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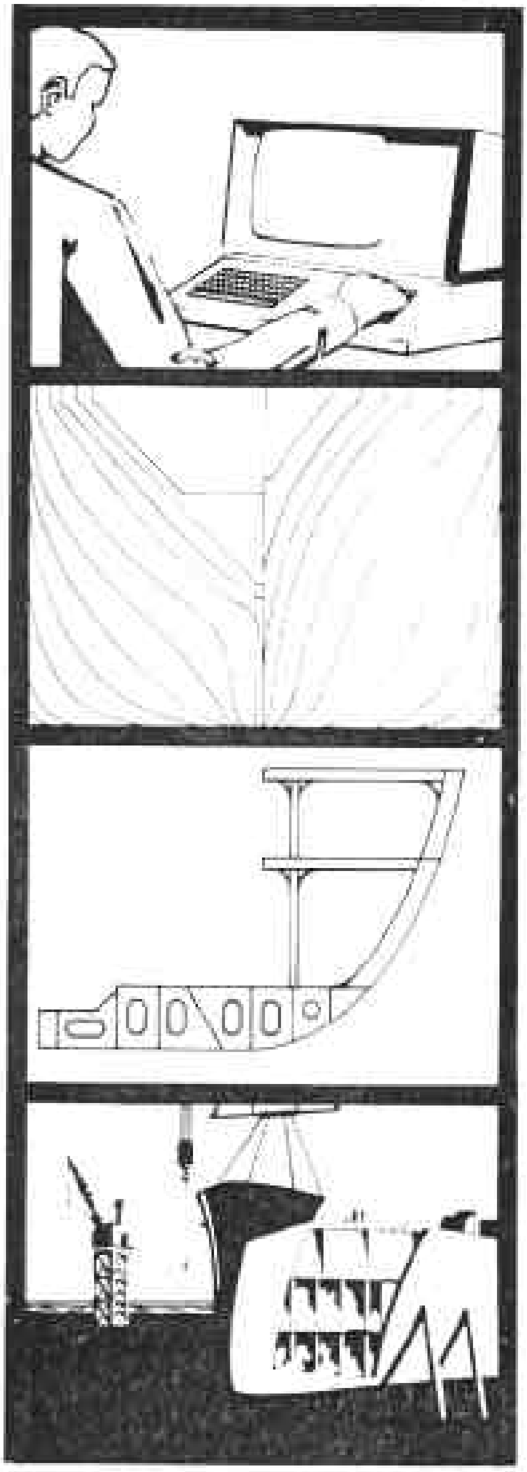

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IN
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AUTOKON'S NEW STRUCTURAL DESIGN CAPABILITIES MOVING IN TO THE DRAWING OFFICE

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SYNOPSIS

This paper describes new modules added to the batch AUTOKON, which have made AUTOKON very attractive for use in the drawing offices. By means of powerful and easy to use features, a computer based structural "model" of surfaces, stiffeners, etc. may be established at an early stage. This model may be interrogated to produce a variety of drawings for design and production purposes.

Benefits: Consistent and accurate drawings, reduction of routine drafting work, rapid transistion of design modifications into updated drawings, improved design coordination, fewer errors down stream. The "model" is available for lofting, will reduce loft hours and smoothen the peak load to generate N/C cutting information.

INTRODUCTION

The title of this paper seems to indicate that use of AUTOKON for drawing office purposes is an entirely new idea, which is not exactly true. Already in 1974/75 a library of ALKON design and production norms were applied in the Aker Group to build up a description of, the steel structure in the database at an early stage, generate drawings and utilize the database information for down stream processing in lofting. A simplified diagram of this procedure is shown in Exhibit 1.

The procedures really never got a break through in the drawing office. The reasons were many; collapse of the shipbuilding market, insufficient flexibility to handle different types of ships, high consumption of computer time, not easy enough to use and finally - the turn around of jobs in the batch enviroment did not lend itself to the effectiveness required.

However, another Aker Group development of an ALKON design and production norms library for jackets (tubular steel structures) turned out to be very successful and is in frequent use. Exhibit 2 is simplified diagram of the procedure.

The norms were defined in ALKON languge and to guide the reader he is referred to Exhibit 3 which shows the lay-out of the system on the AUTOKON-76 level.

Since the early 1970-ies, Italcantieri in Italy, an AUTOKON user since 1968, had been developing a stand alone system called SCAFO-DSI containing parallelsto the AUTOKON functions. By investigation we found that some SCAFO programs called TRALOS,TRADET AND DRAW, could replace the functions we tried to cover by the ALKON ship design norms library: to load internal surfaces with associated stiffening in a computer based structural model from which a variety of drawings could be generated.

We found the solution elegant, powerful1 and easy to use. Italcantieri had been very faithful1 to AUTOKON when intergrating the 3 programs, hence we found it would be easy to incorporate them in the AUTOKON package we offered. In 1978 SRS made an agreement with Italcantieri giving SRS exclusive world wide marketing rights to distribute these modules under the AUTOKON trade mark. Futher, we acquired 10 new ALKON statements, which replace a number of system norms (cutouts, contour generation, etc) which a substantial reduction in computer time consumption as result.

Together with a new lines fairing system BOF and the interactive nesting system AUTONEST, the enhanced system is labelled AUTOKON-79. For the US-user the differences between -71 and -76 are minor compared to the enhancements form -76 to-79.

In AUTOKON-79, we think we really have a system that should attract the drawing office.

This paper will mainly deal with the new software handling internal structures, since it means a boost to the use of AUTOKON at an early stage, However, the early availability of a numerical description of the hull form is a prerequisite to exploite TRALOS, TRADET and DRAW. Therefore some time is devoted to describe how BOF can cope with this demand.

BOF - THE AUTOKON -79 HULL DEFINITION SYSTEM

The use of AUTOKON -79 in design requires loading of a hull definition. There are basically 2 means to get it. Either a preliminary definition from PRELIKON transferred to the AUTOKON data base by the module FILIP/TRABO. Which means that all drawings from DRAW will be preliminary with regard to shell contours. This may be acceptable as a departure point, since the main objective is to get drawings. The other alternative is BOF.

Traditionally, computer fairing has been postponed until model testing wase finished, which is normally late in the design stage. The main reason has been the time and cost of doing lines fairing, even by computer. partly inability to handle local modifications in a reasonable way. Therefore better wait until everything was settled to avoid doing it all over again. For this reason hull fairing has always been a bottleneck leading to delays and peak load in lofting.

BOF makes it feasible to overcome this attitude and look on hull definition as a process that may be allowed to go through several iterations in time. Because it is easy to use, gives the user full control, allows local modifications without unexpected side effects, saves whatever information was acceptable in the previous stage, at less efforts and time. There is no longer a good reason to postpone fairing as before.

