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Updating of shipbuilding CAD/CAM systems

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ABSTRACT

With the rapid changes that are taking place in the field of Information Technology, IT, it has become necessary for any industry and, in particular, for the shipbuilding industry, to renew periodically its computer systems to be able to remain competitive. The object of this article is to lay out in general terms the method of renewing CAD/CAM systems, with emphasis on the special conditions that Russia is at this moment living. This study, based on SENER's experience, considers the original HW and SW used in Russia. The human, technical and economic aspects are analyzed and a recommendation is given on how to optimize the update of the mentioned CAD/CAM systems, taking into account the actual situation and making previsions for the short and medium term.

0. INTRODUCTION

Now, that many shipyards of the former Soviet Union, are envisaging the renewal of their design and production processes, and some have already taken decisions, we would like to present some ideas that can perhaps help to those managers that are now studing the improvement of their designing procedures.

SENER, as first supplier of software to the Russian Shipyards and Institutes and also as permanent developer of a CAD/CAE/CAM System for shipbuilding, thinks to be able to contribute modestly in the clarification of the current situation and in the analysis of future trends. Information Technology, IT, is committed to continuous and far-reaching changes that require fast reactions.

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INITIAL SITUATION. CURRENT STATUS

The shipbuilding CAD/CAE/CAM Systems have grown and changed as shown schematically on Table 1; however the Russian shipbuilding industry is considering to pass directly from first stage to the last one, without a continuous evolution, which could lead to some technical, human, and economic problems. We will try to analyze them below.

Table 1. EVOLUTION OF SHIPBUILDING CAD/CAM SYSTEMS

Y	INSTALATIONS & EQUIPMENT	PROGRAMS	COMPANIES END USERS
1972-78	Big computing centers. Main frames. Punched cards and alphanumeric terminals.	Independent applications. Sequential files. Batch processes.	Big shipyards. High computing level.
79-86	Computing centers. Medium Minicomputers. Alphanumeric terminals and Graphic terminals.	Integrated applications. Medium level. Independent databases. Interactive processes.	Big and medium shipyards. Low computing level.
87-93	Local area networks. Workstations.	Fully integrated applications. Single database. Interactive graphic processes. Open systems.	Big, medium & small shipyards. Low computing level.

2. TECHNICAL ASPECTS:

Main topics concerning technical aspects for CAD/CAE/CAM systems are:

Integration.- The meaning of the word "integration" has been devaluated over the years. Currently it is even applied to systems in which have been brought together different packages, even from different suppliers, having several data bases and many internal interfaces.

A system is a Really Integrated System, RIS, when it incorporates:

- A common and single data base.
- Same language and same access procedures for all modules.
- Intensive use of topology in the definition of the ship model.
- No data redundancy.

The consequence is the elimination of all internal interfaces. When talking about interfaces we always say that "the best interface is that which does not exist".

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The real integration avoids the use of interfaces, guarantees the consistency of the ship model information, allows the single input of data and eliminates loss of information and introduction of errors.

This concept of integration is especially difficult to comply with when the scope is really comprehensive. The wider is the scope of a system, the more difficult is the integration, but, at the same time, the more interesting to take advantage of this characteristic.

Reliability.- The reliability allows the user to work easily and rapidly because results obtained must be always exact, avoiding unnecessary checking and, consequently, it is possible to reduce the margins usually accepted. These margins represent the degree of uncertainty or ignorance on the matter.

Extension.- The shipyard needs to solve all engineering aspects and the technical information for other connected activities. In case the system is not able to cover all these aspects, it would be necessary to complete the scope with additional systems. This solution implies to interface such systems, thus representing the disadvantages mentioned above.

The advisable scope of a RIS includes the following fields:

- Definition/generation of hull forms, decks and bulkheads.
- Hydrodynamic evaluation, such as powering, manoeuvrability and seakeeping.
- Architectural calculations including hydrostatic calculations, capacities, loading conditions, damage stability, longitudinal stress, freeboard, tonnage, launching, etc.
- Outfitting design, mainly devoted to develop diagrams and equipment and fittings ordering.
- Definition of hull structure, comprising shell, decks, bulkheads, internal pieces for both, plates and profiles.
- Steel workshop data for plates and profiles cutting, forming, bending, welding and erecting. (See figures 1 and 2 below).

