THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

Proceedings of the REAPS Technical Symposium

Paper No. 18: Organizing for Numerical Control Production

U.S. DEPARTMENT OF THE NAVY CARDEROCK DIVISION, NAVAL SURFACE WARFARE CENTER
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ORGANIZING FOR NUMERICAL CONTROL PRODUCTION

Vincent H. Nuzzo
Avondale Shipyards
New Orleans, Louisiana

Mr. Nuzzo is the Assistant Superintendent of the Mold Loft and Director of Numerical Control. He has 23 years experience in the mold loft at Avondale and has spent the last ten years in developing the usage of numerical control.
What is the optimum organizational pattern for NC in a shipyard? In an attempt to answer this question, we carefully reviewed our NC operations at Avondale.

Let us regress to 1938, when Avondale began. Avondale Marine Ways purchased the equipment once used to ferry railroad cars across the Mississippi River, and started a marine repair service. Later, as work increased, small boats and barges were constructed.

Today's facility is a modern shipyard employing 8500 workers, and is Louisiana’s largest private industrial employer.

In the last ten years Avondale has constructed a large variety of ships. Destroyer escorts and Coast Guard cutters, as well as commercial oil and cargo carriers, have been delivered. Among our more recent accomplishments is the completion of a large number of LASH vessels and semi-submersible drilling rigs. Presently, we have in service a 900' floating drydock, built by Avondale, to accommodate the launching of the LNG ships now under construction.

By the mid-1960's, we were successfully utilizing engineering and hull calculation programs. Our IBM 1401 computer was performing tedious and time consuming calculations quickly and accurately.

At this time, we signed a contract to construct 27 destroyer escorts. These ships had very complicated webs of 3/4" plate in the sonar domes that would require many man-hours to burn. To cut these webs, an Airco Servograph machine was
purchased. This was our first attempt at automatic burning. Full size templates, drawn with ink on opaque film, were needed to control this machine. Since these templates were very costly to produce by hand, we turned to our computer. A simple program, designed to generate a curve, fit a radius in a corner, and draw a hole, was developed to aid in producing the templates used by the servograph machine. The program generated a paper tape for producing full size templates on a leased 4'x5' Kongsburg drafting machine.

With the advent of supertankers and the outlook for new and larger contracts, Avondale embarked on a $32,000,000 expansion program. Limited acreage and larger ships prompted a need for a highly efficient method of cutting steel. Thus, Avondale turned to NC. Property was acquired for a new plate shop, fabrication area, and steel storage facility. Modern steel handling equipment was purchased, and a Kongsburg drafting machine and director were installed. Two Messer Griesheim burning machines and two flame planers were also put into operation.

While this equipment was being installed, our "in house" program was being improved with new commands and features. Working with the Mold Loft in a production oriented environment, our programmers created a system that served us well for the next seven years.

Originally,. NC responsibilities were shared by engineering and production personnel. However, because of work schedules and a knowledge of lofting practices, the Mold Loft assumed
a substantial role in Avondale’s 'NC development. Later, it became evident that in order to maintain production schedules, it was necessary to further centralize NC operations. Today, with the exception of the Scientific and Computer Applications sections, NC is an integral part of production operations.

In 1973, Avondale contracted with Cali and Associates, to develop and install Avondale “SPADES.”

To date, with the "SPADES" system, LNG tankers, drilling rigs, large and small barges, and our drydock have been successfully completed. Presently, we are working on four 164,000 DWT tankers;

Since the division of responsibilities differs from shipyard to shipyard, let us now look at Figure 1 which depicts the structure of each management group at Avondale - Administration, Engineering, and Production. It is interesting to note that our computer is being controlled by the Administrative group rather than by Engineering. This condition exists because our computer was primarily used for administrative type programs before engineering and NC programs were present at Avondale.

There are four NC related departments under the Engineering Vice President.