Besides that BOF can handle any hull form for surface and submarine vessels. Originally developed for the automotive and aircraft industries, BOF has been adopted to shipbuilding. The system has shown its versatility both in new construction, conversion and repairs.

BOF is a modular, command - oriented system operated in batch mode, with very powerfull interrogation and verification facilities, BOF allows a complete description of the hull form and makes available much more information for down stream processing than the old FAIR module.

Exhibit 5 shows a layout of BOF functions, and its versatility in use appears from Exhibits 6, 7, 8, 9 and 10 which shows results.

BRIEF DESCRIPTION OF TRALOS, TRADET, DRAW

The main objective of this paper is to describe the "mechanics" of AUTOKON-79, the impacts on the shipbuilding process and organization and the advantages and benefits. Nevertheless, a brief description of TRALOS, TRADET and DRAW is considered necessary.

TRALOS

This module can cope with any type of longitudinal surface:

flat, curved, twisted or a combination of 3 geometrical conditions. The description of the surface is dependent on

its geometry, determined transversally and longitudinally by its geometric line configuration

its topology, determined transversally and longitunally by the adjacent surface delimiting its extension in space.

Surfaces are reduced into 2 types: Xsee Exhibit 11)

HSUR - mainly horizontally arranged
USUR - mainly vertically arranged

The module is also provided to handle non-symmetric extension even in presence of a non-symmetric body plan.

The module supplies the intersection points between the longitudinal surface boundaries and transversal plane in correspondence of transverse frame. Furthermore and for each transverse frame, ending points of every penetrating surface are printed.

TRADET

This module stores profiles, seams, minor structures and connections concerning inner structure. All profiles and seams have been reduced into a few family types upon their prevalent arrangement. They are further simplified by the conventional way they are usually represented.

In general, a detail belongs to a structural surface where it is mounted (profiles) or it devides the panel (seam). Thus it follows the way of surface representation which is usually done over three conventional views:

transversial view from aft to fore (web frames, transversal bulkheads, floors etc.);

longitudinal view from starboardside (longitudinal bulkheads, girders etc.);

longitudinal view from top (decks, tanktops, forecastle, etc).

Keeping in mind this way of representation, a detail like a profile could have only two different arrangements upon the face plate or flage orientation its scantling is referred to Exhibit 12
Each execution of a group of profiles the program prints production information as: profile code, scantling, pieces, type of endings, length.

DRAW

The whole internal structure is grapically represented by means of this module which is capable of generating drawings over the various extensions and conventional views of the hull. In short it is capable to furnish following:

- scantling drawings of transverse sections;
- scantling drawings of horizontal sections;
- scantling drawings of vertical sections;
- structural drawings of a transverse frame;
- structural drawings of longitudinal surfaces.

By scantling drawings are meant the section of the actual penetrating structure as if it were "cut" by a plane. Typical example, see Exhibit 13 .
By structural drawings we mean the actual structure which, in addition of the mentioned scantling, includes also stiffeners, seams, holes, inner contours and standard symboles of various details. See example, Exhibit and 14 .

"Windowing" features make it possible to extract partial views of the structure. Therefore, from the same basic, input we may have both lay-out drawings, classification drawings or blockdrawings according to need.

AUTOKON-79 IN STRUCTURAL DETAILING

To have some reference to something established and well known, let us use computer lofting as base for comparison.

Basically and isolated, computer lofting implies

mechanization of highly repetitive tasks such as lines fairing and development of shell plates

converting part by part from drawing data into N/C cutting tapes with a minimum of input code, in fact a process which merely copies information from grapical into numerical form.

Computer lofting means a concentration of software usage in the end of the total preparation phase, as indicated by curve A) in Exhibit 16 . From an organizational point of view, the loft department is the responsible user. In most yards the drawing office has been only occasionally involved, if at all. However, the last 10 years of experience shows that the yards who have benefited most from N/C are those having a close cooperation between design and loft. The loft is merely copying a tremendous amount of detailed design decisions into numerical form. Hence, the drawing office has been able to greatly influence the efficiency of computer lofting by introducing design standards and preparing drawings in a way that utilize all the worksaving features of the software.

The new modules of AUTOKON-79 changed the described pattern and moves the center of gravity closer to the design stage. AUTOKON-79 makes the design office a prime user itself, not only a good collaborator as mentioned above.

THE APPROACH AND "MECHANICS" OF AUTOKON-79

The basic difference in the AUTOKON-79 approach compared to an isolated AUTOKON lofting is to establish a computer based "model" of the entire steel structure at an early stage. This "model" can be interrogated for generation of structural drawings and "harvested" down stream, f.inst. for lofting. The following features should be noted:

- The structural model comprises shell and interal structures with surfaces, openings in surfaces, major and local stiffening as well as seams and butts.

- The internal structure is described in a straight forward way, easy to learn, and stored as a relational (topological) model in the data base. Which implies that the description is independent of the actual geometry and valid as long as the topological relations are the same.

- The model is built up step by step, starting with the global information and gradually increasing the detailing. By doing this in a way that reflects the hierarchy of the steel structure, a fairly high degree of automatic updating of drawings will be made when design modifications are introduced.

  Ex. 1

  A vertical bulkhead with stiffeners described as being delimited by deck A and B will be automatically updated if the distance between the decks is changed.

  Ex. 2

  That will also be the case with a number of local stiffeners described as delimited by two major stiffeners if the latter is subjected to a certain relocation.

- The model itself and consequently the drawings generated from it at any point of time, will be preliminary or final and more or less detailed depending on the extent of basic data' loaded into the computer.

  From a relatively simple model a variety of drawings may be generated quickly at an early stage. For example transverse section on every construction frame, plans and elevations at arbitrary locations, etc.

- The model is updated periodically to reflect all design alternations until it is final. Apart from having been an important tool for the drawing office to speed up generation of drawings, the model itself is available for later computer lofting. A very great deal of the information that the loft would otherwise have to lift from drawings and generate themselves, are now available as reference data.

  The described approach is symbolized by curve B) in Exhibit 16

Since AUTOKON-79 is a common tool for drawing office and loft, it is fully possible to restrict the application to lofting. Instead of the iterative approach the system then will be used as an advanced "copying device" just as was the case with previous versions in the past. This approach may be symbolized by curve C) in Exhibit 16.

AUTOKON-79 allows a number of tasks to be worked on in parallel1 as indicated in Exhibit 17 , which shows the work load versus time corresponding to curve B), in Exhibit 16. In Exhibit 18 the work load curves A), B) and C) correspond with the curved A), B) and C) in Exhibit 16. The curves clearly show the shift of work load and smoothing of the peak. Further they indicate the savings in manhours and lead time by using AUTOKON-79 in an integrated way from an early stage.