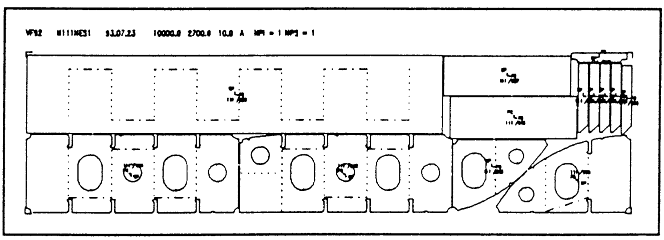

Fig. 1.- Plate Nesting and Marking Path

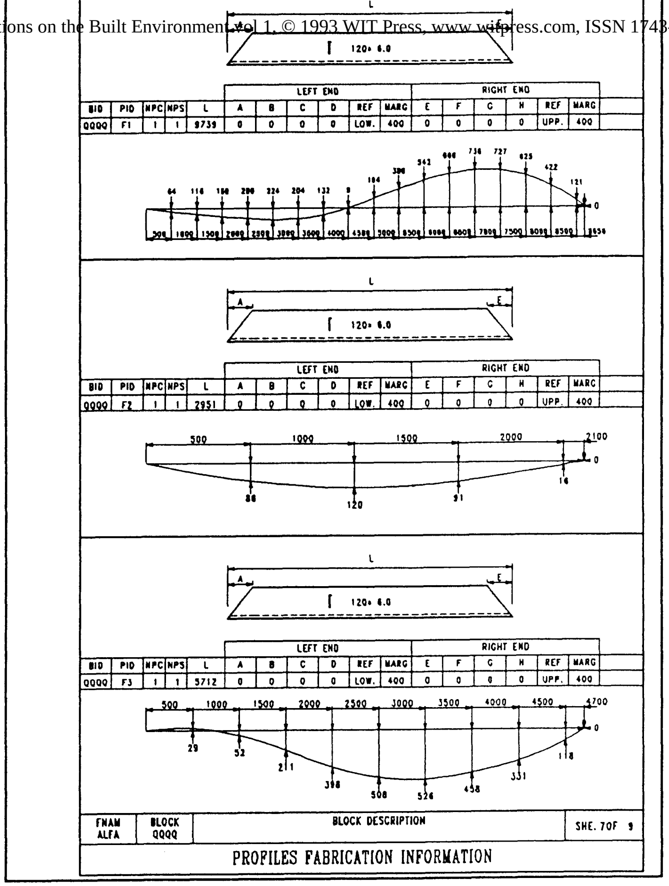

Fig. 2.- Profile Bending and End-cutting

- 3D solid modelling for Outfitting equipments, piping, ducts, cable trays, hatches, ladders, etc. All these elements to be related to the structure and allowing to study the layout, tracing, interferences (clash detection) See Fig.3.

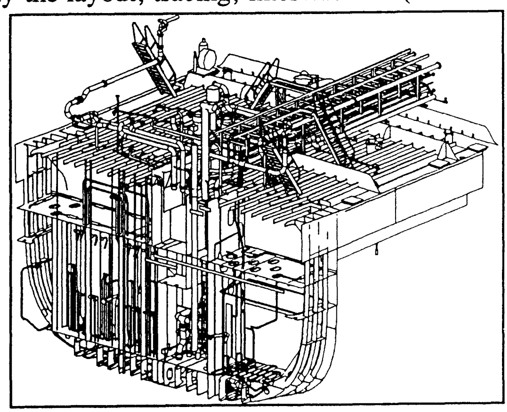

Fig. 3.- Piping and equipment layout

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metrics, lists of pipes and fittings, bills of material, drawings in orthogonal or perspective views, etc. See Figure 4.

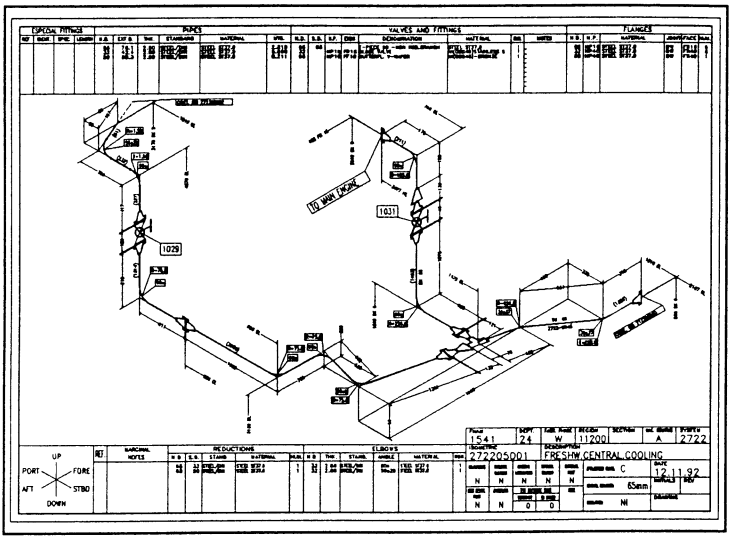

Fig. 4.- Isometric drawing

- Management information from the technical point of view of materials, documents, quality control, etc.