**Computer Applications**

The task of the Computer Applications Section is the development of software for any shipyard function that can be computerized. This department also has personnel working with
AVONDALE'S ORGANIZATIONAL STRUCTURE OF N.C. RELATED DEPARTMENTS

Vice President Administration

Data Processing

Vice President Engineering

Computer Applications

Call and Associates (Contract)

Scientific Section

Hull Section

Vice President Production

Production Department

Steel Purchasing

Production Planning

Material Steel

N.C. Moldloft

Plate Shop

Figure 1.
modifications to "SPADES."

Computer Applications is also responsible for fairing the ship's envelope, generating the frames, and producing offsets for engineering and the field. Computer Applications is equipped with a Kongsburg 8 'x12 '. drafting machine, Kongsburg director, and an IBM System 7 satellite unit. Management is now reviewing the possibility of shifting the fairing responsibility to Hull Engineering or the NC Mold Loft.

Cali and Associates

Cali and Associates is under contract to Avondale for the development and maintenance of our NC system. In addition to NC responsibilities, Cali and Associates is also responsible for the development and maintenance of the hull calculation programs. This organization, along with Avondale personnel, is in the process of developing other new programs.

Scientific Section

Basic structure and hull design is the primary responsibility of the Scientific Section. These tasks are accomplished by use of the "SPADES" hull calculation program and a number of programs developed by Avondale.

As the first users of the data base, their structure design is oriented so that blueprint involvement and parts generation are geared for NC production. Information for the
data base, such as stringer locations and sight edges, is also acquired from this group.

Engineering Hull Section

Engineering detailing and blueprint production is the job of our Hull Section. Working closely with the Production Department, Production Planning, and the NC Mold Loft, information vital to our field operations is gathered for refining the hull drawings.

Emphasis is placed on standardization; items such as holes, brackets, cut-outs, and webs are designed to complement our NC operation.

With a decreasing work load, our hull engineers were recently able to go through a brief NC training period. The purpose was to acquaint the draftsman with the wealth of information available in the data base and to introduce him to the NC tools available for his use. Certainly, this will help him in creating drawings that are pictorially and dimensionally accurate.

The steel take-off group is also a part of Hull Engineering. By utilizing the “SPADES” shell plate program, exact shell plate sizes are obtained. Hull engineering and scantling drawings are used for the balance of the steel take-off. These People prepare the original bill of materials for every job.

There are six NC related departments under the Vice President in charge of Production.
Production Department

The production Department’s function is to organize and control all phases of production operations in the yard.

Numerical control contributes to their operation by furnishing valuable information for production work. Sketches of burning tapes with computed burning time, quantity of plates to be cut., and an accurate representation of the steel part are important aids in the issuance of work orders.

The format of work orders has also changed because of NC. Work orders were issued by drawing, detail, and piece numbers; they are now issued primarily by tape numbers.

Using NC sketches, the production engineer can carefully monitor the allotment of man-hours needed by the plate shop, thereby increasing plate shop productivity.

Steel purchasing

The Steel Purchasing group, working with Production Planning and Material Departments, is responsible for ordering all steel plates and structurals.

Originally, Steel Purchasing was under the Vice President of Administration. However, because of their impact on production scheduling, steel storage, and handling, this section was transferred to the control of the Vice President in charge of Production.
Production Planning

Production Planning is the first section to look at prospective jobs, and to aid management in determining future production schedules. When the proposed contract becomes a reality, the planners produce a detailed work outline for the yard. The hull is divided into units and sub-units (Figure #2). Locations for master butts and stock requirements are decided upon as well as the erection sequence. This information is then used to determine the master erection schedule (Figure #3) and the ground assembly schedule (Figure #4). The planners also prepare an outline of each Units' structure which is used by the steel section for detailing the unit books (Figure #5).

