Technical Aspects

a. Traditional vs Advanced

(1) Expendable labor	(1) Valuable resource
(2) Easily replaced	(2) Difficult to replace
(3) Single craft	(3) Multiple skilled
(4) Tightly controlled	(4) Participative

b. Power shifts moving to locations of Advanced Technology Implementation.

c. Advanced Technology Implementation results in move away from hierarchical leadership.

V. TECHNOLOGY TRANSFER STRATEGY AND TACTICS

A. WON'T JUST HAPPEN....MUST HAVE PLANNING AND IMPLEMENTATION.

B. REQUIRED ARE: NEW ATTITUDES/POSITIONS RELATIVE TO ORGANIZATIONAL PRACTICE.

1. Worker participation
2. Modification of work rules--multi-skilling
3. Reinforcement of concept of job security

C. REQUIRED: MORE EMPHASIS ON STRATEGIC

1. Total Quality Control (Design/Production Integration)
2. Long-term Capital Investment Attitudes

D. CONCLUSION: (PRESENT CONTEXT) COMIC STRIP CHARACTER POGO "WE HAVE MET THE ENEMY AND HE IS US"

POGO TELLS US:

** IT IS US

** IT IS THE DYNAMICS OF THE SYSTEM

** IT IS THE FEAR AND UNCERTAINTY OF THE FUTURE

** IT IS THE COMFORT AND SAFETY OF THE PRESENT AND THE PAST.

** WE MUST CHANGE THE PATTERN.

** WE MUST ENCOURAGE THE INNOVATOR

** WE MUST COMFORT THE FEARFUL

** WE MUST THINK AND ACT FOR A COMPANY AND A CONTINUITY THAT WILL BE PERMANENT--THAT WILL LAST A THOUSAND YEARS, SO-TO-SPEAK.

ONLY THEN WILL WE SUCCEED. THIS WORKSHOP IS DESIGNED TO BEGIN TO MOVE US DOWN THAT PATH!!

Table 1 Ratio of IHI-Aioi to Levingston labor hours and materials for a bulk carrier

Item	Labor Hours	Material Costs
Preliminary and staff items	0.24	0.54
Hull steel items	0.22	0.78
Minor steel items	0.42	0.58
Machinery items	0.47	0.66
Outfitting items	0.35	0.56
TOTAL (all)	0.27	0.65

Table 2 A tanker owner's parametric estimates of relative costs [a]

	% of U.S. Costs	
	Japan	Europe
Labor cost:	35	51
direct labor hours	46	57
wage rate	74	83
Steel cost	71	64
Propulsion machinery and outfit material	70	78

[a] For a ship contracted for in 1981, delivered in 1983.
Source: Reference [5].

TABLE 3.4

	-----FIRST SHIP--		---	-----5SHIP AVERAGE-----		
	ASI	KHI	RATIO KHI/ASI	ASI	KHI	RATIO KHI/ASI
TOTAL PRODUCTION ACTIVITIES, ONLY	1233	588	0.48	1172	556	0.47
DESIGN, PLANNING, AND MOLD LOFT	601	122	0.20	202	38	0.19
HULL PRODUCTION ACTIVITIES, ONLY	561	243	0.43	536	229	0.43
HULL DESIGN, PLANNING, AND MOLD LOFT	250	68	0.27	106	22	0.21
OUTFITTING PRODUCTION ACTIVITIES ONLY	672	345	0.51	636	327	0.51
OUTFIT DESIGN, PLANNING, AND MOLD LOFT	351	54	0.15	96	16	0.17

KHI/ASI PRODUCTION COMPARISON

AREAS OF JAPANESE SUPERIORITY IN SHIPBUILDING

WELDING AUTOMATION

STRICT QUALITY CONTROL

PRODUCTION ENGINEERING

PRODUCTION ENGINEERING FOR ADVANCED OUTFITTING

PRODUCT-ORIENTED DESIGN

TIGHT DELIVERY AND INVENTORY CONTROL

INDUSTRY-WIDE COOPERATION

PROGRESSIVE MANAGEMENT CONCEPTS

APPENDIX C

1986 U. S. SHIPBUILDING DELPHI SURVEY

ROUND TWO DELPHI--U.S. SHIPBUILDING 1986-1995

INTRODUCTION

The following survey of the shipbuilding industry was done in support of the Design/Production Integration Panel Project "Implementation of Advanced Technology in the U.S. Shipbuilding Industry." The survey method used was the Delphi process.

The Delphi method was originally developed by the Rand Corporation for the U.S. Air Force. It is a systematic, iterative method of forecasting. Its objective is to measure the degree of consensus among a panel of experts regarding future events. For this project, the objective was to forecast areas of change that can be expected in the next ten years in U.S. Shipbuilding.

The Delphi forecasting process is basically an opinion poll. The differences between a normal opinion poll and the DELPHI method are twofold: first, the questions are put to people who are recognized experts in the field, in this case shipbuilding. Secondly, the experts are given a chance to see the answers of other experts (anonymously) and to change their opinion if they see fit.

Two rounds of the survey were made. The questions, as posed to the panel of experts, are presented in this Appendix with a summary of the responses. Round 2 of the survey is presented first, with Round 1 starting on page C10.

The opinions of 35 experts in the shipbuilding industry are the basis for this Delphi forecast. Approximately 60% of the Panel was comprised of personnel working in U.S. shipyards. The remainder of the Panel included individuals from government, academia, industry consultanting firms, design agencies, and regulatory bodies. The Panel of experts was developed by the Marine Systems Division of the Transportation Research Institute, University of Michigan, based on its close ties to the industry.

This question is a result of the responses to Question #1 of Round 1.

1-2.1 The implementation of revised construction techniques, such as the use of zone methodology in new construction repair and group technology for product oriented work in shops, has made a major impact on the shipbuilding industry. To what degree can the following areas be expected to be influenced in the next ten years as further implementation occurs?

Assign a percentage weight to the degree of change each area will undergo in the next ten years as a result of the implementation of revised construction techniques. (Total score should equal 100%.)

AREA UNDERGOING CHANGE	% of Total Respondents
Engineering/Production Interface	22
Worker Job Classification	12
Work Reorganization	21
Management Reorganization	11
Use of Standards	13
Material Handling	11
Use of Supplier Subcontracting	8

ROUND 2 QUESTION

This question is a result of the responses to Question #1 of Round 1.

1-2.2 U.S. Government and Navy ability to control and influence the shipbuilding industry has become more pronounced as commercial shipbuilding has dried up. The sources of this influence come from many different areas.

Assign a percentage weight to the following governmental sources of change to the degree that they will affect the shipbuilding industry in the next ten years. (Total score should equal 100%.)

SOURCE OF CHANGE	% of Total Respondents
U.S. Administration Merchant Marine Policy	14
U.S. Navy Effect as Only Customer	36
Government (Navy) Contracting Procedures	22
National Security Issues	10
Influence of Politics on Decisions	18

ROUND 2 QUESTION

This question is a result of the responses to Question #1 of Round 1.

1-2.3 U.S. Shipyards will have to deal increasingly more often with new technology as innovative ship designs are introduced and building materials change. To what degree will the following sources of change influence the level of technology U.S. shipyards are capable of handling?

Assign a percentage weight to the following high-tech sources of change to the degree that they will affect the shipbuilding industry in the next ten years. (Total score should equal 100%.)

SOURCE OF CHANGE	% of Total Respondents
Complexity of Automated Shipboard Systems	31
Use of High Strength Steels	15
Use of Plastics and Glass Reinforced Plastics	16
Automation of Production Processes	29
Other	9

ROUND 2 QUESTION

This question is a result of the responses to Question #1 of Round 1.

1-2.4 The introduction of computerization has been identified as a major source of change for the shipbuilding industry. Many different parts of the shipbuilding process are having to respond to computerization. Of the areas listed below, where can the most emphasis on computerization be expected in the next ten years?

Assign a percentage weight to the following areas to the degree that they will affect the shipbuilding industry in the next ten years. (Total score should equal 100%.)

AREA OF CHANGE	% of Total Respondents
Integrated Information Systems	18
Computerized Planning & Scheduling	19
Computer Aided Design (CAD)	24
Material Requirements Planning (MRP)	19
Computer Aided Manufacturing (CAM)	16
Other	4

ROUND TWO DELPHI--U.S. SHIPBUILDING 1986-1995

ROUND 2 QUESTION

2c.-2 In Question #2c. of the Round 1 questionnaire, the panel was asked to indicate how the function of Marketing would change over the next ten years. The check mark responses resulted in approximately 50% indicating the function "staying about the same" and 50% indicating it would be "significantly different." Relatively few comments were received.

The 50-50 split indicates only that there is not a consensus across the panel, however, further detailed comments are of interest. Please comment below.

* If you feel the function of marketing will stay relatively the same, please indicate why.

* If you feel the function of marketing will significantly change please indicate the direction(s) of the change and the underlying cause(s).

ROUND 2 RESPONSE

ABOUT THE SAME

26% indicated that the Marketing function will remain relatively the same.

Comments primarily indicated that Marketing will remain the same because it has little effect on Navy business under current procurement policy--the customer will be essentially unchanging.

SIGNIFICANTLY DIFFERENT

74% indicated that the Marketing function will undergo significant change.

86% of these comments indicated there would be a proactive change. Over half indicated that Marketing would have to become more technically oriented and gain a better understanding of the shipyard capabilities.
Representative Comments: Increasing emphasis on business and technology aspects (cash flow, automation). Forward-looking shipyard managers will recognize the need to link marketing, technology development (both product and process), and strategic business planning. Marketers will look at non-marine markets, put together joint ventures, and license foreign technology. Marketing will become more involved in R&D and the marketing of the results.