ADVANTAGES AND SAVINGS

After having elaborated the "mechanics" of AUTOKON-79, the advantages and savings of using the system in design may be summarized as follows:

Consistency and accuracy of data and drawings

Every design manager knows that drawings are not exactly to scale, and more than often a drawing shows inconsistency between different views.

No so with AUTOKON-79. No matter whether input data is correct, wrong, final or preliminary, the results will be consistently correct, wrong; final or preliminary for any section, elevation or plan affected by that particular input data. And the result of a design error will be just as numerically and graphically "accurate" as the result of its modification.-

The combination of data consistency and accuracy of results is the very foundation for the quality of information. Any time the model is referenced, a piece of information is always the same. On stable drawing paper, the drawings are "true" to an extent non-existent in a conventional office. This quality is of great importance for all parties using the structural drawings, directly or indirectly. The quality is also increased by the fact that certain data can be retrieved directly from the model in tabular from rather than taking measurements on the resulting drawing.

The model is a single and common source of information available to all draftsmen. It represents the "truth".

Rapid detailing and generation of drawings

Starting from a rather sketchy arrangement and a preliminary hull form, AUTOKON-79 can generate a variety of 'skeleton" drawings in desired scales. These drawings will serve as work documents for further design discussions. When additional details are decided, the input reflecting these decisions is loaded into the system, the model is updated and new drawings are generated.

The main advantage lies in the ease of interrogation of the model to obtain numberous sections, elevations, plans and views,which would otherwise have to be made by hand. Apart from saving drafting hours, the more elaborate drawings mean a considerably improved basis for checking against design flaws.

Rapid updating of drawings

Even a single update, such as location of a girder may affect a great number of structural drawings. The traditional way to save time for updating of drawings is to change dimensions only and leave the contours as they are. After a number of these "updates' the discrepancy between numerical and graphical information and result in design flaws.

AUTOKON-79 makes it possible to overcome these problems and have drawings to be "true".

More flexible drawing procedures

It has already been mentioned that the model can be interrogated to get a variety of drawings: sections, elevations, plans etc. A transverse bulkhead may be seen from aft or forward. Simple instructions may display the same information by different scales for different purposes. By special "window" instructions a deck or other structure may he split in parts and displayed on separate drawings in a different scale than the structural plan, such as when making block drawings. By thinking on the model in terms of "geometry" rather than steel structure alone, and by combining scaling and windowing the model can provide drawings as work documents for special purposes. Just imagine how many times the same contours are drawn over and over again in the various design departments.

The model ensures that this variety of drawing documents contains consistent information.

The above mentioned advantages are basically -concerned with the steel drawing office itself. There are, however, certain spin off effects that should not be overlooked.

Improved coordination of design functions

The hull form and steel structure establish the constraints for almost all outfitting design work. It is common practice that the outfitting design departments either take measurements from the steel drawings or simply place them under a transparency and start working form there. The more comprehensive the outfitting and the less space there is available, the more important is the quality of structural documentation.

AUTOKON-79 provides steel drawings or skeleton drawings that are more elaborate, flexible, consistent and accurate with less efforts. Higher quality means greatly reduced chances for design flaws, which can either be totally avoided or at least discovered at an early stage.

Improved material take-off.

Steel drawings are the basis for material take off and making the bill of material for steel. More often than not steel drawings are inconsistent, inaccurate, in a small scale and inadequate in the sense that they do not give sufficient information to the materials man. He has to do a lot of guessing and tends to add on plenty of green material to make the bill of materials safe againt shortage. The result is unnecessary increase in material costs. For small vessels using standard stock plate sizes this aspect means less than for tailormade orders for very large ships, where each 1% additional allowance may mean US $30-70.000 in purchase costs.

AUTOKON-79 does not only provide high quality drawings for this purpose. The system prints tables with length of frames and stiffeners. For shell plates the bill of material is generated automatically except for certain limitations in the extreme bow and stern.

Reduced lofting work.

The detailed computer model is available as reference for the loft. The drawing office has generated "N/C information" that was the job of the loft. This should not be regarded as a transfer of work load from loft to design. The drawing office will use AUTOKON-79 because it is advantageous in their own work. As spin off the loft will benefit by saving some of their work. Why should the same information have to be defined and loaded twice into the computer? And - what is the difference between a "design contour" and a "lofting contour"? By tradition the first is inaccurate and the latter accurate. In terms of AUTOKON-79 it is the same thing.

THE AUTOKON-79 ENVIRONMENT

The tangible and intangible savings and benefits from AUTOKON-79 are dependent on a number of human and physical conditions outside of the system itself; skill and attitude of the staff and access to hardware.

The operational environment may have a dramatic impact on the lead time of jobs. Good turn around - i.e. the elapsed time from the user delivers his input data to the system until he has all the requested results in hand - tends to reduce working hours as well. Because it allows him to finish his job when he is mentally engaged in it, rather than resume it the next day or the day after.

