CAD/CAM/CIM
(Computer Aided Design/Manufacturing/ Integrated Manufacturing)

- Computers were introduced to ship design in the early 1960’s.
- Early applications were to Naval Architecture and Marine Engineering calculations.
- Computer application for Hull Lines Fairing began about 1963.
- N/C burning machines introduced in US in 1954 as a study of feasibility but nothing done until late 1960’s.
- British Oxygen developed N/C burning machine in 1959.
- Computer applications move in two directions CAD and CAM.
- There are both generic and shipbuilding specific CAD/CAM systems.
- AUTOKON, a shipbuilding CAM system was introduced into US in 1968.
- Avondale and Ingalls develop their own CAM system (SPADES)
- US Navy invests millions of dollars to develop CASDOS a CAD system for developing structural design drawings
CAD/CAM/CIM Continued)

• By 1985 integrated CAD/CAM shipbuilding systems are available.

• In US a number of generic CAD systems are introduced into shipbuilding, but they all suffer from lack of ship fairing capability and ease of use.

• They included:
  - Computer Vision
  - CADAM
  - CATIA

• Shipyardspecific systems included:
  - STEERBEAR (Now part of TRIBON)
  - BRITSHIPS (Now part of TRIBON)
  - Autokon (Today’s version is TRIBON)
  - FORAN
Improvements since 1985 have been in user friendliness and modeling.

Today there are many 3D modeling, integrated CAD/CAM systems available to shipbuilders.

The specific shipbuilding systems are TRIBON, FORAN, NAPA, and HICADEC.

In the US the Navy purchase the INTERGRAPH system and many US naval shipbuilders have followed.

INTERGRAPH is involved in two major development programs for their system, namely COMPASS and FIRST, both supported by MARITECH.
DESIGN FOR PRODUCTION

CAD/CAM/CIM Continued)

• The US Navy and shipyards such as Newport News, General Dynamics and Ingalls are at the forefront of Simulation Based Design.

• Robotics is the next implementation area, although it may not be realized by US shipbuilders because of their low throughput.

• Japanese Shipbuilders Association identified CIM as way to double productivity over 10 years ago and Japanese shipbuilders and research association have worked on verifying potential and developing approach to implementing CIM.

• The key to CIM is the 3D product model. CAD defines the geometry of components and CAM developed N/C information for steel and piping. CAD/CAM is not sufficient to be used effectively for assembly process planning and control.
• The Japanese CIM project offered the following conclusions: Shipbuilding CIM must be dynamic, as opposed to retrieval CIM. This is because of the one-off and small lot design and construction nature of shipbuilding. The 3d product model is essential for shipbuilding CIM. A process planning system for assembly must be in place before CIM can be implemented. The problem with one-off and small lot design and construction systems is in the system development cost. To overcome this problem, efficient use of program modules and computerization are important. The cost to develop a CIM system is too great even for Japanese shipbuilding industry. Therefore, they are working with all manufacturing industries to develop a generic core with shipbuilding specific additional modules.
DESIGN FOR PRODUCTION

CAD/CAM/CIM Continued)

• Product Model Information (*J. Boudreaux. GD*)

• Typical Product Model Size and Complexity

<table>
<thead>
<tr>
<th>Product</th>
<th>Parts</th>
<th>Surfaces</th>
<th>Memory</th>
<th>Paper Data Stack</th>
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<tr>
<td>New Nuclear Sub</td>
<td>500K</td>
<td>150M</td>
<td>445GB</td>
<td>1100 feet</td>
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<tr>
<td>Fighter Interceptor</td>
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<td>2M</td>
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<td>Chrysler Automobile</td>
<td>7K</td>
<td>1M</td>
<td>2GB</td>
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</table>

• Scope of NSSN Design/Modeling Effort
  3500 designers on two shifts
  150,000 to 200,000 scheduled activities

• Characteristics of Training for CATIA
  4000 Commands
  6 months before useful
  78 courses
  50 to 60 people in training at any time
The ideal CAD/CAM system for a shipyard would be one that:

- Allows designer to develop Contract Design, Bid Price and Build Strategy in an integrated (or Federated) database.
- The Functional Design would be developed by completing a 3D product model of the product, which could be accessed by integrated systems that would develop material lists and information for planning including the completion of the Build Strategy.
- The Build Strategy would be used to develop block, unit and zone technical documentation, which would become part of the work station/zone work instruction package.
- All CAM information would be developed from the final 3D Product Model.
- Finally test and support information would be extracted.
DESIGN FOR PRODUCTION

CAD/CAM/CIM Continued)
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