THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

1990 Ship Production Symposium

Paper No. 1A-2: Manufacturing Lead Time -- A Factor to Consider During Planning and Acquisition of Navy Ships

U.S. DEPARTMENT OF THE NAVY CARDEROCK DIVISION, NAVAL SURFACE WARFARE CENTER
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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM'S
1990 SHIP PRODUCTION SYMPOSIUM

Preparing for the 21st Century: Focusing on Productivity and Quality Management

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AND HOSTED BY THE GREAT LAKES AND RIVERS SECTION OF
THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS
Manufacturing Lead Time-A Factor To Consider During Planning and Acquisition of Navy Ships

William V. Ennis, Visitor, Harry F. Speth, Visitor, and Albert Mieskolainen, Visitor, Philadelphia Naval Shipyard, Philadelphia, PA

ABSTRACT

The NAVSEA Shipbuilding Support Office, Philadelphia, PA provides current Manufacturing Lead Time information to Navy planners, designers and acquisition managers responsible for the timely procurement of the latest design Navy ships. Lead time information is critical to effective budgeting and on-time delivery of basic material, hull mechanical and Electrical Components and Combat Systems. This paper will address the methodology for solicitation, statistical consolidation and final assessment of information provided by over 1300 domestic primary and secondary manufacturers. Early detection of lead time change provides a basis for remedial action whereby critical paths may be selected, schedules altered, or substitutions provided. The paper will further address the status of the United States Industrial Base capacity to provide these materials, components and systems and compares the current industrial base with its status five and ten years ago. Loss of domestic capacity has resulted in sole or single source procurement and in some cases sole dependence upon a foreign source for critical subcomponents. The ability of United States manufacturers to respond to peacetime programs and potential surge or mobilization requirements will also be examined.

ORGANIZATION

The NAVSEA Shipbuilding Support Office (NAVSHIPSO) is functionally responsible to Deputy Commander for Acquisition, Planning and Appraisal, NAVSEA 90. NAVSHIPSO is located in the Philadelphia Naval Shipyard and is under the administrative control of its commander. NAVSHIPSO supports NAVSEA in the execution of its shipbuilding and major weapons acquisition programs through manufacturing engineering and industrial planning. It also provides Industrial Preparedness Planning functions for these program. In addition, NAVSHIPSO provides Support to NAVSEA by performing mobilization planning functions assigned to NAVSEA by the Office of the Chief of Naval Operations and other Navy and Defense Department authority. Navy programs are analyzed to determine manufacturing facility and resource requirements. The industrial base is evaluated to determine its ability to support current and projected Navy programs and to identify problem areas and action required to resolve these issues. NAVSHIPSO supports acquisition and industrial preparedness planning with the development of ship and equipment production plans and analysis of individual contractor capabilities, performances, and manufacturing lead times. NAVSHIPSO maintains statistical and historical records on Navy ships time of construction through final disposition.

MANUFACTURING LEAD TIMES

A major element of industrial base planning and evaluation responsibility is the determination of manufacturing lead time (MLT) forecasts. MLT in formation is essential for effective financial planning/budgeting and to support schedule adherence for on-time delivery of shipboard Basic Material, Hull Mechanical and Electrical Components and Combat Systems. Early detection of future MIT change provides a basis for remedial action whereby critical paths may be selected schedules altered or substitutions provided. Specifically, within NAVSHIPSO, MITs form the core of various industrial assessment and shipbuilding program related reports, including the following.

SYSTEM/EQUIPMENTS MANUFACTURING LEAD TIME STUDIES - An annual document which provides a breakdown of factors considered in a manufacturing process and result in quoted MLT for a specific component or system. DATA IS presented in a time phased Gantt chart format and includes an overview of subcomponents/manufacturers production rates, and ship end use. Figure 1 depicts a typical study.

SPECIAL STUDIES- Reports are prepared on subjects of particular importance to the Navy's shipbuilding program. Typical topics have included anchor chain, ball bearings, forgings, diesel engines, composite materials, periscopes, torpedo tubes and electric propulsion. Table 1 lists recently completed and planned studies. Some of these studies, such as ball bearings (quiet), anchor chain and forgings, have directly resulted in purchase restrictions to US and Canadian sources. Others, diesel engines, strategic
materials, periscopes, propellers and electric motors have highlighted sole sourcing conditions or dwindling domestic industrial base capabilities concerns and have provided recommended plans of action to alleviate possible mobilization production constraints.