14% of these comments indicated a decline in the importance of the Marketing function. Focus will change from selling to "pencil sharpening." As marketing function diminishes, more focus will be placed on influencing the Navy, Congress, et al.

ROUND TWO DELPHI--U.S. SHIPBUILDING 1986-1995

ROUND 2 QUESTION

2f.-2 In Question #2f. of the Round 1 questionnaire, the panel was asked to indicate how the function of Industrial (Human) Relations would change over the next ten years. The check mark responses resulted in approximately 40% indicating the function "staying about the same" and 60% indicating it would be "significantly different." Relatively few comments were received.

The 40-60 split indicates that there is not a clear consensus, however, further detailed comments are of interest. Please comment below.

* If you feel that Industrial Relations will stay relatively the same, please indicate why.

* If you feel that Industrial Relations will significantly change please indicate the direction(s) of the change and the underlying cause(s).

ROUND 2 RESPONSE

ABOUT THE SAME

17% indicated that the Industrial Relations function will remain relatively the same.

Comments primarily indicated that there would be insufficient workload to make significant changes.

SIGNIFICANTLY DIFFERENT

83% indicated that the Industrial Relations function will undergo significant change.

Representative Comments: The labor/management relationship will moderate. More innovative arrangements for sharing of the risk/reward of the company will be made. A product oriented management will result in changing of the craft lines, participative management, cross training and a more sophisticated workforce. Heavier emphasis on support of production to institute training programs, formal job qualification/job description statements to allow competence to be defined, measured, improved.

ROUND TWO DELPHI--U.S. SHIPBUILDING 1986-1995

1ROUND 2 QUESTION

2g.-2 In Question #2g. of the Round 1 questionnaire, the panel was asked to indicate how the function of Technology Development would change over the next ten years. The check mark responses resulted in approximately 40% indicating the function staying about the same and 60% indicating it would be significantly different. Relatively few comments were received.

The 40-60 split indicates that there is not a clear consensus, however, further detailed comments are of interest. Please comment below.

* If you feel Technology Development will stay relatively the same, please indicate why.

* If you feel Technology Development will significantly change please indicate the direction(s) of the change and the underlying cause(s).

ROUND 2 RESPONSE

ABOUT THE SAME

19% indicated that the Technology Development function will remain relatively the same.

Comments primarily indicated that there would be insufficient market and funding sources to make significant changes.

SIGNIFICANTLY DIFFERENT

81% indicated that the Technology Development function will undergo significant change.

20% of these comments indicated Technology Development will be the result of more sophisticated ships.

40% of these comments indicated Technology Development would be the result of modernizing the ship production process. Technology Development will be directed toward cost saving techniques, lower installation cost components, lower maintenance items, and equipment that is more tolerant to shipyard environments and handling conditions.

20% of these comments indicated there would be a decrease in the function of Technology Development. Primarily this would be due to a lack of government support for the R&D effort that companies will not try to make up.

ROUND 2 QUESTION

2h.-2 In Question #2h. of the Round 1 questionnaire, the panel was asked to indicate how the function of Finance would change over the next ten years. The check mark responses resulted in approximately 60% indicating the function staying about the same and 40% indicating it would be significantly different. Relatively few comments were received.

The 60-40 split indicates that there is not a clear consensus, however, further detailed comments are of interest. Please comment below.

* If you feel the function/role of Finance will stay relatively the same, please indicate why.

* If you feel the function/role of Finance will significantly change please indicate the direction(s) of the change and the underlying cause(s).

ROUND 2 RESPONSE

ABOUT THE SAME

57% indicated that the Finance function will remain relatively the same.

Comments primarily indicated that there is no reason for change. Representative comments included: Adherence to strict government accounting principals dictates relatively no change in finance function. If the market broadens, creative financing will play a major role in an evolving commercial market.

SIGNIFICANTLY DIFFERENT

43% indicated that the Finance function will undergo significant change.

Representative comments included: The role Finance must play is one that develops innovative methods that result in "bottom line black ink" for all elements of the maritime industry (shipbuilding, shipping, and shippers). Visibility into all aspects of a shipyard's operations will improve dramatically as management systems are improved.

ROUND 2 QUESTION

5.0-2 In Question #5 of Round 1, the panel was asked to review a list of factors and their relationship to change occurring within the shipyard. Additional factors have been added as a result of Round 1 responses.

Please assign a percentage score to each factor as to its influence toward the implementation of beneficial change within a shipyard. (Total score should equal 100%.)

	% of Total Respondents
Profitability	17
Quality	10
Cost Reduction	18
Quality of Work Life	3
Safety and Health	4
Corporate Image	3
Customer Requirements	9
Schedule Reduction	9
Survival	10
Education & Training	5
Communications & Understanding	5
Contracting Practice	4
Others	4

ROUND 2 QUESTION

6a.-2 In Question #6a. of Round 1, the panelists were asked an open-ended question regarding the impediments to effective and timely change. In order to establish a weighted ranking of the impediments to timely change, assign a percentage score to each of the following factors identified in the Round 1 response. (Total score should equal 100%.) Add additional factors if appropriate.

FACTORS IMPEDING CHANGE	% of Total Respondents
Economics and the Shipbuilding Market	26
Cultural--People and Intrenched Habits	16
Management's Resistance to Change	16
Lack of Expertise in Implementing Change	10
Upper Management's Short Range Concerns	16
Cost (Dollar) of Change	15

ROUND 2 QUESTION

6b.-2 In Question #6b. of Round 1, the panelists were asked an open-ended question regarding the accelerators of effective and timely change. In order to establish a weighted ranking of the accelerators of timely change, assign a percentage score to each of the following factors identified in the Round 1 response. (Total score should equal 100%.) Add additional factors if appropriate.

ACCELERATORS OF CHANGE	% of Total Respondents
Survival/Competition	29
Management Commitment	20
Financial Rewards	11
Knowledge/Training	8
Good Communication	6
Customer/Regulatory Requirements	10
Available Funds for Change	11
Industry Cooperation	6

ROUND 2 QUESTION

9.0-2 In Question #9 of Round 1, the panel was asked an open-ended question to identify the areas of likely automation within the shipbuilding industry.

In order to establish a weighted ranking of the areas likely to be automated in the next decade, assign a percentage score to each of the following areas that were identified in the Round 1 response. (Total score should equal 100%.) Add additional factors if appropriate.

Area Likely to be Automated	% of Total Respondents
Welding	18
Steel Fabrication	13
System Testing	5
Material Handling	13
Sheet Metal Fab. & Assembly	9
Outfit Assembly	4
Structural Assembly	6
Pipe Fabrication & Assembly	14
Machine Shop Fab. & Assembly	7
Surface Preparation & Coating	11

ROUND ONE DELPHI QUESTIONNAIRE & RESPONSES--U. S. SHIPBUILDING 1986

ROUND 1 QUESTION:

1. Between now and the year 1995 there will, undoubtedly, be changes in the way Naval and Commercial Ships are built, overhauled or repaired. Many of these changes will be externally generated such as changing requirements (designs, specifications, regulations). Others will result from technical breakthroughs that have clear and economic application to ship construction and repair. Still others will be a response to changing market conditions. Many of these potential changes are already visible although their effect on shipbuilding firms is not generally apparent. In your opinion, what are the most important changes that are likely to occur within the next decade which will effect U. S. shipbuilding? Please list them in the relative order of importance and include a brief (one or two sentence) explanation.

ROUND 1 RESPONSE

The above question was asked in round one of the Delphi. The responses have been grouped into the following five major sources of change.

1. Implementation of Revised Construction Techniques

   Of the responses, 28% indicated that a major source of change would be the implementation of new construction techniques resulting in important changes in: engineering/production interface, worker job classification, work reorganization, management reorganization, use of standards, material handling, and supplier subcontracting.

2. Market Conditions

   Of the responses, 19% indicated that a major source of change would be due to the market conditions of the shipbuilding industry. Changes would occur in the shipbuilding base as the private yards and public yards go after insufficient work. Foreign competition both in shipbuilding/ship repair and marine equipment suppliers will result in increased procurement from overseas. Shipyards will enter into non-marine markets.

3. Government Related Issues

   Of the responses, 19% indicated that a major source of change would be due to government related issues. One customer, U.S. Government, will make product decisions political vs. economic. Attitudes toward awarding to the lowest bidder will change. The amount of control over the shipyard by the customer (Navy) will increase. Government will have to move to salvage industry due to present lack of U.S. merchant marine policy.

4. High Technology - New Ship Types and New Materials

Of the responses, 18% indicated that a major source of change would be due to the development of new ship types and the use of new materials. Innovative ship design utilizing modular ship components and more complex systems will require shipyards to be high-tech oriented. Use of new materials: high strength steels, new welding consumables, and plastics will require increased technological levels within the shipyard.

5. Advances in Computer Utilization

Of the responses, 15% indicated that a major source of change would be due to the increased use of computerization. Computer enhancements in CAD, CAD/CAM, integrated information systems, and bills of materials will take place. Automation of the production area will be introduced.

ROUND 1 QUESTION:

2a. Within the next decade, how is Production/Manufacturing likely to change in terms of its traditional function, emphasis, and/or relative importance within the firm? If you indicate "significantly different", please add a few words of explanation.

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

21% indicated that the Production/Manufacturing function will stay about the same.

SIGNIFICANTLY DIFFERENT

79% indicated that the Production/Manufacturing function will undergo significant change.

Over 50% of these comments indicated that significant change would primarily be due to the traditional function of Production/Manufacturing being impacted by new production philosophies (Modular Construction and Zone Outfitting, Process Flow, Group Technology, etc). The remaining comments indicated that the change would be due to mix factors such as requirements for higher productivity, improved human relations, CAD/CAM interface, and the impact of cross trading.