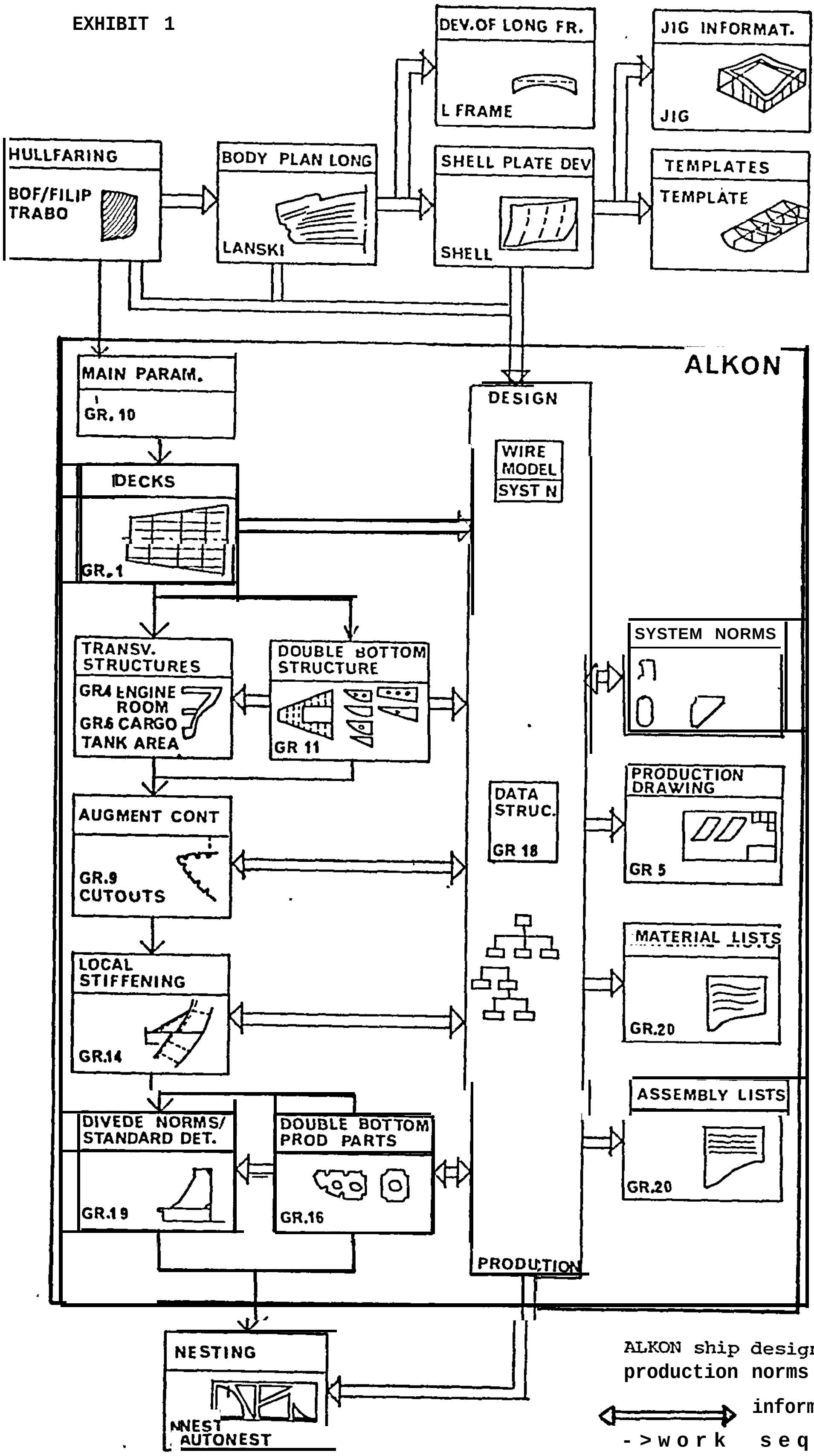
Experience shows that this aspect is neglected by many yard managements, leaving the user in a situation where the software does not really help him. In the worst case it may even turn out to be an obstacle rather than a help, where even the most enthusiastic user will find good reasons to abandon the system. From management point of view, this is bad utilization of invested money.

Design is always a bottleneck in shipbuilding. Lead time is essential, hence the operational environment for AUTOKON-79 in design is even more crucial than for AUTOKON-lofting.

Design lead time is dependent also of factors that are not directly influenced by use of AUTOKON-79: Waiting for approval of owners and authorities, waiting for vendor drawings, slow internal decision making, thinking of design solutions, deliberate design modifications, etc.

AUTOKON-79 certainly reduce routine drafting hours and reduce errors and hours thanks to higher quality of documentation.

EXHIBIT 1



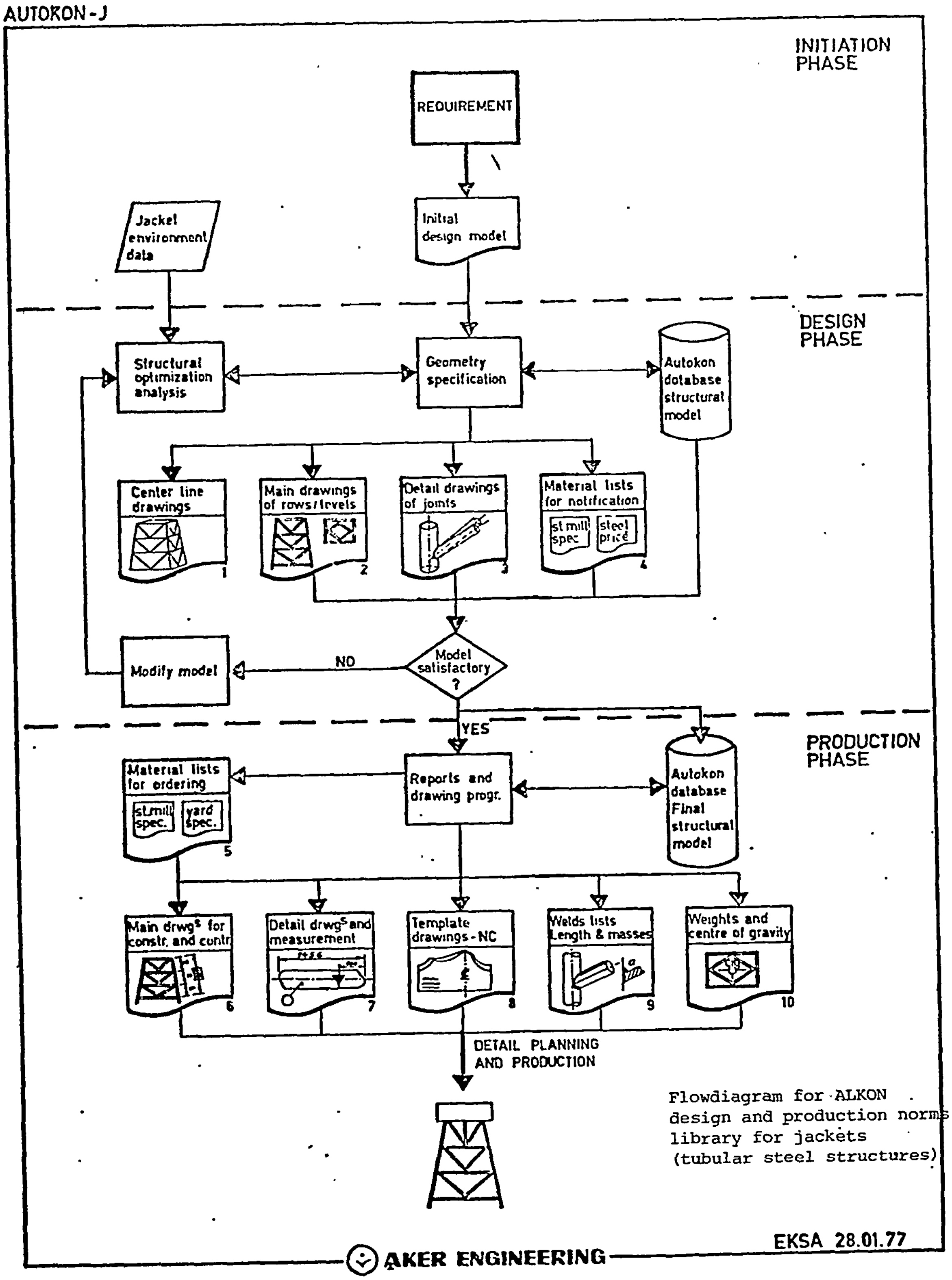
ALKON ship design and production norms library