A typical APS consists of:

**Table 1. Special Studies**

<table>
<thead>
<tr>
<th>Completed</th>
<th>In-Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Motors</td>
<td>Electric Propulsion</td>
</tr>
<tr>
<td>Electronic Equipment MFG</td>
<td>Propulsion Motors</td>
</tr>
<tr>
<td>Foreign Dependency</td>
<td>Prime Movers</td>
</tr>
<tr>
<td>Productivity Trends</td>
<td>Composite Material</td>
</tr>
<tr>
<td>Large crankshafts</td>
<td>Shafting</td>
</tr>
<tr>
<td>Tubochargers</td>
<td>Strategic Materials</td>
</tr>
<tr>
<td>Arresting Gear</td>
<td>Machine Tools</td>
</tr>
<tr>
<td>Deigaussing system</td>
<td>Noise Quiet Bearings</td>
</tr>
<tr>
<td>Propellers</td>
<td>IAMPS/RAST</td>
</tr>
<tr>
<td>Anchor chain</td>
<td>Torpedo Tubes</td>
</tr>
<tr>
<td>Forgings</td>
<td>Satellite Communications</td>
</tr>
<tr>
<td>periscopes</td>
<td>AN/UYQ-21 Display System</td>
</tr>
<tr>
<td>Global Positioning System</td>
<td>Over-The-Horizon Radar</td>
</tr>
<tr>
<td>Dehydrators</td>
<td>MK86 Gunfire Control</td>
</tr>
<tr>
<td>Main Propulsion Machinery</td>
<td>Command/Control/Division</td>
</tr>
<tr>
<td>Critical Forging Restrictions</td>
<td>AN/WSN-5 Navigation System</td>
</tr>
<tr>
<td>Anchor Chain Restrictions</td>
<td>Navy Use of Composites</td>
</tr>
</tbody>
</table>

Fig. 1 - MANUFACTURING LEAD TIME STUDY

BUSINESS SENSITIVE
Ships Data Sheet - Provides proposed ships principal physical characteristics: length, beam, draft, displacement, type of propulsion plant, shaft horsepower, mission and any special systems or requirements peculiar to the ship design.

Assumptions and Notes - Such as availability of drawings and specifications prior to contract award; long lead time and controlling items which may require advance procurement, and source(s) of MLTS and land-on-ship times.

Program summary - Chronological sequence of milestones prior to ship delivery, including contract award, procurement of controlling and long lead time items by both the shipbuilder and government and start construction dates.

Construction Rationale - Provides justification for construction period which includes analysis of actual construction schedules of similar type ships and construction methods and facilities of possible shipbuilders.

Erection Schedule - Narrative description of major events listed chronologically by month.

Manday Estimates - Developed by NAVSHIPSO and are calculated by construction, method of construction and ship characteristics.

Advance Planning Lead Time study (APLTS) - Provides MLT, land-on-ship time, quantity, procuring agent, type of specification of long lead time and controlling items.

Publication of Manufacturing Lead Times-(MLTPUB)

This document is issued annually and provides a twelve month projection of MLTS for Hull, Mechanical and Electrical Ship Components, Basic material and Combat Systems utilized by shipbuilders performing Navy related work. The publication is divided into six parts. Each is described below as to function and use. An excerpt from part 1 is shown as Figure 2.

Included in parts 1 and 2 is the range column which is the composite of all MLTS provided to NAVSHIPSO by manufacturers for each item. Two numbers separated by a hyphen represent the lowest and highest MLTS provided for U.S. Government Specification repeat orders. For example, if the numbers, 16-18 appear, it indicates NAVSHIPSO validated manufacturer responses ranging from 16-18 months. Both the current lead time and the change from the previous issue are provided. For example, 14(-3) indicates a current lead time of fourteen months and a decrease of three months from the previous seventeen months figure. Items added since the previous issue are identified by a single asterisk (*) to the left of MLT column(s).