ROUND 1 QUESTION:

2b. Within the next decade, how is Design/Engineering likely to change in terms of its traditional function, emphasis, and/or its relative importance within the firm? If you indicate "significantly different", please add a few words of explanation.

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

24% indicated that the Design/Engineering function will stay about the same.

SIGNIFICANTLY DIFFERENT

76% indicated that the Design/Engineering function will undergo significant change.

50% of these comments indicated that significant change would primarily be due to the impact of Engineering changing its emphasis to support design for production.

42% of these comments indicated that significant change would primarily be due to the use of computer aided design and support of computer aided manufacturing.

ROUND 1 QUESTION:

2c. Within the next decade, how is Marketing likely to change in terms of its traditional function, emphasis, and/or its relative importance within the firm? If you indicate "significantly different", please add a few words of explanation.

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

53% indicated that the Marketing function will stay about the same.

SIGNIFICANTLY DIFFERENT

47% indicated that the Marketing function will undergo significant change.

50% of these comments indicated that Marketing would change its emphasis into non-marine work. Other comments were mixed, anticipating changes in Marketing as it becomes an integral part of production/manufacturing and more technically oriented than in the past.

ROUND 1 QUESTION:

2d. Within the next decade how is Purchasing/Material Management likely to change in terms of its traditional function, emphasis, and/or its relative importance within the firm? If you indicate "significantly different", please add a few words of explanation.

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

24% indicated that the Purchasing/Material Management function will stay about the same.

SIGNIFICANTLY DIFFERENT

76% indicated that the Purchasing/Material Management function will undergo significant change.

25% of these comments indicated that change will be primarily due to the Purchasing/Material Management function becoming an integral part of production and engineering.

24% of these comments indicated that the type of material purchase will be the most significant change. Increased use of standardized items and finished products will occur.

16% of these comments indicated a significant change in company/vendor relationships: closer relationships and fewer vendors

16% of these comments indicated a significant change due to the impact of computer based material management systems and automated warehousing.

16% of these comments indicated a significant change in the timing of material purchase and receipt, supporting the just-in-time philosophy.

ROUND 1 QUESTION:

2e. Within the next decade how is Production, Planning, and Control likely to change in terms of its traditional function, emphasis, and/or its relative importance within the firm? If you indicate "significantly different", please add a few words of explanation.

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

24% indicated that the Production, Planning, and Control function will stay about the same.

SIGNIFICANTLY DIFFERENT

76% indicated that the Production, Planning, and Control function will undergo significant change.

35% of these comments indicated that significant change has an increased emphasis in the firm as Production, Planning, and Control becomes fully integrated with production, manufacturing, and engineering.

35% of these comments indicated that significant change will occur in the accuracy of information through the utilization of computer based planning systems and statistical techniques.

20% of these comments indicated that significant change will occur as the Production Planning, and Control function undergoes decentralization within the shipyard.

ROUND 1 QUESTION:

2f. Within the next decade how is Industrial (Human) Relations likely to change in terms of its traditional function, emphasis, and/or its relative importance within the firm. If you indicate "significantly different", please add a few words of explanation.

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

41% indicated that the Industrial (Human) Relations function will stay about the same.

SIGNIFICANTLY DIFFERENT

59% indicated that the Industrial (Human) Relations function will undergo significant change.

35% of these comments indicated the significant change in Industrial Relations will be an increase in management/labor cooperation.

24% of these comments indicated the significant change in Industrial Relations will be through the use of work teams, along the lines of quality circles.

Other comments covered a broad spectrum of change: the impact of automation and CAD/CAM, increased training programs, relaxation of work rules, increased materialism.

ROUND 1 QUESTION:

2g. Within the next decade how is Technology Development likely to change in terms of its traditional function, emphasis, and/or its relative importance within the firm? If you indicate "significantly different", please add a few words of explanation.

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

43% indicated that the Technology Development function will stay about the same.

SIGNIFICANTLY DIFFERENT

57% indicated that the Technology Development function will undergo significant change.

56% of these comments indicated that technology development will increase and be more sophisticated. The following are a number of the drivers that were associated with this view: new computer tools, new materials and welding consumables, advanced manufacturing methods and zone construction approach.

Other comments varied--from an indication that a decrease in Technology Development will occur as Government R&D efforts dry up, to change primarily occurring due to new hull forms and ship design.

ROUND 1 QUESTION:

2h. Within the next decade how is Finance likely to change in terms of its traditional function, emphasis, and/or its relative importance within the firm? If you indicate "significantly different", please add a few words of explanation.

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

63% indicated that the Finance function will stay about the same.

SIGNIFICANTLY DIFFERENT

38% indicated that the Finance function will undergo significant change.

Representative of the few comments received are the following:
Finance will have to be able to accommodate "zone" design, planning and construction. Shifts in Navy contracting procedures will have a significant impact.

ROUND 1 QUESTION:

3. Which of the functional areas in questions 2a.-2h. (a.Production/Manufacturing, b.Design/Engineering, c.Marketing, d.Purchasing/Material Management, e.Production Planning & Control, f.Industrial Relations, g.Technology Development, and h.Finance) will be impacted the most as a result of new technology? Which will be impacted the least?

ROUND 1 RESPONSE

The following prioritization of the list and the associated response weight listed below are for the functional areas that will be impacted the MOST as the result of new technology:

FUNCTIONAL AREA	% of Responses
Production/Manufacturing	36%
Design/Engineering	29%
Production Planning & Control	11%
Purchasing/Material Management	10%
Marketing	8%
Industrial (Human) Relations	<5%
Technology Development	<5%
Finance	0

ROUND 1 RESPONSE

The following prioritization of the list and the associated response weight listed below are for the functional areas that will be impacted the LEAST as the result of new technology:

FUNCTIONAL AREA	% of Responses
Finance	39%
Industrial (Human) Relations	17%
Marketing	10%
Technology Development	<5%
Production/Manufacturing	<5%
Design/Engineering	<5%
Purchasing/Material Management	<5%
Production Planning & Control	<5%

ROUND 1 QUESTION:

4a(1). How is the overall mix of personnel likely to change for the Total Work Force?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

22% indicated that, overall, the mix of the Total Work Force will stay about the same.

SIGNIFICANTLY DIFFERENT

78% indicated that, overall, the mix of the Total Work Force will be significantly different.

53% of these comments indicated that a higher level of training would be required.

35% of these comments indicated that the number of personnel would decrease due to technology improvements (improved engineering and planning and use of automation) reducing the manhours per job.

ROUND 1 QUESTION:

4a(2). How is the overall mix of personnel likely to change in regard to the blue collar vs. white collar ratio?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

29% indicated that, overall, the mix of the Blue Collar vs. White Collar ratio will stay about the same.

SIGNIFICANTLY DIFFERENT

71% indicated that, overall, the mix of the Blue Collar vs. White Collar ratio will be significantly different.

85% of these comments indicated that there would be a decrease in the ratio, ie. fewer blue collar worker and more white collar workers. Reasons given for this were: more automated equipment, increased planning, increased reliance on subcontractors, increased engineering.

ROUND 1 QUESTION:

4a(3). How is the overall mix of personnel likely to change in regard to the layers of management?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

39% indicated that, overall, the layers of management will stay about the same.

SIGNIFICANTLY DIFFERENT

61% indicated that, overall, the layers of management will be significantly different.

61% of these comments indicated there would be a decrease in the number of layers of management. The availability of improved decision-making tools and work team concepts were cited most often as the reason for this shift.

ROUND 1 QUESTION:

4a(4). How is the overall mix of personnel likely to change in regard to the ratio of work planners vs. doers?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

24% indicated that, overall, the ratio of work planners vs. doers will stay about the same.

SIGNIFICANTLY DIFFERENT

76% indicated that, overall, the ratio of work planners vs. doers will be significantly different.

70% of these comments indicated an increase in the ratio as more planning is required.

ROUND 1 QUESTION:

4b(1). How is the mix of personnel in Production/Manufacturing likely to change in regard to the ratio of skilled vs. unskilled workers?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

23% indicated that in Production/Manufacturing the ratio of skilled vs. unskilled workers will stay about the same.

SIGNIFICANTLY DIFFERENT

77% indicated that in Production/Manufacturing the ratio of skilled vs. unskilled workers will be significantly different.

70% of these comments indicated there would be an increase in skill level required in Production/Manufacturing.

Representative comments: *skills will be in demand, but a different type than present day shipbuilders, more production line oriented; *new technology requiring greater skill, emphasis on "doing it right the first time" (accuracy control); *automation will require more skills; and *multi-skilled individuals and unskilled tasks disappear.

18% of these comments indicated there would be a decrease in the skill level required in Production/Manufacturing.

Representative comments: *classification of work by problem categories and superior work instructions; and *less total skilled workers due to automation that requires simple set up.

ROUND 1 QUESTION:

4b(2). How is the mix of personnel in Production/Manufacturing likely to change in regard to craft mix?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

31% indicated that in Production/Manufacturing the craft mix of workers will stay about the same.

SIGNIFICANTLY DIFFERENT

69% indicated that in Production/Manufacturing the craft mix of workers will be significantly different.

50% of these comments indicated that craft lines would change significantly from that of today.

Representative comments: *multi-skilled; and *particular work area with multi-disciplined production teams.

28% of these comments indicated that changes in traditional craft emphasis will be the most significant change.

Representative comments: *increased electrical specialization, *increase in repair and outfitting crafts; and *new crafts for new materials such as GRP.

ROUND 1 QUESTION:

4b(3). How is the mix of personnel in Production/ Manufacturing likely to change in regard to cross crafting (cross trading)?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

6% indicated that in Production/Manufacturing the cross crafting of workers will stay about the same.

SIGNIFICANTLY DIFFERENT

94% indicated that in Production/Manufacturing the cross crafting of workers will be significantly different.