Material (Steel) Section

Material Steel Section has complete control of steel plates and structural. Their first job is to screen the Hull Section's bill of material against yard stock. Grouping of odd size plates and structural for economical storage is also implemented into the bill of material. Material yard arrival schedules, handling, identifying, storage, and delivery of steel are Material Section functions. Detailed information of pieces and storage location go into the unit book.
# Avondale Shipyards Inc. Master Erection Schedule

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**Launch:** 6-11-77  
**Delivery:** 10-18-77  
**Job Code:** C4-1620  
**Piping:** SOHIO

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**Figure 5.**
NC Mold Loft

The NC loft manages and controls the data base for all jobs. Information is passed from the Scientific, Computer Applications, and Hull Sections to the NC loft for continual updating of the data base. Initial hullload and hullload maintenance are prepared by NC loft personnel. This is done in cooperation with the Hull and Scientific Sections.

Part generation (Figure 6), nesting (Figure 7), frame-bending, and yard sketches are also functions of the NC loft. NC burning tapes and template information is completed in the unit books; this is done by the NC loft prior to the books’ being sent back to Production for distribution.

NC loft equipment consists of a Kongsburg drafting machine and director, System 7, and IBM printer, and 4 IBM 2250 CRT Units tied to an IBM 2840;

Although the NC loft is not responsible for fairing, occasions have arisen where we have successfully faired a number of ships.

Plate Shop

All the steel used in the yard is processed through the Plate Shop whose output capacity is 800 plates per week. Because the Plate Shop is located strategically between the steel storage and fabrication platens, material flow is automated (Figure 8). A 17 ton capacity Via Nova crane automatically loads plates onto a conveyer system that leads into a Pangborn
Figure 7.
shot blaster, and through a Binks paint booth. Structural are
deflanged, if required, and processed through an adjacent
automated system. Plates or structurals can be directed back
to storage or onto the collator automatic stacking in the
Plate Shop. This system is controlled from a console located
over the paint and blast booth. Two 17-1/2 ton Via Nova cranes
then distribute the plates to the appropriate machines. Figure
#9 shows the layout of the Plate Shop.

Our NC burning equipment includes two Messer Greisheim
and two C.R.O. (2 two axis and 2 three axis machines, with bevel
capability) burning machines. Each machine has eight burning
heads (4 master torches and 4 slave torches). All of our NC
burning machines are directed by Kongsburg directors linked with
IBM System 7.

Paper tapes are kept as a means of emergency “back-up”.
Other burning equipment in our plate shop includes two C.R.O.
flame planers and one servograph machine. The rest of our shop
equipment is composed of presses, Rolls, shears, a newly in-
stalled panel line and a 700 ton Hugh Smith frame bender.

Adjacent to the plate shop is the pre-fabrication area and
Tee beam manufacturing facility. Sub-units, girders, webs, etc.
are moved from this site to the unit fabrication platens located
at the end of the plate shop. Completed units then go through
the shot blast and paint building to have the interiors finished.
These units are then transported by trailer or crane to a holding
area or to the ship assembly area across the levee.
What is the optimum organizational pattern in a shipyard? We must conclude from our own NC experience that a precise answer to this question does not exist. Many things influence a shipyard’s operation: management attitudes, personnel availability, finances, and geographical limitations are but a few. Without consideration for any of these factors, a good NC structure for a shipyard should be as follows:

A computer applications section to develop or procure the software necessary for a good NC program;

A fairing group, established in a department, that has the ability to manually fair a ship, and the adaptability to learn computer fairing;

A scientific section that uses the data base for hull calculation programs, and provides the basic information needed for fairing and hulload;

A hull engineering department, producing accurate drawings by utilizing the data base for drafting purposes, and supplying detailed information for fairing and hulload;

A hulload group comprised of engineering and NC loft people -- initial loading of the data base should be done by hull engineering, with the NC loft, taking responsibility for the maintenance of hulload when part generation begins.
An NC mold mold, under production management, whose duties include part generation and nesting programming, as well as data base control -- this group should have access to whatever equipment is necessary to accomplish their duties.

A review of the NC operations of several successful shipyards will be an effective method of determining a suitable NC system. Such a study will enable management to decide what hardware, software, and organizational pattern would best suit their needs.
Additional copies of this report can be obtained from the National Shipbuilding Research and Documentation Center:

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