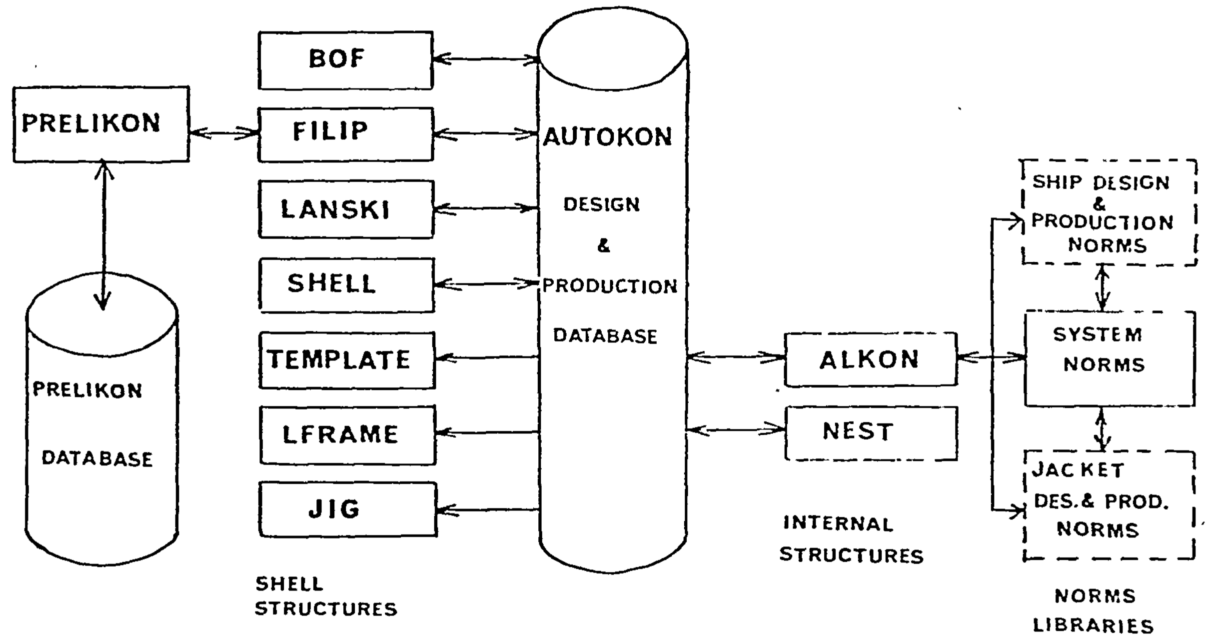
information flolw

->work sequence

COMPUTER AIDED DESIGN - AND WORK PREPARATION FOR JACKETS

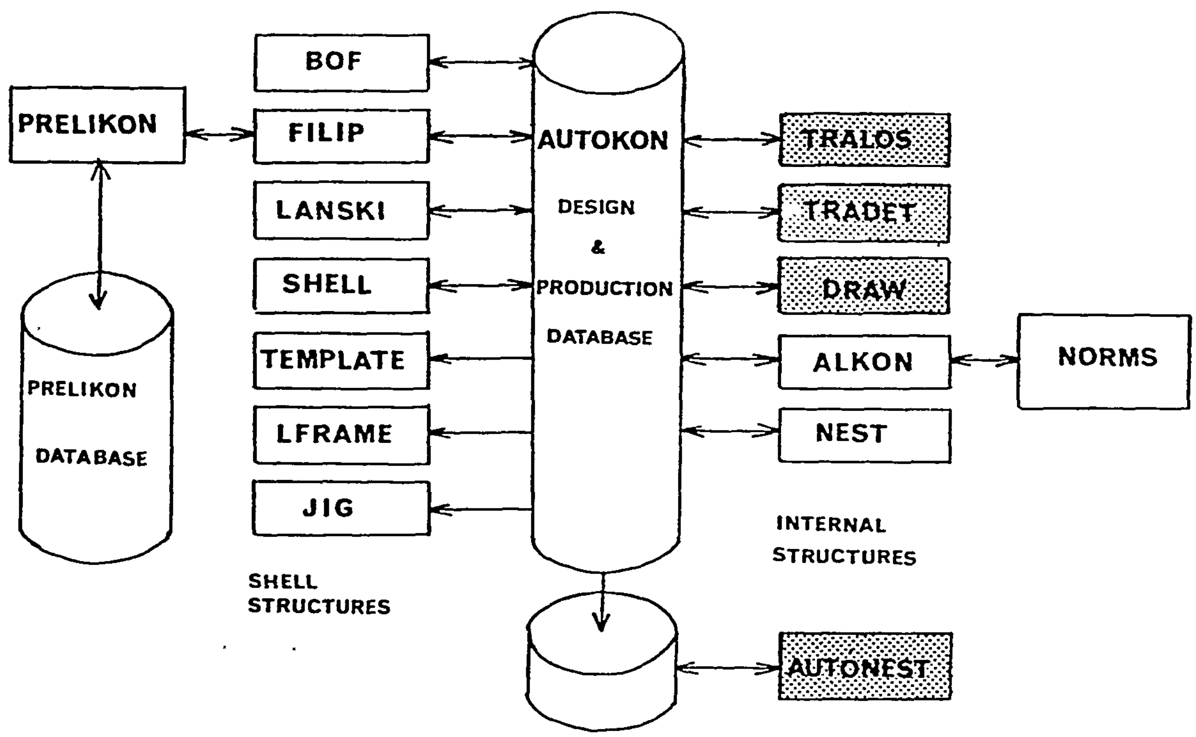
EXHIBIT 2





AUTOKON - 76

EXHIBIT 3



AUTOKON - 79

EXHIBIT 4