Of these comments, all indicated that cross crafting would take place in some form.

Representative comments: *multi-skilled individuals and/or multi-skilled work groups; *increased use of flexible work rules; *dramatic elimination of craft distinctions is underway; *craft identity will soften; and *increased cross trading including "master craftsman concept."

ROUND 1 QUESTION:

4b(4). How is the mix of personnel in Production/Manufacturing likely to change relative to areas of Fabrication vs. Assembly vs. Erection?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

29% indicated that in Production/Manufacturing the mix of personnel relative to areas of Fabrication vs. Assembly vs. Erection will stay about the same.

SIGNIFICANTLY DIFFERENT

71% indicated that in Production/Manufacturing the mix of personnel relative to areas of Fabrication vs. Assembly vs. Erection will be significantly different.

60% of these comments indicated manhours shifting from erection and fabrication toward assembly.

Representative comments: *zone outfitting will increase work at assembly; *greater reliance on subcontractors therefore fewer fabrication workers; and *more emphasis on assembly due to modular construction.

ROUND 1 QUESTION:

4b(5). How is the mix of personnel in Production/Manufacturing likely to change relative to the ratio of first line supervisors to workers?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

64% indicated that in Production/ Manufacturing the ratio of first line supervisors to workers will stay about the same.

SIGNIFICANTLY DIFFERENT

36% indicated that in Production/ Manufacturing the ratio of first line supervisors to workers will be significantly different.

Of these comments, all indicated that fewer 1st line supervisors would be needed.

Representative comments: *work teams need less supervision; *fewer supervisors due to improved planning; and *fewer supervisors as total work force becomes more experienced/skilled.

ROUND 1 QUESTION:

4c(1). How is the mix of personnel in technical departments likely to change relative to the ratio of degreed vs. non-degreed personnel?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

41% indicated that, in technical departments, the ratio of degreed vs. non-degreed personnel will stay about the same.

SIGNIFICANTLY DIFFERENT

59% indicated that in technical departments the ratio of degreed vs. non-degreed personnel will be significantly different.

Of these comments, all indicated an increase in the number of degreed personnel in the technical areas of the shipyard.

Representative comments: *more degreed people due to (1) general increase in education of population, and (2) sophisticated manufacturing processes; *increase in the number of associate degrees and some increase in baccalaureate degrees; and *more degrees in industrial engineering and manufacturing technologies

ROUND 1 QUESTION:

4c(2). How is the mix of personnel in technical departments likely to change relative to the ratio of design engineers vs. production engineers?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

26% indicated that in technical departments the ratio of design engineers vs. production engineers will stay about the same.

SIGNIFICANTLY DIFFERENT

74% indicated that in technical departments the ratio of design engineers vs. production engineers will be significantly different.

60% of these comments indicated that an increase in the number of production engineers would occur.

30% indicated that the distinction between design engineering and production engineering would dissolve, with more personnel becoming production engineering oriented.

ROUND 1 QUESTION:

4d(1). How is the mix of personnel in management departments likely to change relative to the ratio of technical vs. non-technical backgrounds?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

59% indicated that in management departments the ratio of personnel with technical vs. non-technical backgrounds will stay about the same.

SIGNIFICANTLY DIFFERENT

41% indicated that in management, technical backgrounds will be significantly different.

Of these comments, all indicated a more technically competent management would be in place.

Representative comments: *return to technically based management from financial; *management will have to have a "hands on" approach to running the yard; and *more industrial engineers and fewer naval architects.

ROUND 1 QUESTION:

4d(2). How is the mix of personnel in management departments likely to change relative to the ratio of professional vs. non-professional backgrounds?

About the same____. Significantly different____.

ROUND 1 RESPONSE

ABOUT THE SAME

63% indicated that in management departments the ratio of personnel with professional vs. non-professional backgrounds will stay about the same.

SIGNIFICANTLY DIFFERENT

38% indicated that in management departments the ratio of personnel with professional vs. non-professional backgrounds will be significantly different.

Of these responses, all felt that an increase in professionals would occur within the organization.

ROUND 1 QUESTION:

4d(3). How is the mix of personnel in management departments likely to change relative to the size of middle management?

About the same_____. Significantly different_____.

ROUND 1 RESPONSE

ABOUT THE SAME

48% indicated that, in management departments the size of middle management will stay about the same.

SIGNIFICANTLY DIFFERENT

52% indicated that, in management departments the size of middle management will be significantly different.

Of these comments, all indicated a reduction in the size of middle management.

Representative comments: *reduced due to access to decision-making information; *smaller and more efficient; and *reduced as top management is more involved and workers are better trained and need less supervision.

ROUND 1 QUESTION:

5. On a scale of 1 to 10 (10 being the highest), which of the following factors provide the most "pull" towards the implementation of beneficial change?

Profitability	Quality
Cost reduction	Competition
Workforce	Safety and Health
Corporate Image	Customer Requirements

ROUND 1 RESPONSE

The following prioritization resulted:

FACTOR	WEIGHT
Cost Reduction	9.9
Competition	9.9
Profitability	9.8
Quality	7.7
Customer Requirements	6.2
Safety and Health	5.6
Corporate Image	5.0
Workforce	4.4

ROUND 1 QUESTION

6a. What are the greatest impediments to effective and timely change?

ROUND 1 RESPONSE

A summary of the responses indicated the following as the greatest impediments to effective and timely change, in the order of most commonly noted.

1. Economics and the Shipbuilding Market
2. Cultural--People and Intrenched Habits
3. Management's Resistance to Change
4. Lack of Expertise in Implementing Change
5. Upper Management's Short Range Concerns
6. Cost (Dollar) of Change

ROUND 1 QUESTION:

6b. What are the greatest accelerators to effective and timely change?

ROUND 1 RESPONSE
A summary of the responses indicated the following as the greatest accelerators to effective and timely change, in the order most commonly noted.

1. Survival / Competition
2. Management Commitment
3. Financial Rewards
4. Knowledge/Training
5. Good Communication
6. Customer/ Regulatory Requirements
7. Available Funds for Change
8. Industry Cooperation

ROUND 1 QUESTION:

9. Production Automation

a. What areas of fabrication and assembly are the most likely to be automated during the next decade?

ROUND 1 RESPONSE

Areas Likely to be Automated

Welding
Steel Fabrication
System Testing
Material Handling
Sheet Metal Fab. & Assembly
Outfit Assembly
Structural Assembly
Pipe Fabrication & Assembly
Surface Preparation & Coating

ROUND 1 QUESTION

9d(1). The application of the zone-by-stage methodology for planning and executing ship work is probably the most recent and well known innovation undertaken by U. S. shipyards.

What were the aspects of this approach that made management so responsive to a rapid implementation.?

ROUND 1 RESPONSE

The following is a list of those primary aspects of zone methodology which made it a change which could be rapidly implemented in the shipbuilding industry.

* Proven Concepts
* Cost Reduction Potential
* Better Management Control
* Improved Delivery Schedule

Other aspects mentioned were:

* Need for Quality Improvement
* Available Guidance (NSRP program and Japan)
* Need for Compressing Schedules
* Logic of Approach
* Need to Reduce Manhours
* Fear of Competition

ROUND 1 QUESTION

9d(2). The application of the zone-by-stage methodology for planning and executing ship work is probably the most recent and well known innovation undertaken by U. S. shipyards.

What were the most serious impediments to a rapid implementation?

ROUND 1 RESPONSE

The following is a list of those primary aspects of zone methodology which inhibited rapid implementation in the U.S. shipbuilding industry:

* General People Resistance to Change
* Changing of the Design Process
* Personnel Untrained in New Concepts
* Changing Scheduling and Planning Functions
* Management Unwilling to Change

Other aspects mentioned were:

* Procurement Policies and Vendor Timing
* Lack of Workload to Achieve Change
* Cost Accounting Procedures
* Down-Stream Effects
* Labor Union Resistance to Change

ROUND 1 QUESTION

10. Statistical process control has been discussed as an important innovation in a number of fabrication and assembly industries (referred to as "accuracy control" in shipbuilding). In your opinion, is this technology likely to have an impact on shipbuilding? In what way?

ROUND 1 RESPONSE

79% indicated that statistical process control would have an impact on the shipbuilding industry.

Representative comments: *statistical approach creates corporate knowledge which is essential for management's analysis of work performances; *shipyards that do not implement statistical process control in all manufacturing operations and make a commitment to introduce those requirements in their engineering process will not be competitive; and *it will help rationalize the shipbuilding process toward a more disciplined and orderly preplanned process requiring greater team planning up-front and less rework in the field.

14% indicated that statistical process control would not have an impact on the shipbuilding industry.

Representative comments: *statistical process control is window-dressing; very rarely does shipbuilding have sufficient flow of similar parts to render it meaningful; and *since shipbuilding does not lend itself to mass production techniques, statistical control will have less of an influence than found in other industries.

7% indicated no comment or unknown.

ROUND 1 QUESTION

11. Over 50% of the cost of new ship construction is for the purchase of materials and components. What innovations are likely to address material cost?

ROUND 1 RESPONSE

Based on the number of comments, the primary innovations addressing material cost were:

Standardization of Parts	18%
Just-In-Time & Improved Schedule	16%
World Market - Increased Foreign Purchase	16%
Computer Based Material Control	13%

Other comments:

- High-tech materials
- Improved vendor relationships
- Movement away from awarding to low bidder
- Better Design and Planning
- Improved Material Handling

APPENDIX D

LECTURE SUPPORT MATERIAL FOR "ORGANIZATIONS OF SYSTEMS: TRADITIONAL MANAGEMENT VS OPEN-SYSTEMS MANAGEMENT"

Organizations as Systems: Traditional Management Vs. Open-Systems Management

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I. Purpose:

1. Provide managers with an understanding of how to define and view organizations as systems and explore the implications of "system thinking" for the management of change.