When a lead time is "not applicable" to a specific item, "NA" has been inserted in the respective column. In general, "NA" in the repeat order column indicates the item has not been produced to date or is not related to a known production line. "NA" in the initial order column indicates the item is a Qualified Products List (QPL) component, a single source item or standardized to the point that a new design is not anticipated.

Commercial marine specification lead time is designated "NA" when components are purchased solely under government specifications.

Part 1- Hull, Mechanical and Electrical

All lead times in the Hull, Mechanical and Electrical (HM&E) Ship Components section have been derived by NAVSHIPSO from Navy procurement experience and data obtained directly from manufacturers. The lead times under "U.S. Government SPECS" apply to ship components purchased under Federal or Military Specifications; where possible, specification numbers are listed. The lead times under "COMMERCIAL MARINE SPECS" apply to ship components which generally meet commercial standards specified by various technical associations including:

- American Bureau of Shipping Rules For Building and Classing Steel Vessels
- U.S. Coast Guard Electrical Engineering Regulations (OG-259)
- U.S. Public Health Service Handbook on Sanitation of Vessel Construction (Standards of Sanitation and Rat Proofing For the Construction of Vessels), except that sheathing requirements are not applicable
- Institute of Electrical and Electronics Engineers, Incorporated (IEEE) Standard No. 45 (Recommended Practice for Electric Installations on Shipboard)
- The National Electrical Code (NEC)
- The National Electrical Manufacturers Association (NEMA) Standards
- The American Gear Manufacturers Association (AGMA)
- The American Society for Testing and Materials (ASTM)
- The American Society of Mechanical Engineers (ASME)
- United States of America Standards Institute (USASI)
- American Standards Association (ASA)
- National Institute of Standards and Technology (NET)

Manufacturing Lead Times are a general guide for timely placement of purchase orders. The lead time is defined as the interval between the date a manufacturer accepts a firm order and the shipment date of the first complete production unit.

The lead time estimate does not include any allowance for the administrative time required to develop purchase specifications, to prepare procurement requisitions, or to conduct negotiations prior to award of production
contracts. Additionally, because of various factors such as material and physical specifications, end use, temperature and pressure conditions, qualifications apply to the following components:

Propallers - Design is not included in initial order of solid propellers, add two months for prairie masher
Shafting - Lead times include finish machining
Valves - Add two to four months for 100% radiography

The lead times listed for ship components are shown for both Initial Order and Repeat order. NAVSHIPSO definitions for each type order follows:

Initial Order - The time to design and produce a component within the state of the art (without extensive research and development) by a manufacturer who has not previously Produced. The it includes the time necessary for the manufacturer to design, obtain plan approval, tool, procure material and subcomponents manufacture, assemble, conduct tests, and prepare the first production unit for shipment. When a Military Specification requires testing of the prototype or preproduction model at government facilities or a private laboratory, an allowance is included in the lead time. If floating shock platform testing is required, two to four months should be added to the listed lead time.

---

**Fig. 2 - MANUFACTURING LEAD TIME PUBLICATION**

The lead times stated herein assume that purchasers indicate, on their procurement documents, the order is certified for national defense use under Defense Priorities and Allocations System regulations and pass on the authorized rating assigned (i.e., D0-A3, D1-A3). The use of ratings on contracts and orders is mandatory through all tiers of procurement.

The lead times listed for ship components are shown for both Initial Order and Repeat order. NAVSHIPSO definitions for each type order follows:

Initial Order - The time to design and produce a component within the state of the art (without extensive research and development) by a manufacturer who has not previously Produced. The it includes the
amount of the basic material (i.e., mill lot) the producer will accept as a firm order to justify production. The lead times listed are for basic material purchased in accordance with Federal or Military Specifications or comparable commercial specification.

The lead time estimate for basic material is defined as the interval between the date that the producer accepts firm order and the shipment date. Lead times include the time necessary for certification of chemical content and tests as stipulated in the specification. However, it is emphasized lead times do not apply for less than mill lot orders of basic material, are generally available from inventories maintained by distributors and suppliers.

It must be recognized that forgings and castings are not standard production and lead times are subject to negotiation with individual foundries and forge shops. Lead times shown are for general guidance only.

Specific lead times for individual orders are dependent upon the complexity of the customer's drawing specification sizes quantities amount of machining required, and other factors. Approximately eight weeks should be added to the listed lead times for Number 1-A-2-5.