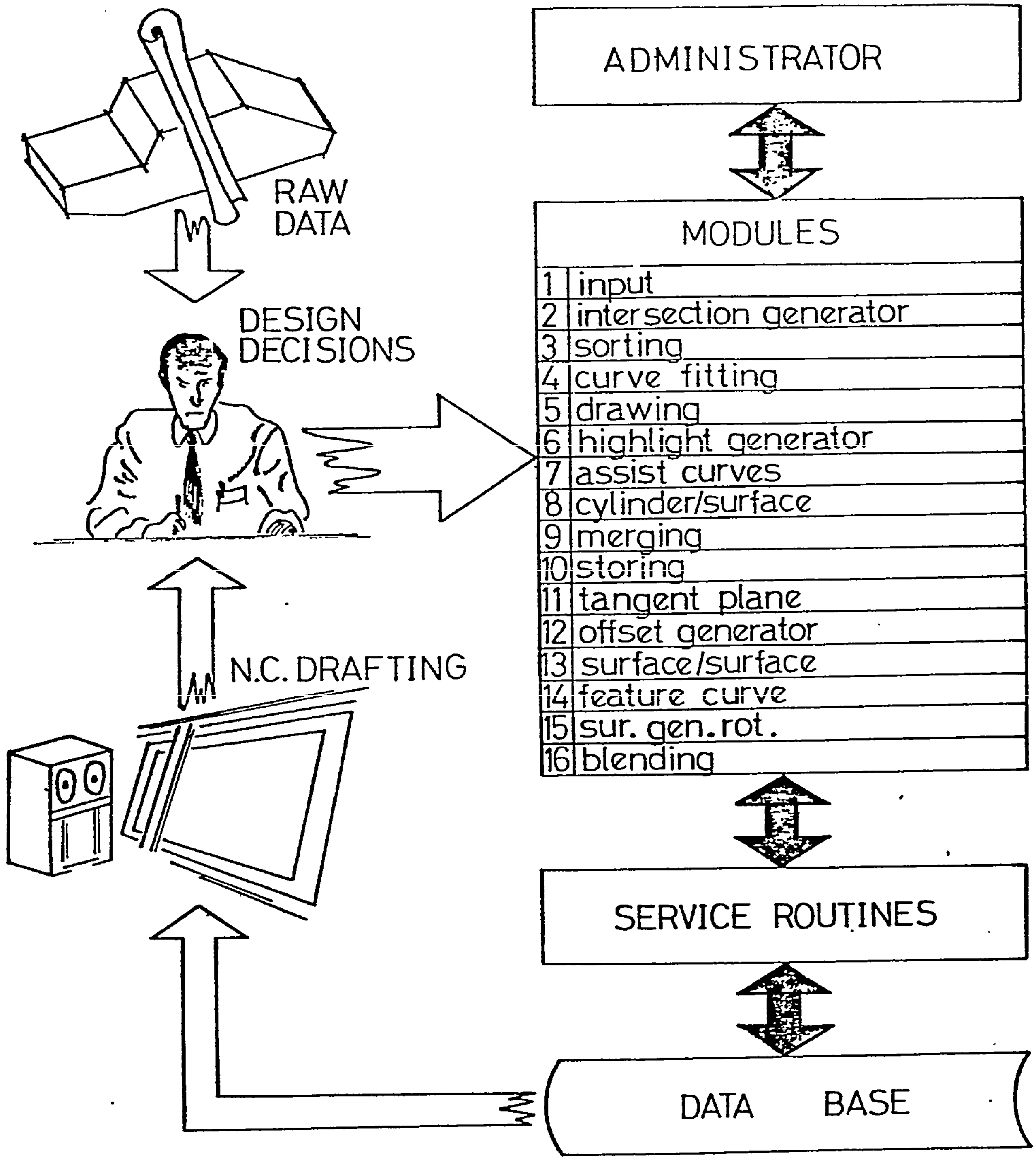
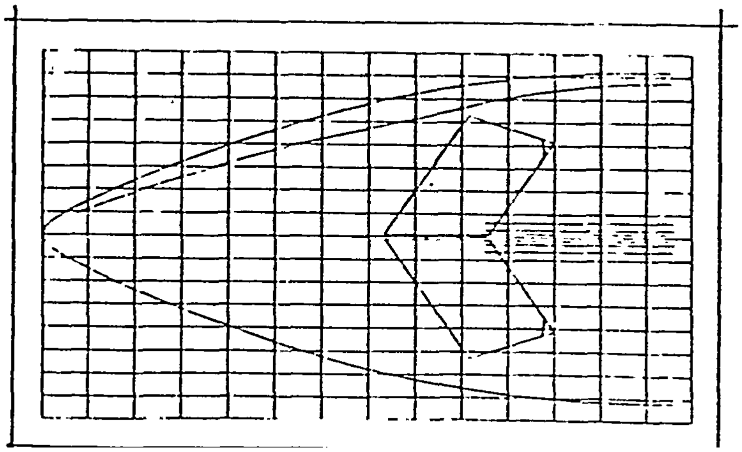
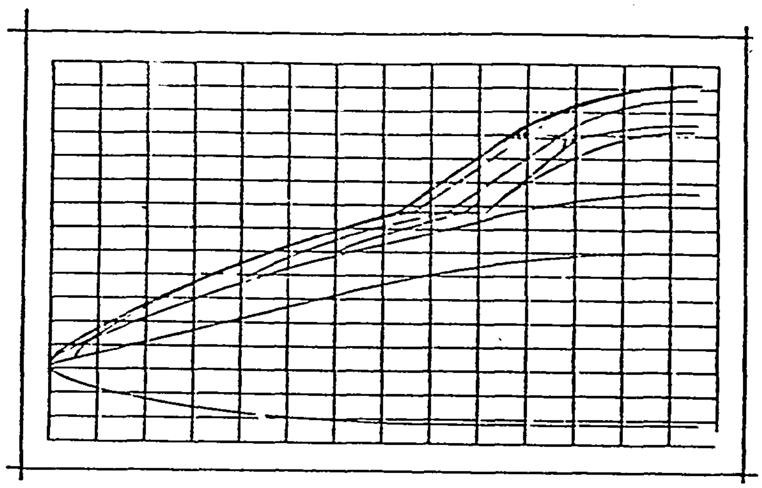


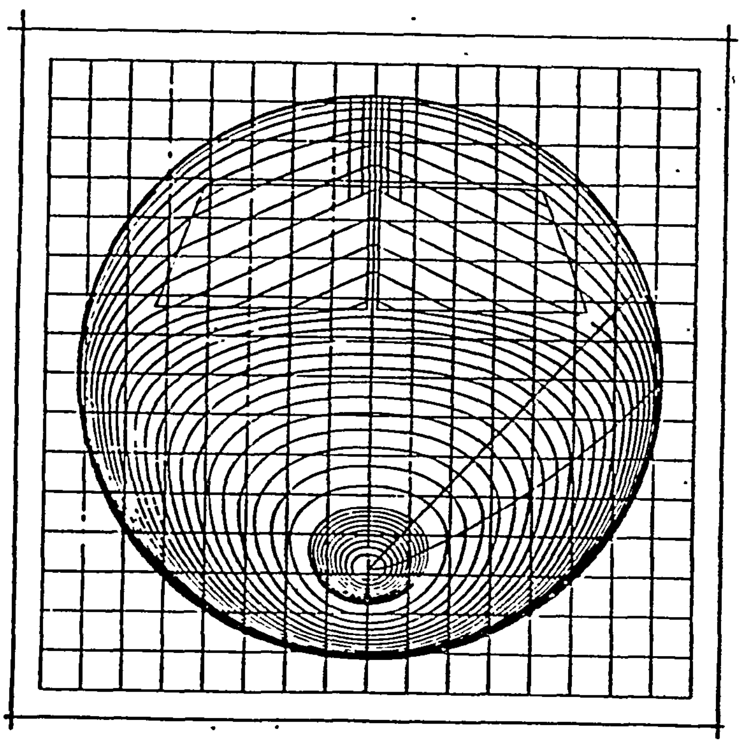
EXHIBIT 5

The BOF surface definition system. Layout of system functions.