2. "Systems thinking" viewed as way of thinking about organizations, a descriptive tool, not a prescriptive tool.

II. **Exercise:** Let participants discover system concept through free-association exercise as follows:

A. Think of the term "organizational structure" and write down all of the words that come to mind (or draw a picture).

B. Think of the term "organizational systems" and write down all of the words that come to mind (or draw a picture).

III. **Definition of System:** An inter-relation of parts. The word 'inter-relation' conveys the sense of an arrangement of *interacting* and *interdependent* parts - which thus form the unified whole (the system). (exs. penal systems, legal systems, school systems, plumbing systems and social systems.). Key is sense of integration, blending into a whole, uniting with something else, belonging together. Changing the arrangement of a piece of the system changes the system even if no parts are added or subtracted.

IV. **Types of Systems (particularly open systems):** The many different types of systems include closed, open, mechanical, human, etc. Al share notion of interrelation, but each type differs in character and complexity. J. Boulding in "General Systems Theory: The Skeleton of Science (1956, Management Science) listed a hierarchy of system types and their defining characteristics:

A. Closed Systems:

1. Static Structure - Changeless system -- e.g.,ordering of planets in social system. Actually artificial concept cause all things change, but some slowly.

2. Simple, dynamic system.-- e.g. Most machines. The laws of Newtonian physics apply.

3. Cybernetics System -- Comes from Greek word Kybernetes meaning pilot or governor. Has a control mechanism based on close-loop feedback e.g. thermostat.

B. Open Systems:

4. Simple Open System -- self-perpetuating structure, such as single cell. They are goal seeking -- "programmed" to survive. Key difference from 1,2, and 3 is all open systems are living. Living systems are *acutely dependent on their external environment for survival.* This means the system boundary must have openings, must be permeable to permit the vital transactions with the outside world to take place. As complexity increases up to level 8, so too does the system's openness to change and modification from the outside -- the system becomes more dependent on its environment.

5. Genetic/Societal System -- Division of labor, with sub-systems. e.g. plant life. Again goal directed, however, not just goal seeking, but goal choosing -- surviving by rejuvenation, reproduction, and evolution.

6. Animal systems -- includes self-awareness and mobility, as well as specialized subsystems for receiving and processing information.

7. Human systems -- Adds capacity for self-consciousness and use of symbolism to communicate ideas.

8. Social Systems -- An organization. People are sub-systems within the larger system - the organization. A by-property is morphogenesis, which means capable of "growing new" systems and shedding existing ones.

C. In summary:

1. A system is a collection of elements that in some way belong together such that altering one element alters the whole. The arrangement of the parts is key. Altering the arrangement alters the system.

2. An open system is a system which has the following properties:

A. it is living

B. it is goal choosing

C. it depends upon transactions with its surrounding environment in order to survive; to continue living.

D. it has a permeable boundary

3. Open vs Closed -- Key difference is viewing is the inclusion of the surrounding environment in the picture. To use a photographic analogy, a *closed system* is like a snapshot of an organization made with the aperture set so that one object is in the foreground and everything else is blurred in the background. An open system camera allows for complex focusing and light settings and can take pictures of the object and its environment in motion.

V. **Simple Open-System Model** - Based largely on Social Psychology of Organizations by Daniel Katz and Robert Kahn (1966).

A. Boundary - (Draw rectangle with dotted lines)

1. According to Webster "anything that limits or confines." Four main types:

a. Physical -- e.g. fence around shipyard or individual's skin.

b. Temporal -- e.g. project or party

c. Social -- e.g. defined by membership (churchgroup, profession, company)

d. Psychological -- e.g. individual human elements like needs for satisfaction at work, temperament, sociability.

2. Choice of boundary depends on particular purpose. Analysts definition. For early parts of workshop we will define your shipyard as inside boundary and everything else as the environment. However, for later stages when you are working on a specific problem you may want to change your definition of the boundary.

3. Dotted line depict permeable boundary -- since conditions change, both the boundary location and its porousness must be flexible.

B. Inputs - (Draw arrow entering rectangle) Anything entering system, includes:

1. technical -- information, energy, material, blueprints from outside design firm.

2. human -- skills, knowledge, personality ("You can't hire just a hand, you get the whole man," e.g. family member's problems, day care needs)

C. Output - (Draw arrow leaving rectangle) Anything leaving system, includes:

1. produced goods
2. service
3. information
4. vapors from a chemical process
5. member satisfaction

D. Transformation process - (Divide rectangle into production, social, and individual) process which takes inputs and rearranges to make different output. View as three types of processes:

1. Production Process - technical processes aimed at producing system's prime output (e.g. scheduling systems, production technology, tools, research, etc.). Often major management efforts devoted to optimizing this alone; other processes are then left to happen or not.

2. Individual Process - Often referred to as individual "fulfillment" process. Each individual member has a unique set of needs-- for affiliation, power, creativity, autonomy, status, responsibility, avoiding responsibility, recognition, and for contribution. Individual processes can work toward desired system outputs or against them.

3. Social Process - Brings other two together; glue of system. Directed at interactions and relationships of members working together. Includes interpersonal dealings, e.g. empathy, communication, trust, and group dynamics--leadership, participation, feedback, conflict management, problem solving, and decision-making.

4. System balance -- Management is deciding what the needs are of each core process and how they are to be fulfilled. Object is to design the transformation to meet the maximum number of needs; production, individual and social. It is an act of strategy and on-going balancing acts.

E. System Goal/Mission (Draw bulls eye from output arrow) -- Goals which system attempts to direct its outputs toward. Often not formally defined, but defining and highlighting mission makes its attainment more likely, particularly if shared view by all people in system.

F. Environment --(Write outside system) That system is interdependent with environment is cornerstone of open systems theory, e.g., customers, suppliers, legal system, parent company. Each identified segment of the environment is, in turn, an open system with properties similar to the subject system.

G. Feedback -- from environment, is necessary to keep the system on course. How permeable the boundary is determines where and how much feedback enters.

VI. Examples -

A. Use of Outside Design agents. Change in inputs which changes all internal transformation processes of engineering within the shipyard. Changes technical needs, communication patterns, structure of jobs, satisfaction of internal engineers, etc.

B. Change in customer from commercial to Navy. Again dramatically changes internal transformation processes of shipyard.

VI. **Open- Versus Closed-System Management (See attached sheet)**

VII. **Open-Systems Approach and Organization of three day seminar** -- Describe tasks of next 2 1/2 days in open-systems terms. Key Questions:

A. What is present environment, inputs and outputs?

B. System's present position (goal or purpose)

C. What are the current transformation processes--production, individual, social

D. What is the preferred future organization, for whole system. given realistic, but optimistic predictions about the environment.

E. What are the challanges to getting to the preferred future?

F. What are some strategies for meeting the challange?

"The new form has the flexibility and the resilience to cope with turbulent environment fields, whereas the old form lacks these capabilities." --Eric Trist

Closed-System "Machine" Thinking

Conceptual View of Organizations:

1. Distinct parts performing clearly defined functions
2. Simple, linear chain of cause and effect
3. Environmental change is slow, predictable
4. People as extensions of machines, expendable spare parts

Management Implications:

1. Imperative: Optimize efficiency of parts of production process
2. Maximum task breakdown into simple, narrow skills
3. External controls: supervisors, specialists, standard operating procedures
4. Tall organization chart rigidly defines organization
5. Autocratic, top-down management
6. Communication through formal chain of command
7. Division of Purpose: Management seeks business goals, employees seek personal goals
8. Management focuses on short-term profitability and internal accountablility
9. Supervisor spends time on:
    - supervising
    - "fighting fires"
    - coordinating
    - detailed scheduling and control
10. Low participation, low morale, "turned off" people

Open-System "Organic" Thinking

Conceptual View of Organizations:

1. Dynamic whole composed of interacting parts with changing functions
2. Joint causation: interdependent, interacting systems
3. Environment in foreseeable future is turbulent, uncertain
4. People as complementary to machines, resources to develop

Management Implications:

1. Imperative: Joint Optimization of production, social, individual systems
2. Optimum task grouping into multiple broad skills
3. Internal controls: self-regulating subsystems
4. Flat organization chart as rough guide to organization functioning
5. Participative management style
6. Network Communication through appropriate channels
7. Commonality of purpose: All members seek blending of organization and personal goals
8. Management spends time on planning for the future and interacting with outside forces.
9. Supervisor ("Team leader") guides, teaches, facilitates provides resources, "linking pin"
10. High participation, high morale, energized and committed people

APPENDIX E

LECTURE SUPPORT MATERIAL FOR "SOCIO-TECHNICAL SYSTEMS MODEL"

FACTORS CRITICAL TO MOTIVATING WORK

1. AUTONOMY; RESPONSIBILITY FOR A RANGE OF WORK

2. TASK IDENTITY; DOING A "WHOLE" PIECE OF WORK

3. TASK VARIETY; LEARNING AND USING A VARIETY OF SKILLS

4. FEEDBACK; ONGOING DATA TOWARD GOAL ACCOMPLISHMENT

5. TASK SIGNIFICANCE; SEEING THE IMPORTANCE OF THE WORK

SELF MANAGING WORK GROUPS

WHAT ARE THEY?

1. GROUPS RESPONSIBLE FOR A LARGE TASK WHICH:

   - SPECIFY THEIR OWN WORK ARRANGEMENT
   - MANAGE THEIR OWN MEMBERSHIP, EVALUATION AND REWARD

WHERE SHOULD THEY BE USED?