The selected combat system/Equipments herein can be purchased commercially as contractor furnished material (CFM) for Navy Shipbuilding programs, however, for the most part, they are procured as Government furnished material (GFM). The applicable Navy model designator has been included in the item description for specific identification. The conditions for procurement parallel the criteria listed for part 1, HM&E Ship Component.

Part 4 - Combat System/Equipments Trends

The combat system/Equipments herein are available for the most part as a "turnaround", or "one for one" exchange, as GEM. The applicable Navy model designator has been included in the item description for specific identification of the indicated period is the nominal "turnaround" time required by the manufacturer or refurbishment agency.

Part 5 - Selected Manufacturing Lead Time Trends

Manufacturing lead time trends are provided for three general categories: HM&E Ship Component, Basic Material and Combat System. For each category, typical historical representative samples of repeat order lead times were chosen. Ten year history of selected items is presented both numerically and graphically.

Part 6 - Participating Manufacturers

This part is used by Canadian manufacturers, by product, that assist NAVSHIPSO by providing lead time information. Without this invaluable assistance, the publication would not be possible.

In the table, the following abbreviations are used as required.

<table>
<thead>
<tr>
<th>AB</th>
<th>Alberta</th>
<th>NT</th>
<th>Northwest</th>
<th>Territories</th>
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</thead>
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<td>BC</td>
<td>British Columbia</td>
<td>ON</td>
<td>Ontario</td>
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<td>Manitoba</td>
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<td>New Brunswick</td>
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</tr>
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<td>NS</td>
<td>Nova Scotia</td>
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<td>Saskatchewan</td>
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<tr>
<td>NF</td>
<td>Newfoundland</td>
<td>NB</td>
<td>New Brunswick</td>
<td>PE</td>
</tr>
</tbody>
</table>

Canadian manufacturers MT information was solicited during 1989 and appears for the first time in the January 1990 publication.

MANUFACTURING LEAD TIME DETERMINATION METHODOLOGY

MTS are obtained by large data collection efforts from five sources. The most significant being an annual office of Management and Budget approved mail solicitation to 1300 US and Canadian manufacturers, Figure 3. As can be seen, other key data elements such as capacity utilization rates, workload distribution, employment levels and value of shipments are also collected.

After initial solicitation is received, most of the data, with exception of "company data" elements, preprinted on subsequent solicitations in order to reduce the burden on respondents. Since 1980 the solicitation format and the data base have both grown substantially. In 1980 solicitations consisted only of basic MT data elements. In 1984 capacity utilization was added and in 1986 the solicitation was expanded to include most of the factors of 1990 solicitation. The process used to collect, validate and analyze MTS is substantially automated. It is a process within the modeling system "ALIAS", a NAVSEA approved computer system. This automated process includes:

1. MANUFACTURING LEAD TIME PRODUCTION SORICATIONS (MTS) - This form is preprinted with previously supplied "product data" (MTS and Production Rates) for selected components, material or system that manufacturers are, have or are capable producing for Navy Shipbuilding programs. MTS solicitations are mailed to each manufacturer for pen/ink change, additions or deletions and return to NAVSHIPSO.

MANUFACTURING LEAD TIME PRODUCTION SORICATIONS (MTS) - This form is preprinted with previously supplied "product data" (MTS and Production Rates) for selected components, material or system that manufacturers are, have or are capable producing for Navy Shipbuilding programs. MTS solicitations are mailed to each manufacturer for pen/ink change, additions or deletions and return to NAVSHIPSO. A cognizant Industrial specialist, after reviewing and validating the data, will typically find changes in the manufacturers addresses, points of contact, or "company/product data elements which are incorporated into ALLAS. On occasion, manufacturers respond with a narrative containing exceptions or
qualifying remarks to the M11s presented. Examples are M11 increases for testing (environmental, stress, shock), special processes (heat treating, plating, inspections, etc) or exclusion of certain subcomponents (government furnished, long lead time or foreign sourced).