EXHIBIT 6

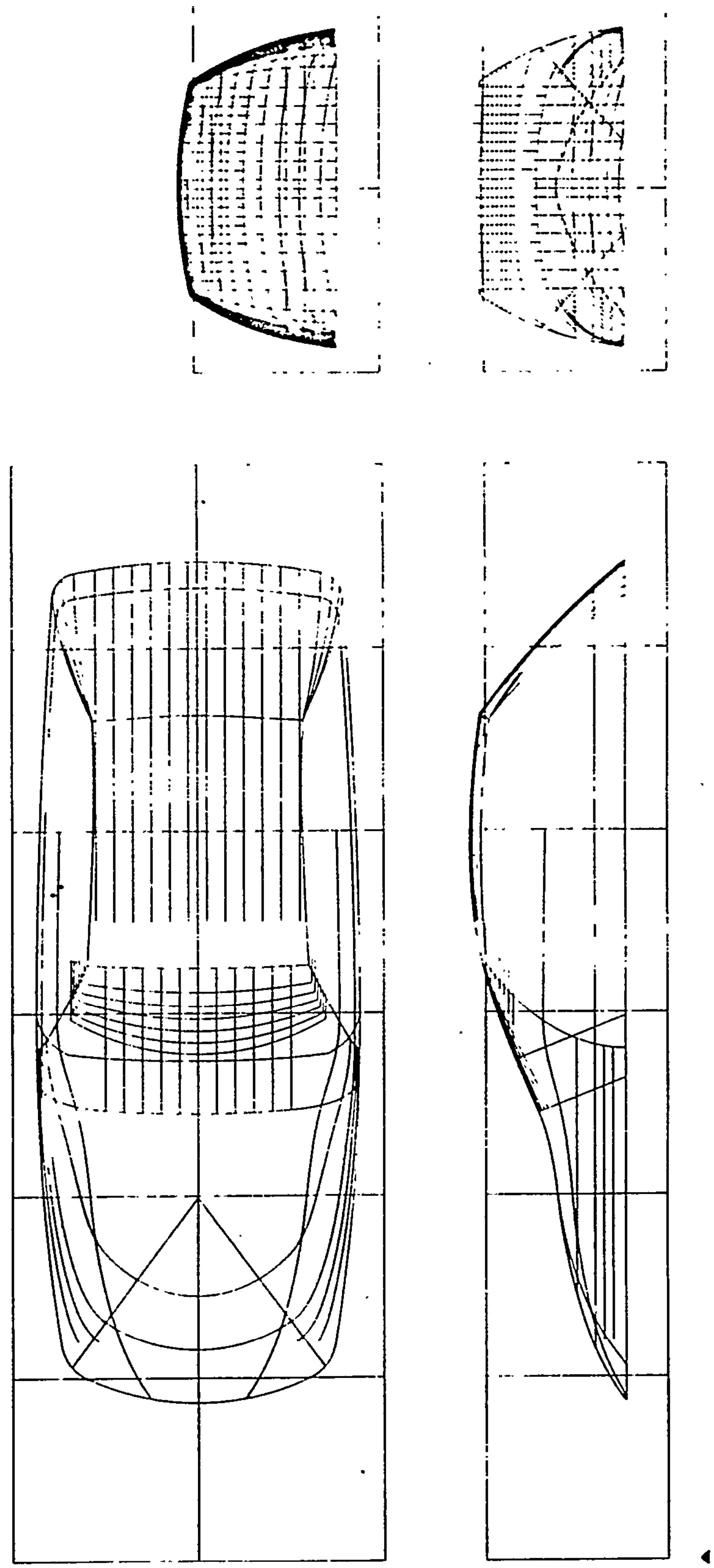




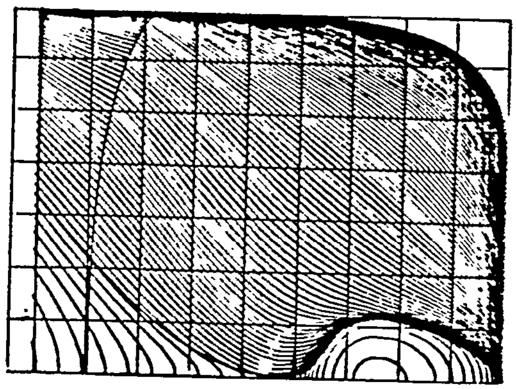


The BOF surface definition system. Extract of results from aircraft application.

EXHIBIT 7

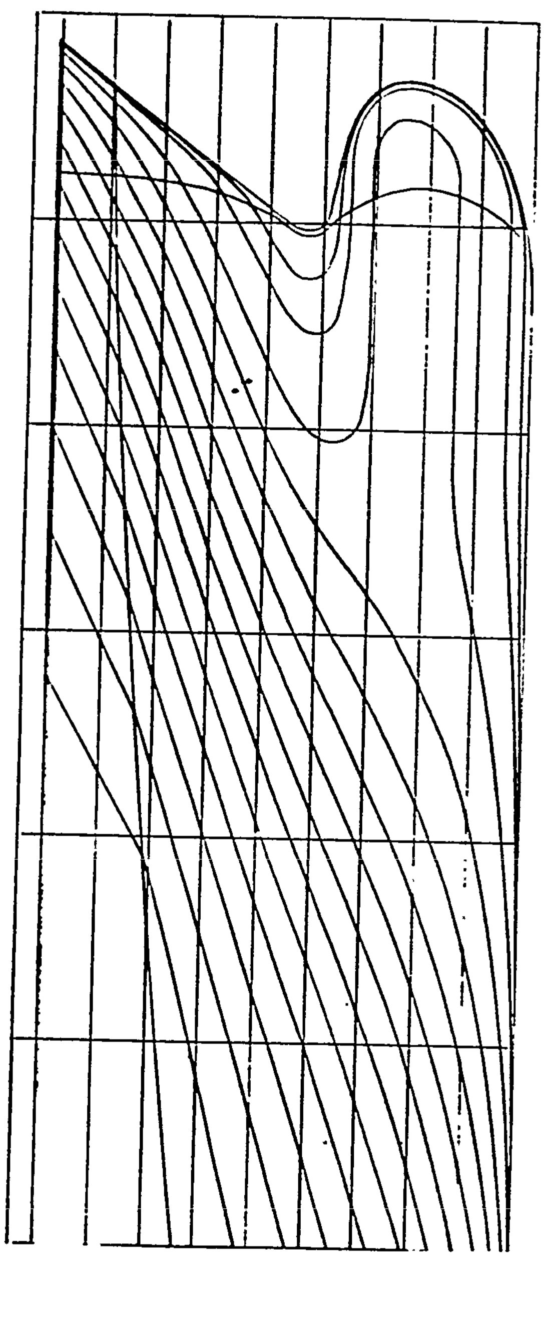


The BOF surface definition system. Extract of results from an automotive application.



