COMPUTERS IN SHIPBUILDING

Some Views

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INTRODUCTION

Two important pressures tend to expand the use of computers in shipbuilding, one is the computers' capacity to readily cope with large amounts of information and the other is the insatiable demand by bureaucracies for increasing amounts of data concerning shipbuilding contracts. Large portions of this desired information are clerical and are similar to that in shipbuilding management and information systems. It requires both sophisticated and extensive data handling capability on the part of the shipyard computer group. At present this area of computer applications is not as well developed as others, both with respect to programming and to the equipment; for these reasons, this aspect is merely mentioned as background for this paper. In the author's opinion, however, the systematic use of computer systems in shipbuilding requires a comprehensive understanding of shipbuilding, computer programming systems, and computer hardware in order to take full advantage of computers as applied to shipbuilding, and this may take some time to achieve.

With regard to many computer systems, software and hardware, problem solving by the use of this powerful tool in the area of naval architecture calculations, structural analyses, and many other well developed engineering problems, has become a highly developed science. Although bugs still exist in several of these programs, current familiarity with them precludes any need for comment in this paper. The prevalence of using computer programming in various areas of design development,

/2...

optimization and parametric studies is quite common throughout the profession. However, it is difficult to assess the worth and the actual use of these kinds of programming in the decision making processes of ship procurement. The present depressed conditions of world shipbuilding would seem to support such an idea.

This paper describes those areas of computer applications in shipbuilding that have a proven record of performance and are widely used in North America. They are systems of computer programming for the development of lines plans that are used for parts manufacture, by creating either magnetic or punched tape used to drive numerically-controlled, flame-cutting machines, as well as other operations that will be noted in passing.

Computers and Shipbuilders

A variety of attitudes toward computers prevails throughout the industry, ranging from complete distrust to rank enthusiasm. It is difficult to pin-point the reasons for this diversity, but an evaluation of some background conditions appears to be in order. Without much doubt, major factors behind these attitudes have been the rapid pace of developments and the continuing state of change in available equipment and in the programming associated with it. The size of the shipbuilding industry, in comparison with other large enterprises, has limited the developmental work needed for its unique programming requirements, and the industry has also been unable to stimulate the development of specialized training programs for the various areas of computer applications in shipbuilding. As a result, many of the computer applications personnel come from outside the industry and must try to assimilate the unique characteristics of shipbuilding as they apply their specialist talents and techniques.

/3.....

During this time, however, various combinations of 1/10-scale lofting and developing computer programming have served the needs of the numerically-controlled production equipment used in the shipbuilding industry. Computer programming progressed slowly from coping with the flat and cylindrical surfaces of the parallel mid-body, first through those areas having easy, long radius curvature and, finally, extending to those shell areas of the bow and stern having the most complex curvature at the bow and stern. During these stages, combinations of 1/10-scale mold loft procedures and computer processes were used to loft parts, some of which were then entered into the computer data base by using digitizers. Many of the problems with computer fairing were related to the difficulties of program development and their applications to the work of lofting. By 1977, the programming has developed to the stage where a number of programming systems have complete lofting capability, and the need for conventional lofting facilities for new construction work has been reduced to the point where a few smaller yards still use the older methods.

Computerized lofting requires the use of various items of computer hardware capable of handling the programming or software, and consisting of several interacting modules of programming compatible with one another and with the computer in use. The hardware consists of a large capacity main frame computer, mass storage, a card reader, and output facilities to create punched cards, magnetic, or punched tapes. Modern tele-communications provide facilities for using high capacity computers on a rental basis through remote terminals that are equipped with the proper input and output hardware and also the required telephone hook-up equipment.

5/.....

having the required training in methods of coding in the input data, ovided they are quite familiar with the basic principles of lofting and associated aspects of shipbuilding. However, this work encompasses so much minute coding detail that continuous work in such areas can only insure reasonable levels of productivity.

Some modules, such as the one for fairing the lines, are more complex and more demanding than others, and few of them are entirely free of bugs, either in the programming or in the documentation. In addition, ideas for increasing computer applications in shipbuilding are continually being introduced. The systematic character of computer systems requiring comptability for both the software and the hardware used, identifies the need for tight administrative control over the solutions to bugs, alterations in the software, and the introduction of new programs. Personnel involved at these levels require a thorough knowledge of the many aspects of shipbuilding and also of computer operations in order to keep the systems operating smoothly. Organizations controlling programming systems have developed servicing groups capable of resolving the more difficult problems arising from the use of their programs. These groups also generate new programs that are compatible with the existing systems.

The several software systems available in 1977 are made up of varying numbers of program modules having names that usually relate to the work they do, such as hull fairing or lines definition, defining the detailed body plan, naval architecture calculations, and others. Each of these modules is made up of programs consisting of many sub-routines, several of which may apply to more than one module. The sub-routines are linked together by programming and are stored as complete units in memory for ready availability. These modules all tie in with a common data base

/7...