The industrial specialist is responsible for interpreting the remarks and adjusting the M11 quote according to circumstances reported and Navy procurement methods and requirements. When all responses deemed required are received, generally averaging 90%, and data validation and entry is complete, NAVSHIPCO

***SAMPLE***

DATE: 20 AUG 90

CAGE: xx001  COMPANY: XYZ CORP
H. SPECH  TITLE: PRESIDENT
(215) 897 3161

PRODUCT DATA

DESCRIPTION/OV1T SPEC  M.LT GOVT COMM  PRODUCTION RATES  MONTHS TO REACH  UNIT OF
CIRCUIT BREAKER, AIR, ACB/MIL-C-17587/11c-17587  PERIOD  RO/10  CURRENT  SURGE  MOB ISSUE
MONTHS  6/8  6/7  234  360  500  8  12 FACH

DEFINITIONS:

MLT = MANUFACTURING LEAD TIME
GOVT = PRODUCED TO GOVERNMENT/MILITARY SPECIFICATIONS
COMML = PRODUCED TO COMMERCIAL MARINE SPECIFICATIONS
RO = REPORT ORDER MIT
ID = INITIAL ORDER MIT
CURRENT = NUMBER OF UNITS PRODUCED TO MEET CURRENT CONTRACTUAL COMMUNITIES.
SURGE = ACCELERATED PRODUCTION WITH EXISTING FACILITIES AND EQUIPMENT IN A PEACETIME ENVIRONMENT - NO DECLARED NATIONAL EMERGENCY. ONLY PEACETIME PROGRAM PRIORITIES WILL BE AVAILABLE.
MOB = FULL EXPANSION RESULTING FROM ACTION BY CONGRESS AND THE PRESIDENT TO MOBILIZE ALL UNITS AND THE MATERIAL RESOURCES NEEDED FOR THESE UNITS. PRODUCTION OF NON-ESSENTIAL CONSUMER GOODS MIGHT DECLINE SIGNIFICANTLY AND MODIFIED DESIGNS WOULD PROBABLY BE USED TO MAXIMIZE PRODUCTION RATES.
UNIT OF ISSUE = PHYSICAL MEASUREMENT OR COUNT OF A PRODUCT.
CAPACITY UTILIZATION = RATIO OF CURRENT PRODUCTION TO SURGE PRODUCTION.
VALUE OF SHIPMENTS = VALUE IN CURRENT DOLLARS OF ALL PRODUCTS SHIPPED DURING LAST ACCOUNTING YEAR.
REMARKS = ANY SIGNIFICANT AMPLIFYING INFORMATION ON PRODUCTION UNITS, PRODUCT MIX AND/OR CONCURRENT OR INDIVIDUAL PRODUCTION EFFORTS.

COMPANY DATA:

1. CAPACITY UTILIZATION = 72.00%
2. CURRENT EMPLOYMENT LEVEL = 200
3. WORKLOAD DISTRIBUTION PERCENTAGES:
   NAVY = 2.00%  ARMY = ___
   OTHER GOVT = 5%  COMMERCIAL = 30%  FOREGEN = 5%
4. VALUE OF SHIPMENTS = $6,000,000.

Fig. 3 - MANUFACTURING LEAD TIME PRODUCTI ON SOLICITATION
personnel, the first step is to perform a regression analysis of MLTS, product by product, using a standard deviation to determine control limits.

The resultant figure is then subjected to a validation process by industrial specialists, comparing it to recent performances by Navy support contractors and MLT data from other sources. The primary sources for recent actual MLTs (performance) are:

- Material Management guides (MMG) - An MMG is derived by NAVSHPSO from shipbuilding Material ordering schedules for ships under construction. Each summarizes the most important components/systems and provides as a minimum the following information:
  - Item Nomenclature
  - Manufacturer (or other source, such as a distributor)
  - Purchase Order Award Date
  - Required-in-Yard Date
  - Land-on-Ship Date
  - Scheduled Delivery Date
  - Actual Delivered Date

- Plant Load Report (PLR) - A PLR provides a manufacturer's Navy shipbuilding material ordering data for the PLR order. It is prepared by NAVSHPSO and includes data on material ordering, component/s and system requirements, and delivery dates. A typical PLR provides:
  - Item Nomenclature
  - Contract
  - Customer
  - Data of order
  - Order Required Date
  - Estimated Shipment Date
  - Actual Shipment Date