2. IN SITUATIONS OF "TECHNICALLY REQUIRED COOPERATION"

CONCLUSIONS

1. GROWING USE OF STS DESIGN IN THE U.S.

   - SATURN
   - NEW PLANTS

2. IMPORTANT BENEFITS

   - FLEXIBILITY
   - MOTIVATION
   - SATISFACTION

3. BIGGEST ROADBLOCKS

   - INCONGRUENT MANAGERIAL SYSTEM
   - RESISTANCE TO CHANGE

APPENDIX F

LECTURE SUPPORT MATERIAL FOR "Impelmenting and Managing Resistance to Change"

Large-Scale Organization Change at Ford

by

Al Davenport, Kathleen Dannemiller and Bruce Gibb

- Organization Consultants of Ann Arbor, Inc.

Ford Motor Company is undergoing what is probably the largest sustained organizational change effort in the United States today. Because of the size of the organization, the degree of change needed, and the number of other organizations dependent on the U.S. auto industry, the success of this particular change process is vitally important.

This change effort began in 1979 as an outgrowth of contract negotiations between the company and the United Auto Workers. From these negotiations, it was agreed that the "Quality of Work Life" concept then existing at several sites within General Motors would be adopted as a policy across Ford.

Initially, there was little support for the concept, but with the beginning of the recession in late 1979 and 1980, the company became committed to changing the way it managed its employees. Ford's share of the automotive market during that period fell from about 25% to about 19%. Almost all of this 6% loss had been picked up by Japanese automakers. Market surveys had shown that a major reason for the loss of sales involved quality. Management shortly thereafter realized that quality would best be improved by getting employees more involved in their products. This employee involvement, E.I. ,was accomplished first by means of basic problem-solving groups. These groups generally included several employees working in the same shop or the same production line. The groups worked on issues of quality, cost and employees' work environment.

As a result of support from the company management, the union, and employees in general, these groups were, on the whole, quite successful in fixing problems affecting their own production lines. They brought about substantial improvements in quality, major cost savings, and a general increase in employees' concerns about the importance of their own effort. These problem-solving groups usually involved a subset of the employees working in that area, and after one problem was resolved, the group would continue to go on to attack another problem.

For example, in one plant, early quality indicators improved 100% in two years. They moved from 42nd to 3rd in safety across the company; went from over 400 to less than 100 grievances per year, and had a 30% reduction in scrap.

The next step in Ford's change process occurred when it became apparent that many of the answers to the problems being worked on by the problem-solving groups involved actions outside the control of the group. Communication with other areas within the plant, or with the engineering or finance departments, was often necessary to resolve problems. As a result, task forces across functional lines began to emerge. They existed solely to solve the problem. Occassionally, task forces would get together from supplier and customer plants to work on issues between them.

All in all, problem-solving groups and task forces functioned in about 70 plants across Ford. Their success has been apparent but, at the same time, most of the success occurred in specialized groups outside the mainstream of the organization. With organizational change occurring, for the most part, in a "test tube" outside the "real" organization, most

employees were only being indirectly impacted. Salaried employees had generally been excluded because the problem-solving group approach did not seem applicable to their work situation. Top management, relatively comfortable with a long standing autocratic style of management, did not seem aware of a need to change their own behavior. A change method that involved all levels and functions of the organization was required if the entire organization wanted to improve. While E.I. was a beginning, it was recognized that it wasn't enough - either for that point in time or for what Ford would be facing in the future. Ford needed new technology, not just in the design and manufacture of its products, but new ways of managing people at all levels and in all areas. These new ways needed to release the creativity and energy of all employees so that the company could be flexible and adaptive to its turbulent environment.

One of the first efforts at Ford to change management practices and behavior at all levels of the organization was the participative management effort in Diversified Products Operations (DPO).

DPO has nine divisions which include the production of many of the materials that go into the construction of an automobile -- steel, glass, electrical/electronics, castings, climate control, and plastics. Also included within DPO are Ford Aerospace, Tractor Operations and Land Development. In all, 45,000 of Ford's nearly 400,000 employees work in Diversified Products Operations.

A process of organizational change was launched across the nine businesses of DPO at the executive and management levels. Any change effort involving so many people, in the widely varying technologies of DPO, would be quite complex.

Four external consultants were hired to work with the Ford professionals to develop a participative management change effort for DPO. The team agreed upon a conceptual framework for describing individual, group and organizational behavior change that could be used (and understood) by operating executives and managers to bring about a successful system-wide change.

The change model which was the underpinning of the Participative Management effort was Dick Beckhard's: D x V x F > R. The product of dissatisfaction within the present (D), a vision of what is possible (V), and first steps in reaching the vision (F) must be greater than the resistance to change (R) in order to bring about change. If any of the elements is missing, the product will be 0, which will not be bigger than R - we all resist change to an unknown state. The team saw that the environment (Japanese competition, oil crisis, etc.) had caused dissatisfaction (D) throughout the system. What was needed was agreement on a new vision, and on first steps that would work to move toward that vision.

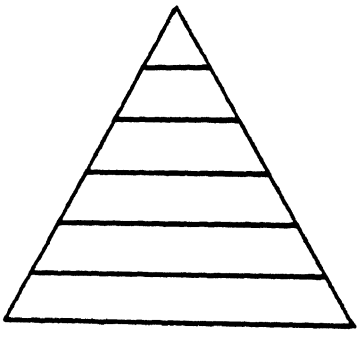
As the team worked together, they began to see another framework that could shape their work, which they called the "arthritic organization theory."

Ford is structured in what Peter Drucker calls "federal decentralization," organized in a number of autonomous businesses, each with responsibility for its own results and its own contribution to the total company. The targets for the Ford DPO intervention were te separate divisions, each having several locations and plants. Within each of these divisions are the normal functions required for a manufacturing organization: engineering, manufacturing, finance, business planning ,

quality assurance, personnel, manufacturing engineering, and product development.

This "federal decentralization" form of organization that is so prevalent in old-line business and industry developed in part from two major ideas from the 19th and early part of the 20th century, those of Max Weber and Frederick Taylor.

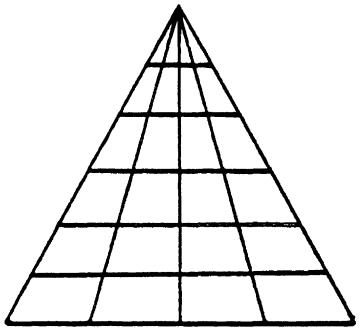
Weber's work suggested that the chaos which had developed through quickly enlarging organizations could be controlled by dividing up responsibilities into layers; which would look like this:



Each layer would have a clear sense of "boundary" and nothing would fall through the cracks. Everyone would be connected, from worker to founder."

Taylor's ideas of scientific management suggested that more specificity was needed: divide the tasks as well as the responsibilities. If tasks could be split up and carefully defined down to the simplest form (the "age of specialization"), the work could be controlled more effectively and there would be more predictability in the organization's results. Use of these concepts led to the creation of the "functional chimney," top to

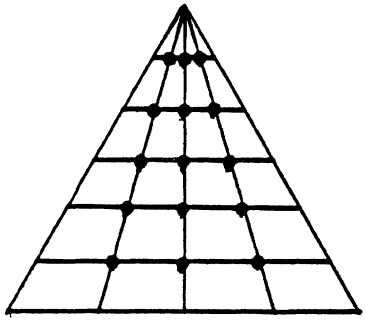
bottom, which when added to Weber's responsibility levels, and looked like this:



The structure worked well for many years, for those organizations prospering in times of stable growth. Organization development consultants focused on building teams within the boxes that the structures created -- at the top (off sites), in the middle (goal setting), or at the front line (EI/QWL teams).

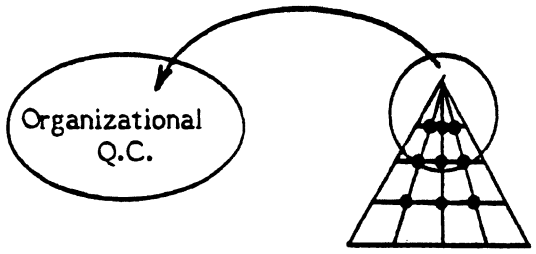
Then "Future Shock" hit -- the environment (customers, workers, advancing technology, and competition) began to change and disintegrate. The result was so radically different that many organizations needed to change how they defined themselves, how they worked, how they marketed, and especially the quality of what they produced and what it cost. They needed to respond system-wide -- and rapidly.

Managements' ability to respond was directly related to the structure and age of their organizations. Using the analogy of osteoarthritis in an aging human body, the consulting team saw that these organizations had become "arthritic," with blockages at every joint:



People were living in their own narrowly defined "arthritic boxes" -- at all levels of the organization, across departments, divisions, and even on the assembly lines. The message that was programmed into these old line organizations was "I do my job - you do yours," and the work of the company would get done. Over time, the functions and levels became so separated that conflicting objectives or tasks were often sent up and down the "functional chimneys" -- i.e., if marketing met its goals, manufacturing could not; if finance met its goals, research and development could not, and so on. Total system change became difficult, if not impossible.

Recognizing this reality, as it was expressed at Ford by the managers themselves, the decision was made to pull together large groups of managers -- in their intact work groups and in their functional chimneys -- out of the "arthritic organization," creating, in effect, an organizational "quality circle," as represented in this diagram:



and designing a "team building experience" for the top four to five levels of the organization. The focus of the intervention was to help them find new ways to interrelate -- vertically and horizontally. They needed an opportunity to reflect together on their current practices, explore individual and group aspirations of how they wanted to manage and be managed, and then commit to, and plan for, a new style of managing which would fit their organization and would be supported by the emerging culture of that organization as they would be developing it. To reach individual managers via training would not be enough.

Based on the change formula and on the arthritic theory, the first seminars were designed. Knowing that the top level managers who would need to be impacted had been exposed to numerous management training programs over the years, and that they had, by and large, remained autocratic in their style of management, the major presenting problems seemed to be to give managers a vision of another style -- a participative team-oriented style -- that they could believe in and begin to practice. It would take a significant paradigm shift - a change in the way they made sense out of the workplace. Most of them had never experienced that style, at least in the time they had worked at Ford.