Defining and Fairing the Lines

The programming in this module fairs the lines of the vessel and generates a data base according to the ship's stations or transverse frames and the hull boundary control lines. A complete lines drawing can be developed, or any portion of it, and a shell expansion drawing may also be included.

A fairing program is capable of adapting in mathematical forms the drafting techniques of a lines draftsman by using elastic beam theory to create an exact representation of a loftsman's spline. The resulting mathematical curves are faired through an iteration process where the position of each data point is adjusted to ease the strain in the "beam" to a minimum. First, the control lines at the boundaries of the hull, stem, keel and stern contours, side and bottom tangents, deck lines, etc. are faired independently. Fairing the remainder of the hull surface uses data points for a selected number of design stations, and an interactive surface fairing is performed automatically within limits between design stations by using a selection of diagonals. After each step in the process, drawings of stations and diagonals can be made to ensure that the program and the method of using it are functioning properly. Fairing programs may have the capability of allowing the user to select fairing planes at any position and angle to the centerline plane of the hull, a characteristic giving such a program great power and versatility. On completion of the fairing construction frames can be positioned and their shape stored in the data base along with the conventional lines drawing. These frames are actually special fairing planes.

/9....

members. This data is entered through the use of various modules in different systems, or it may be additional programming to a hull definition module. The input data required includes that required to be coded in by the user and also that recalled from the data base by using of special sub-routines within the programming.

The output data from this programming consists, in general, of the following :

decks and flats

breast hooks

longitudinal bulkheads

shell and longitudinals and sight edges

deck and bulkhead longitudinals and seams

cut-out requirements and details

cut-out and member descriptions

The various computer lofting systems available establish through their programming and documentation the requirements for input data and the characteristics of their output, all of which are unique to each system. These conditions emphasize the need for strict control over the programming and for proper servicing of each system of programs to ensure that compatability is maintained throughout, and also that the data base management schemes provide for continuing developments in them.

Hull Technical Calculations

With all of the hull geometry lodged in the data base, most computer software systems for lofting include a module that has programming capable of performing the many naval architectural calculations associated with the design and construction of ships. With inputs locating the boundaries of tanks and compartments, all of the volumes of the spaces in the ship and their centers of gravity, are calculated. In many systems, this

/11...

drawn on an N/C drafting machine for initial checking.

When the parts to be generated are large and can be done as a complete unit, such as a transverse or longitudinal bulkhead or a large web frame, pieces can be separated out by additional programming included in the module. This is done by specifying the boundary seams and butts of the pieces within the entire sub-assembly; then, each piece can be generated separately to its proper geometry with cutting information included. In addition, contours on decks and longitudinal bulkheads can be generated in way of sheer and camber by programming features able to handle deck expansion.

The Nesting Module

As of the late 1970s, there are few workable programs for nesting ship parts that are capable of automatically and efficiently arranging flat structural parts on a given plate. A more common procedure consists of using N/C drawn diagrams of separate parts at a convenient scale and arranging them by hand on a similarly scaled plate layout. Each generated part can be positioned in absolute location on the plate or relative to a previously specified part, thus allowing for a common cut between them; mirror images of a part in a plate can also be provided for. The position and description of each part on the plate is noted so that its contour can be recalled from the data base and positioned in agreement with hand nesting arrangements. Once all the parts have been positioned on the plate, the information of each part, its position relative to the plate, and the side up, is coded into the input data for the nesting module. When this is fed to the computer, the module generates the tape to be used on the N/C cutting machine. Punch markings and inner cuts can be done automatically and with minimal cutting head travel. Burning the outer contours is performed in a specified sequence

/13....

in the module also describes burning procedures, kerf compensation, and a material list tabulating the required size of each plate can be provided.

Other Modules

The numerous software systems for computerized lofting have other modules, some having many more than others, depending on the levels and difficulties encountered in their developmental efforts. The areas covered include manufacturing aids for production, roll set templates that are drawn with reference lines on an N/C drafting machine and used in making the templates, girth tables, frame bending data for N/C frame benders, pin jig heights for the construction of jigs for curved plate assemblies, and programs to manage the internal complexities on the computer's data base.

This description of computer applications in actual use provides some insights into the nature of such systems involved in ship building. The parts generation module, previously mentioned, created information stored in the data base containing all of the structural parts used to build the ship. Information concerning those parts, such as weight, configuration, center of gravity with respect to ship base lines and more, can be made available for use in additional program modules for other purposes such as production control and management information. Similarly, all other materials going into the ship can be stored in a data base making it quite extensive but more difficult to manage, since its usefulness would depend on ready access to the information on the many parts required by such programs. Compatibility between the programming, the data bases, and the computer facilities must be maintained in order to get the full use of the data stored by all of these interacting programs, and to promote the orderly progress of extending

/15...

/14...