- On-site Industrial Plant Surveys - Plant surveys conducted to collect and validate MLTS, capacity, facility and manpower data relative to Navy shipbuilding, conversion, and repair demands for ship components, material and system information previously provided by the manufacturer. Obtained from other sources, this information is verified and validated. Figure 4 shows a typical plant survey.
### NAVSHIPSO INDUSTRIAL PROFILE

#### A. COMPANY NAME: 
#### DIVISION: 
#### COMPANY ADDRESS:  
#### (STREET) PO BOX (CITY, STATE, ZIP) 
#### CAGE: 
#### PIN: 
#### CONTACT NAME: 
#### TITLE: 
#### PHONE:  

#### B. GOVERNMENT REPRESENTATIVE:  

#### C. TOTAL EMPLOYMENT LEVEL:  

<table>
<thead>
<tr>
<th>CATEGORY / PERSONNEL</th>
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<th>HRS/ DY</th>
<th>DyS/WK</th>
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<td>(2)</td>
<td>(3)</td>
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<tr>
<td>PRODUCTION</td>
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<td></td>
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</tbody>
</table>

#### D. UNION:

| CONTRACT EXPIRATION DATE: |

#### E. CAPABILITIES FOR:  
FORGINGS  
CASTINGS  

#### F. FACILITIES:  

1. TOTAL PLANT ACREAGE:  
2. PLANT FLOOR SPACE:  
   (Square Feet)  
3. FUEL USED:  
4. UTILIZATION

#### G. CURRENT NAVY CONTRACTS:  
(Direct or Indirect)  
NAVY  

<table>
<thead>
<tr>
<th>CONTRACT OR P.O. NUMBER</th>
<th>PURCHASER</th>
<th>AWARD</th>
<th>ITEM</th>
<th>PROGRAM</th>
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<tbody>
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<td></td>
<td>DATE</td>
<td>PROVIDED</td>
<td>SUPPORTED</td>
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#### H. PAST NAVY CONTRACTS:  
(Direct or Indirect)  
NAVY  

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<th>CONTRACT OR P.O. NUMBER</th>
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<th>AWARD</th>
<th>ITEM</th>
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<tr>
<td></td>
<td></td>
<td>DATE</td>
<td>PROVIDED</td>
<td>SUPPORTED</td>
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#### I. PRODUCTION CAPABILITY:  

<table>
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<tr>
<th>ITEM DESCRIPTION</th>
<th>GOV'T MOL. QUARTERLY PRODUCTION RATES</th>
<th>MONTHS</th>
<th>TIME TO REACH UNIT OF</th>
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<tbody>
<tr>
<td></td>
<td>MAINT. (28% OF)</td>
<td></td>
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#### J. SPECIAL LABOR REQUIREMENTS:  

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<th>SKILL/TRADE/PROFESSION</th>
<th>NUMBER OF PERSONNEL</th>
<th>TYPE TRAINING PROVIDED</th>
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<td>(OJT, TUTITION AID, APPRENTICESHIP ETC.)</td>
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#### K. SUBCONTRACTORS:  
(Major, Sole Source, Unique, Overseas, Etc.)  
NAME/ADDRESS:  
ITEM/SERVICE:  
MIL MFG. MANUFACTURING  
CITY/STATE/ZIP:  
REQUIRED:  
ITEM SUPPORTED:  
SITE:  

#### L. PLANT EQUIPMENT:  
(Major/special; machine tools, inspection, test, etc.)  
SOURCE MANUFACTURER:  
TYPE:  
CAPACITY:  
YEAR:  
BUILT:  
ORIGIN:  

#### M. COMMENTS:  

---

**Fig. 4 - NAVSHIPSO INDUSTRIAL PROFILE**
MIT TRENDS

Although the shipbuilding supporting industrial base has contracted over the past decade, MITs for some Basic Material and BME components have generally decreased while Combat Systems/components increased. Tables II and III provide ten year overviews of selected items' MITs. BME and Basic Material MIT improvements are attributed mainly to the aggressive Navy shipbuilding program which consisted of a large number of follow-on orders (large lot procurement) for DD 963, FRG 7, AO 177, CG 47, ISD 41, T-HD 187, SSN 688, SSN 726, T-AK 251 and KC-L classes of ships and craft. This building program afforded many manufacturers opportunities to:

Improve workforce learning curve

Improve processes, workflow and testing methods

Develop capable subcontract material suppliers and subcontracted work support

Improve plant equipment and facilities

Improve planning and scheduling

Stabilize design

All of these conditions affected BME and Basic Material MITs during the 1980's.