The critical element to bring about the paradigm shift toward a participative style was to design the seminar in such a way that participants worked only on real organizational issues starting with building a "common data base" about "(1) how we all see the past (dissatisfaction) and why we need to change, (2) what steps we can all agree are worthwhile in order to begin to change (first steps)."

Each of the participative seminars was five days, with the top management of each division with numbers ranging from 60 managers to 150. Often it was the first time the group had been in one room together. Each group included all of the "functional chimneys" and four or five levels of the hierarchy. Managers worked in differing groups during the five days: functional teams, work teams, cross-functional/cross-level teams, and, finally and especially, the organization-wide team -- a team that could collaboratively build a new vision of how it could work together, and what it needed to do to get there.

Decisions about design for specific pieces of the seminar were based on interviews and diagnosis with the key managers of each division, to identify particular issues that needed to be addressed on in order to break down the most destructive "arthritic joints": i.e., interfunctional conflict about conflicting goals, a common "preferred future" picture of "what we are capable of doing differently, "etc.

As successful results began to emerge from the five-day seminar, it became clear that it was necessary to diffuse the "macro-team building" down through the plants and offices, in order to support changes in "world view" that had begun to emerge at the top. The Ford internal consultants and the external consultants worked closely together to design and implement these diffusion seminars. Over time the external consultants gradually worked their way out of the process believing that real change in the organization can only be effectively sustained by a group of committed, trained internal people providing on-going development and support. A week-long "training of trainers" session was held in several places to prepare the internal groups for their role. These diffusion seminars began to happen about a year after the initial seminars started and took about a year to accomplish throughout the DPO divisions.

While this downward diffusion was taking place, the Executive Vice President at DPO asked the original consulting team to develop a second seminar to enable the change to take hold and continue. The second seminar, called "Leadership for Change," was built around the theme: "Now that you've begun to change, let's make sure you become the kind of organization you need to be in order to become leaders in your field."

The new seminar used the same macro-team building model and added a "Task Force for Excellence" made up of a group of leaders in various functions of DPO who visited outside organizations including Dana, IBM, 3M, and Hewlett Packard to analyze what they were doing successfully. The Task Force presented this data as part of the second generic seminar, as a way of helping managers create a new vision of how they could work together successfully in the changing environment.

Dynamic change has begun to occur. Conventional assumptions are being challenged. Personnel is beginning to change the definitions of their roles to become more service oriented, defining the rest of the division as their customers. Controller units are working together to redefine their roles to become "business advisors" to line management, instead of their traditional "controlling" role. Line managers are using more ad hoc task forces and collaborative cross-functional meetings as part of daily management. Decision-making is being delegated downward in more arenas. Most divisions are conducting semi-annual or annual "reunions" of the same large group to keep the team connected and responsive to continuous environmental changes. Managers are beginning to manage in a more team-oriented style. Many managers report that they are feeling freed to be the kind of manager they had always wanted to be!

It is obvious to both the consultants and the different organizations within DPO that a great deal of continued effort will be required to continue overall change at Ford. However, it seems from the initial results that real progress is being made. The change at Ford thus far is truly the beginning of the story and not the end.

A WORKING THEORY OF GROUP PROCESS

As groups of people (two or more make a group) meet, there is always available for observation what is called "process". Process is defined separately from Content.

Definition: Process: n., something going on; a natural phenomenon marked by gradual change that leads toward a particular result.

Definition: Content: n., something contained; the matter dealt with in a field study; substance; gist.

The content of a meeting is the matter(s) being dealt with. The process is how the persons work with each other in dealing with the content.

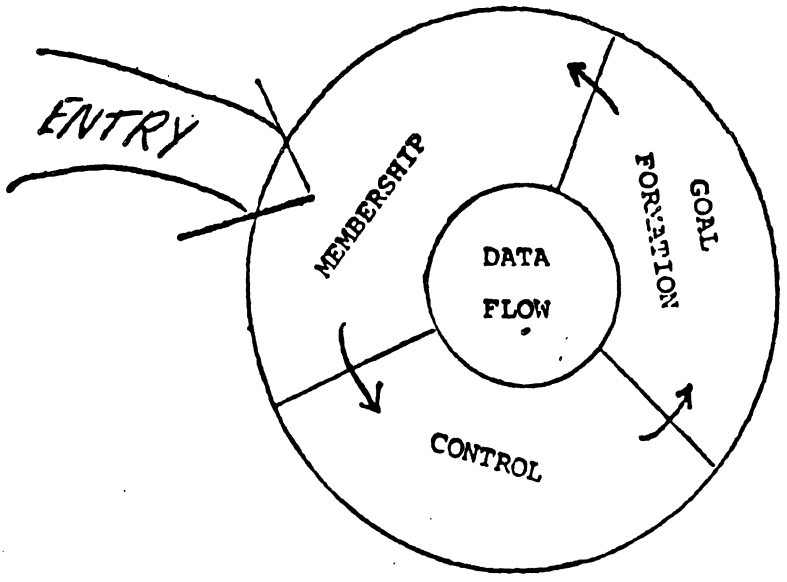
Process, then, can be open and unstructured or closely regimented and tightly controlled or anywhere on the spectrum. The results and the process are valued only as appropriate or inappropriate, not as "right" or "wrong". In any case the process will always cover (in one form or another) the following three areas.

1. Membership/Belonging: Do I belong in this group? On what terms may I belong? Do I want to belong? Who else is here? Who do I have to be (pretend to be) to be here? What values and assumptions are we working under?

2. Control/Leadership: Who's in charge here? What style of leadership prevails? Do I have any control over what happens? How much do I have or want? When conflict emerges, how do we handle it? When decisions are reached, who implements them and how?

3. Goal Formation: What do we want to accomplish? How will we know we have done it? What do I want to see happen?

In a sketch, it would look like this:



We start with Membership issues, proceed to control issues and then to goal formation issues. The process is facilitated by appropriate data flowing in response to each issue. As groups develop, the cycle is repeated at a "deeper" level.

When groups neglect Membership and Control issues and attempt to start with the Formation of Goals they often find a low level of commitment to those goals. This is particularly true of committees and task groups that have strangers in them and somewhat less evident in department and staff meetings where everyone nominally knows everyone else.

To raise these issues at an appropriate level and deal with them is called "Trust Formation" or "Team Building". When each person knows a little of each other person's values and history (not assumptions, but knowledge) groups are better able to make decisions that fully utilize each person's talents and viewpoints.

Deciding When to Involve Others in Decisions

A manager's effectiveness can be measured on two dimensions, the ability to marshall the efforts of others to accomplish an objective (output), and the level of morale or satisfaction of their subordinates (organizational strength). Accomplishment can be assessed by the quantity, quality, timeliness, and cost of the output of his/her unit. These accomplishments are determined in part by the manager's ability to make decisions. (One of the first decisions a manager must make is to decide how to decide.) Decision-making involves two processes, the technical process of assembling and weighing relevant data and the social process of involving or not involving subordinates and relevant others in the process of making the decision.

This paper outlines a procedure[1] which managers can use to decide the social process -- who and how to involve others in making the decision -- in order to obtain the best implementation of the decision. The best decision is one which obtains the specified quality, quantity implementation for the least cost in time and resources.

This ultimate effectiveness of a decision will be the result of three factors: (1) the quality or rationality of the decision; (2) the acceptance or commitment of those who have to implement the decision; and (3) the amount of time required to make and to implement the decision.

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[1] Adapted from Vroom, V., "A New Look at Managerial Decision Making" Organizational Dynamics, 1:4, 1973.

There are eight social processes or decision-making modes from which the manager can choose. They are listed in Table 1 below with a letter which represents the type of process and a roman numeral representing the variations within the type. "A" represents autocratic, "C" represents consultative, "G" represents group, and "D" represents delegated decision processes.

Table 1

Decision Modes

AI You make the decision by yourself using the information you have available.

AII You obtain information from your subordinate or others and you decide by yourself.

CI You share the problem or objective you want to achieve with subordinate(s) individually and obtain their ideas, suggestions, or recommendations, then you decide.

CII You share the problem or objective with your subordinates and others as a group, obtain their ideas or recommendations and then you make the decision.

GI You share the problem or objective with a subordinate and you both generate and evaluate alternatives, then you reach a decision by consensus on the actions to be taken.

GII You share the problem or objective with a group of subordinates, as a group you generate and evaluate alternatives, and reach a group consensus about the actions to be taken.

DI You decide that a subordinate has the information and judgment to make the decision so you delegate it and accept his or her decision.

DII You delegate the decision to a group of subordinates and you accept their decision.

Now, how does the manager decide which of these decision modes is the appropriate one for a particular decision? Selection of the decision mode requires an analysis of the decision itself. There are seven questions which a manager can ask to determine the appropriate mode.

First, is it an important decision, will it make a significant difference to the organization, would there be real output differences if you made the decision one way or another?

Second, do I have sufficient information to make the decision by myself?

Third, is this a routine decision of a type I have made before, the structure of the decision is clear and I just need information to fill in the structure?

Fourth, is acceptance and support of the decision by subordinates critical to effective implementation?

Fifth, if you were to make the decision yourself, is it reasonably certain that it would be willingly accepted by your subordinates?