Ease of access and intercomunication.- The generation of standard formats facilitates possible interfaces with other systems "opening the system". These standard formats could be: DXF, IGES, HPGL. In this way the operational flexibility is improved.

The Local Area Network (LAN) is now an absolutely necessary arrangement, which allows the intercommunication between different departments and sections of the shipyard and the optimization of hardware resources. The hardware requirements can be adjusted to each phase thus allowing to graduate investments over a longer period.

3. HUMAN ASPECTS

It is common to consider that the future users of a system must be special people with a strong knowledge in computing. This is absolutely wrong. The users of the system can and must be those experts in each field who were previously developing the job by manual or simple methods. Training of users includes the necessary learning to handle a workstation without any problem after the corresponding course. Our own experience refers to many shipyards which were using only manual procedures and the results have been 100% successful. Any person, of any age can be perfectly trained, provided that he knows the technical matter in which he will be involved.

Training is a very critical phase of the implementation of a system. Usually the training is carried out at the software supplier premises. The reasons are mainly the availability of all the adequate trainers and the better efficiency of the training, due to the absence from local interference of the trainees. Availability of hardware is also a decisive point to be considered. It is very important to optimize the training duration bearing in mind that a considerable number of technical people must be absent for a period of several weeks. For this reason and because a system should facilitate a comfortable use and, of course, a shortening of time involved, the user interface is a very important characteristic.

Some tools to improve the user interface are: mouse driven dynamic menus, and pop-up menus, user definable function keys, guided data entry windows, multi-window capabilities, etc.

It is very important to complete the training and become expert in the use of the system using a real ship and not by spending time on 'test' ships. It is clear that all savings will not be obtained when developing the first ship, but some attractive savings can even be obtained.

A human aspect to be clarified is the degree of automated work incorporated in a RIS. Many annoying tasks are avoided and even some decisions are taken, but only when those decisions do not imply the contribution of specific criteria. The important decisions are always taken by the user who has a very effective tool to explore alternatives and to carry out the boring work.

A system should facilitate the addition of programs previously developed by the shipyard, when these programs contribute with some specific requirements of the shipyard. In this way the system is enriched with particular aspects and the acceptance of the system is improved. The system is not then considered as a destructive tool of previous procedures but as an efficient support to solve all main requirements in which specific own developments can be added. For this reason the system should be prepared to accept such contributions.

4. ECONOMIC ASPECTS

For studying the rentability of the investment the following costs must be considered:

- Acquisition and implementation of Hardware, HW, and Software, SW.
- Maintenance of both, HW and SW.
- Training.

The first two costs are known after deciding the number of required users; the yearly maintenance cost is usually a percentage of the acquisition cost of HW and SW. Training has two different stages, the first considers the teaching from HW and SW suppliers (with known cost) and the second considers the practing with this new knowledge (the costs of which, are not directly accountable, but are normally incorporated to the first project developed).

On the other hand the savings and/or reductions to be considered are:

- Reduction of costs in ship engineering (design).
- Reduction in the delivery time of ship engineering development.
- Savings on production costs.

The main user of CAD/CAM System is the technical department but it is not the main objective of the introduction of such a system to reduce the hours of this department in the ship project, but by producing better information to save production man hours either directly or by errors reduction. On top of these savings, a very important improvement is obtained by reducing the delivery time of both, ship design and ship construction. This increases the competitiveness of the shipyard due to reduction of direct and financial costs; additionally the shipyard increases its production and, as a consequence, may build more ships during the same time. For a reduction of elapsed time, from beginning of erection to launching or floating, of 10%, the number of ships to be delivered, maintaining the same general expenses, increases in the same percentage. General expenses would be than divided by a bigger number of ships; consequently those expenses would decrease in the same percentage, only for this reason.

In Figure 5 are shown the differences, in scheduled time (calendar months) and in required man-power (man-months) between the use of a Real Integrated System, RIS, and Independent Computer Programs, ICP, with interfaces.

Savings by departments can be summarized as follows:

- **Technical Department:**

  · In general, a reduction of coordination effort by the use of RIS with 3D and topological model (Easy handling of changes).

  · General Design.- Increment of number of alternatives under development, increment of accuracy of calculation and then a reduction of design margins (weights, speed, volumes, etc).

  · Design and Production of Hull Structure.- Better and more accurate definition of the ship structure. It is the way to use special tools and devices and will be the only way to future implementation of CIM. Drawings and other documents are a consequence of the 3D Model definition.
  Expected saving on man power: 30-40%.