MITs increases in the same time period are attributable to:

- Increased backlog at prime or subtier level for such components and material as castings, forgings, bearings, motors, plate and sheet.
- More stringent specifications requiring increased testing or requirements; such as reduced airborne and structureborne noise levels, improved efficiency, weight and volume reductions and increased mean-time-between failure.

- Change orders which interrupted production schedules

- Material/subcomponent costs

However, for Combat Systems MIT increased slightly in the last decade due mostly to longer MITs for material and subcomponents, minor changes in regulations and long lead time material purchasing practices, alternate sourcing (initially) and complex systems reaching full production status.

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**TABLE II**

MANUFACTURING LEAD TIME TRENDS FOR SHIP COMPONENTS

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TABLE III
MANUFACTURING LEAD TIME TRENDS FOR MAJOR COMBAT SYSTEMS
(IN MONTHS)

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IMPACT OF MLT ANALYSIS

Perhaps the most concise assessment of MLT analysis is that which appears in reference [1]. "Defense system typically exhibit lead time volatility. In the discussions of scheduling it is noted that the start date for contractor activity is normally based on a set back from the required completion date. The set back is dictated by the operation flow time and the material and component lead time when the lead time is in error, two possible problems exist. If the lead time estimate is excessive, the funds requirement will be established unnecessarily early. This may lead to an overstatement of the lead time and could result in funds being drawn unnecessarily from other areas of need. If the lead time estimate is understated, specific contractor activities could experience a start date that will not support the required delivery date without the expenditure of premium effort, resulting in higher than necessary program cost or even potential schedule slippage." These results, as stated, have in the past and unfortunately, without accurate estimates and forecasts could plague future programs.

SHIPBUILDING SUPPORTING INDUSTRIAL BASE

The industrial base that manufactures key systems, components and material is comprised of approximately 1200 US and Canadian companies. This base consists of a cross-section of major corporations, small business concerns, sole proprietorships, partnerships, government-owned, government-operated and government-operated facilities. Complementing this base is a network of support companies including distributors, design agencies, service companies, assembly plants and subcomponent manufacturers. The major manufacturers under contract to government and shipbuilders are dispersed throughout the country. Large smokestack industries continue to be concentrated in the Northeast and Midwest, whereas the combat systems base is located predominantly in California and the Northeast. Canadian manufacturers of major components and systems are located mostly in the Eastern part of the nation. Primary products manufactured by this North American Industrial Base includes, rebuilding gears, shafting, steam and diesel engines, gas turbines, combat systems/components, ordnance, communication and electrical equipment.

Although many HI&E industries can be considered "healthy", capacity reductions and MLT increases are occurring in some key Navy supportive segments. The segment of the base that manufactures propulsion diesel engines and gas and steam turbine engines has been reduced by approximately 40% since 1980. There are currently only two active producers of steam turbines, one of which, has recently consolidated and moved its manufacturing site. There is only one manufacturer of gas turbines and one of large diesel engines and they do not manufacture slow speed engines frequently used in new commercial ships. MLTs for diesel engines have increased slightly since 1987. There were six man reduction gear manufacturers producing reduction gears for large naval applications in 1980. Today, five are supporting Navy programs and only three have in grinding capability to produce state-of-the art hardened and ground reduction gears. Since 1988, MLTs have increased from 15 to 19 months. The depressed condition of the gear industry is of such significance to the Navy that procurement of some Navy reduction gears has been restricted to US manufacturer.
Large marine propeller manufacturers in the US have experienced in their attempts to become competitive on the international market, continued loss of capacity and MLT increases many key industries is expected throughout the foreseeable future. Continued erosion of the US Base will result in increases of single and sole sourcing loss or transfer of production capacity to foreign sources, causing a significant reduction in domestic productive capacity.

REFERENCES

Additional copies of this report can be obtained from the National Shipbuilding Research and Documentation Center:

http://www.nsnet.com/docctr/

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