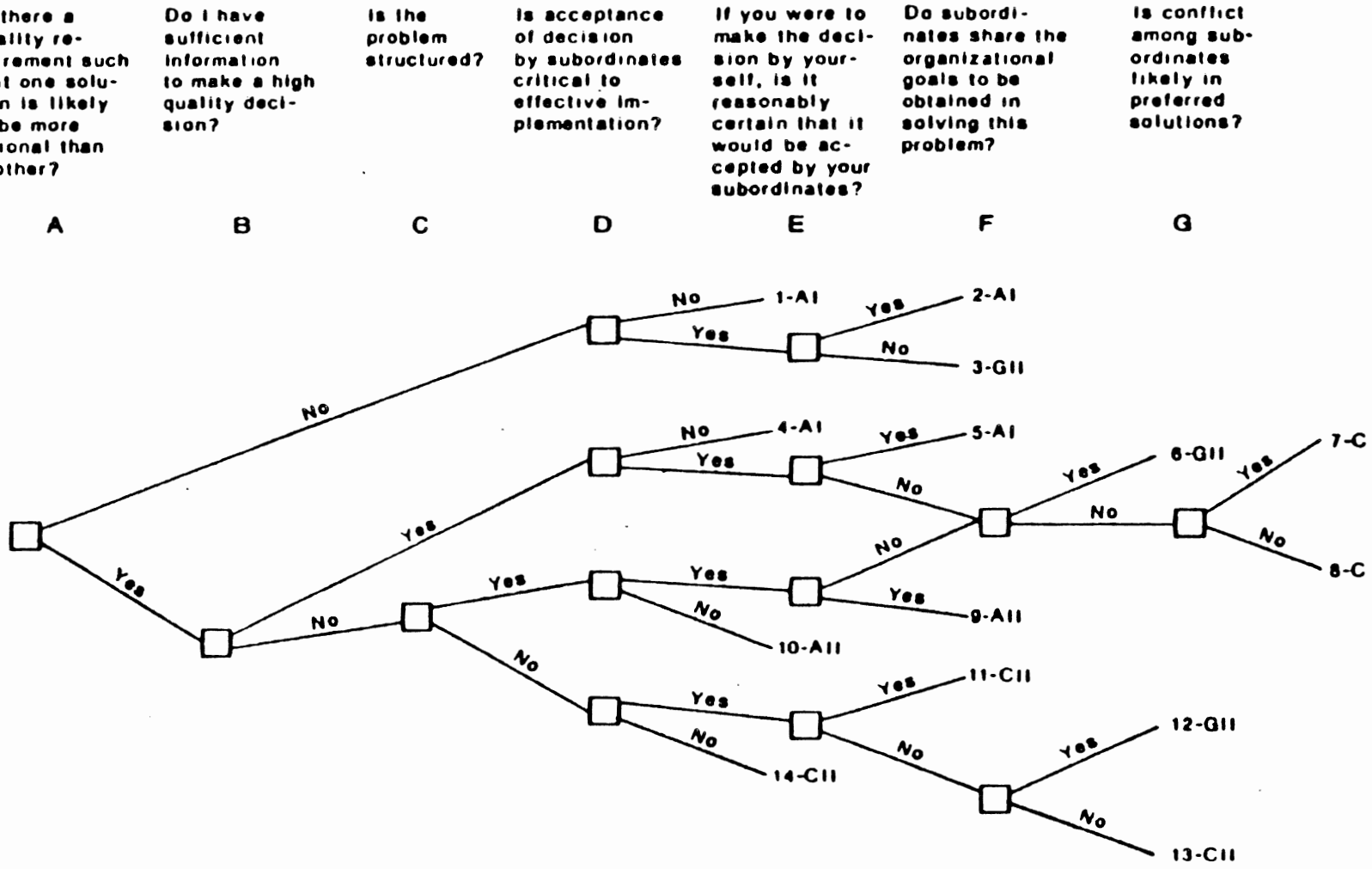
Sixth, do subordinates share the organizational goals to be obtained in making this decision?

Seventh, are subordinates likely to conflict about preferred solutions?

These questions are arrayed across the top of Figure 1. To use this decision tree, start by stating the problem or objective and by asking each question and answering it with a yes or no, pick a branch to follow until you arrive at the recommended decision mode.

Figure 1.

DECISION MODEL



You will note that the delegated decisions are not included in Figure 1. The tree is designed for those you have already decided you will make. This prior determination can be made by asking if a subordinate or a group of subordinates have the information and judgment to make the decision. If the answer is yes, you can delegate it, if the answer is no, proceed to use the tree to determine if and how to induce them in the decision.

To illustrate the use of the model, four cases will be cited from Vroom.

Case 1. You are a manufacturing manager in a large electronics plant. The company's management has recently installed new machines and put in a new simplified work system, but to the surprise of everyone, yourself included, the expected increase in productivity was not realized. In fact, production has begun to drop, quality has fallen off, and the number of employee separations has risen.

You do not believe that there is anything wrong with the machines. You have had reports from other companies that are using them and they confirm this opinion. You have also had representatives from the firm that built the machines go over them and they report that they are operating at peak efficiency.

You suspect that some parts of the new work system may be responsible for the change, but this view is not widely shared among your immediate subordinates who are four first-line

supervisors, each in charge of a section, and your supply manager. The drop in production has been variously attributed to poor training of the operation, lack of an adequate system of financial incentives, and poor morale. Clearly, this is an issue about which there is considerable depth of feeling within individuals and potential disagreement among your subordinates.

This morning you received a phone call from your division manager. He had just received your production figures for the last six months and was calling to express his concern. He indicated that the problem was yours to solve in any way that you think best, but that he would like to know within a week what steps you plan to take.

You share your division manager's concern with the falling productivity and know that your men are also concerned. The problem is to decide what steps to take to rectify the situation.

Analysis

Questions —

A (Quality?) = Yes

B (Managers Information?) = No

C (Structured?) = No

D (Acceptance?) = Yes

E (Prior Probability of Acceptance?) = No

F (Goal Congruence?) = Yes

G (Conflict?) = Yes

Feasible Set — GII

Minimum Man-Hours Solution (from Figure 1) -- GII

Case II. You are general foreman in charge of a large gang laying an oil pipeline and have to estimate your expected rate of progress in order to schedule material deliveries to the next field site.

You know the nature of the terrain you will be traveling and have the historical data needed to compute the mean and variance in the rate of speed over that type of terrain. Given these two variables, it is a simple matter to calculate the earliest and latest times at which materials and support facilities will be needed at the next site. It is important that your estimate be reasonably accurate. Underestimates result in idle foremen and workers, and an overestimate results in tying up materials for a period of time before they are to be used.

Progress has been good and your five foremen and other members of the gang stand to receive substantial bonuses if the project is completed ahead of schedule.

Analysis

Questions —

A (Quality?) = Yes

B (Manager's Information?) = Yes

D (Acceptance?) = No

Feasible Set — A1, AII, CI, CII, GII

Minimum Man-Hours Solution (from Figure 1) — A1

Case III. You are supervising the work of 12 engineers. Their formal training and work experience are very similar, permitting you to use them interchangeably on projects. Yesterday, your manager informed you that a request had been received from an overseas affiliate for four engineers to go abroad on extended loan for a period of six to eight months. For a number of reasons, he argued and you agreed that this request should be met from your group.

All your engineers are capable of handling this assignment and, from the standpoint of present and future projects, there is no particular reason why anyone should be retained over any other. The problem is somewhat complicated by the fact that the overseas assignment is in what is generally regarded as an undesirable location.

Analysis

Questions —

A (Quality?) = No

D (Acceptance?) = Yes

E (Prior Probability of Acceptance?) = No

G (Conflict?) = Yes

Feasible Set — GII

Minimum Man-Hours Solution (from Figure 1) — GII

Case IV. You are on the division manager's staff and work on a wide variety of problems of both an administrative and technical nature. You have been given the assignment of developing a standard method to be used in each of the five plants in the division for manually reading equipment registers, recording the readings, and transmitting the scorings to a centralized information system.

Until now there has been a high error rate in the reading and/or transmittal of the data. Some locations have considerably higher error rates than others, and the methods used to record and transmit the data vary among plants. It is probable, therefore, that part of the error variance is a function of specific local conditions rather than anything else, and this will complicate the establishment of any system common to all plants. You have the information on error rates but no information on the local practices that generate these errors or on the local conditions that necessitate the different practices.

Everyone would benefit from an improvement in the quality of the data; it is used in a number of important decisions. Your contacts with the plants are through the quality-control supervisors who are responsible for collecting the data. They are a conscientious group committed to doing their jobs well, but are highly sensitive to interference on the part of higher management in their own operations. Any solution that does not receive the active support of the various plant supervisors is unlikely to reduce the error rate significantly.

Analysis

Questions —

A (Quality?) = Yes

B (Manager's Information?) = No

C (Structured?) = No

D (Acceptance?) = Yes

E (Prior Probability of Acceptance?) = No

F (Goal Congruence?) = Yes

Feasible Set — GII

Minimum Man-Hours Solution (from Figure 1) — GII

To facilitate your understanding of the model and its application to your situation, complete the following worksheet.

Think of an important decision you made recently and answer the following questions about it.

1. What was the decision? _____

_____

2. What decision mode did you use to make the decision? _____

_____

3. Using the decision tree, what decision mode is recommended for this decision? _____

4. If your actual decision mode is different from the recommended mode, what question led you to make the decision differently? _____

_____

_____

Think of a pending decision, one you have to make in the near future and answer the following questions about it.

1. What is the situation requiring a decision?

_____

_____

2. What decision mode would you normally use to make the decision?

_____

3. What decision mode does the decision tree specify for the decision?

_____

Think of a decision your supervisor has made recently that you were involved in implementing. Answer the following questions about it.

1. What was the decision? _____

_____

2. What decision mode was used? _____

3. What decision mode is specified by the decision tree?

_____

4. If a different mode was recommended than was used, how do you think the implementation would have been effected by using the recommended mode?

_____

_____

_____

APPENDIX G

SUGGESTED READINGS

SUGGESTED READINGS

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