  · Outfitting Design and Production.- Due to the use of a 3D ship model, including hull structure, equipment, ducts, cabletrays, piping, fittings, etc, the fabrication of 3D plastic model (at 1/20-1/25 scale) for clash detection is not needed. Pipe penetrations on hull structure are also coordinated.
  Savings on plastic models : 100%
  Expected savings on man power : 25-40%

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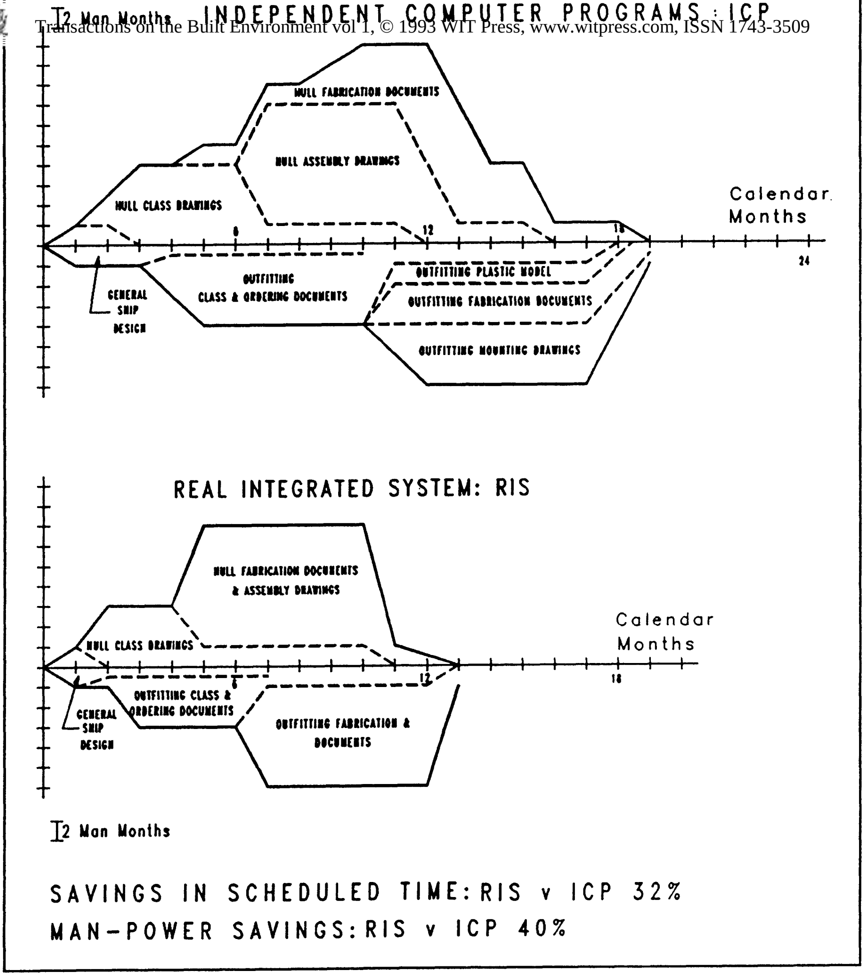

Fig. 5.- Ship engineering. Scheduled time and man-power

- Production Workshops:

· Steel Workshops.- CAM Systems have allowed the use of different tools and control devices, such as: Numeric control, NC, machines for cutting plates; NC machines for cutting ends, notches and holes of profiles; and NC machines for bending profiles. Also a RIS gives information for: Plate bending by cylinder, press or heating lines; flat panels lines; fabrication berths (jigs) of curved panels; and planning and management (cutting lengths and welding lengths by positions and types, including upturned panels or sections). A RIS will allow the eventual CIM introduction in shipyards.

· Outfitting workshop.- The information for pipe lines, ducts and cabletrays fabrication and mounting is usually improved, because of the use of perspective drawings. CAM systems allow the integrated use of numeric control machines for pipe cuttings and bending, and welding flanges.

· Summarizing important savings are obtained for: reduction of man hours because better coordination (less errors mainly due to clash detection); more information of a higher quality. The need of such a system is essential for the use of improvement technologies, currently available with CAM Systems and in the future for CIM systems.

Currently direct savings in manpower on Production Workshops by using a RIS are estimated in 5-10%. Savings in elapsed time for construction are estimated between 10 - 15%.

- **Departments of planning, quality control, store control, etc.**

  Interchange of information between shipyard departments is obtained by the use of "Open Systems" on the same network, linking the CAD/CAM System with other systems such as: Planning; storing; accounting; etc.; etc.; etc.

In the current difficult market situation it is absolutely necessary for a shipyard to survive to be up to date in the latest technology, and a very important part of this shipbuilding technology is the CAD/CAE/CAM System.