The BOF surface definition system.
Lines plan from shipbuilding application.

EXHIBIT 8



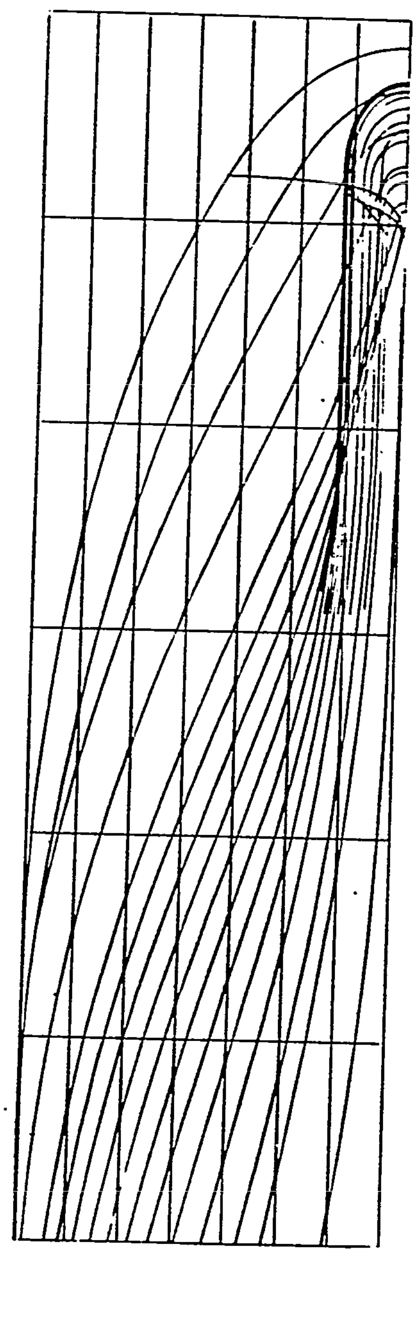
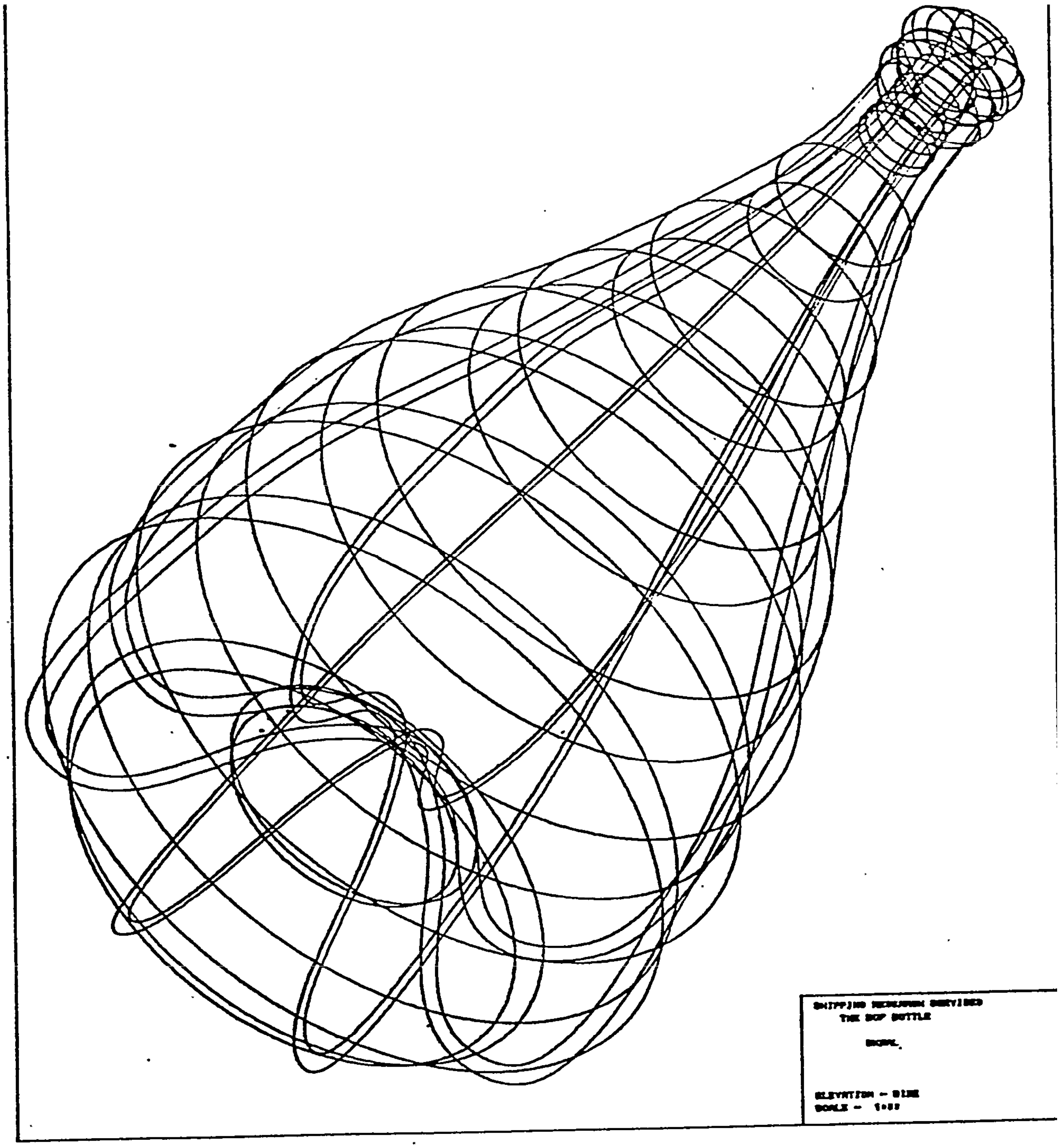
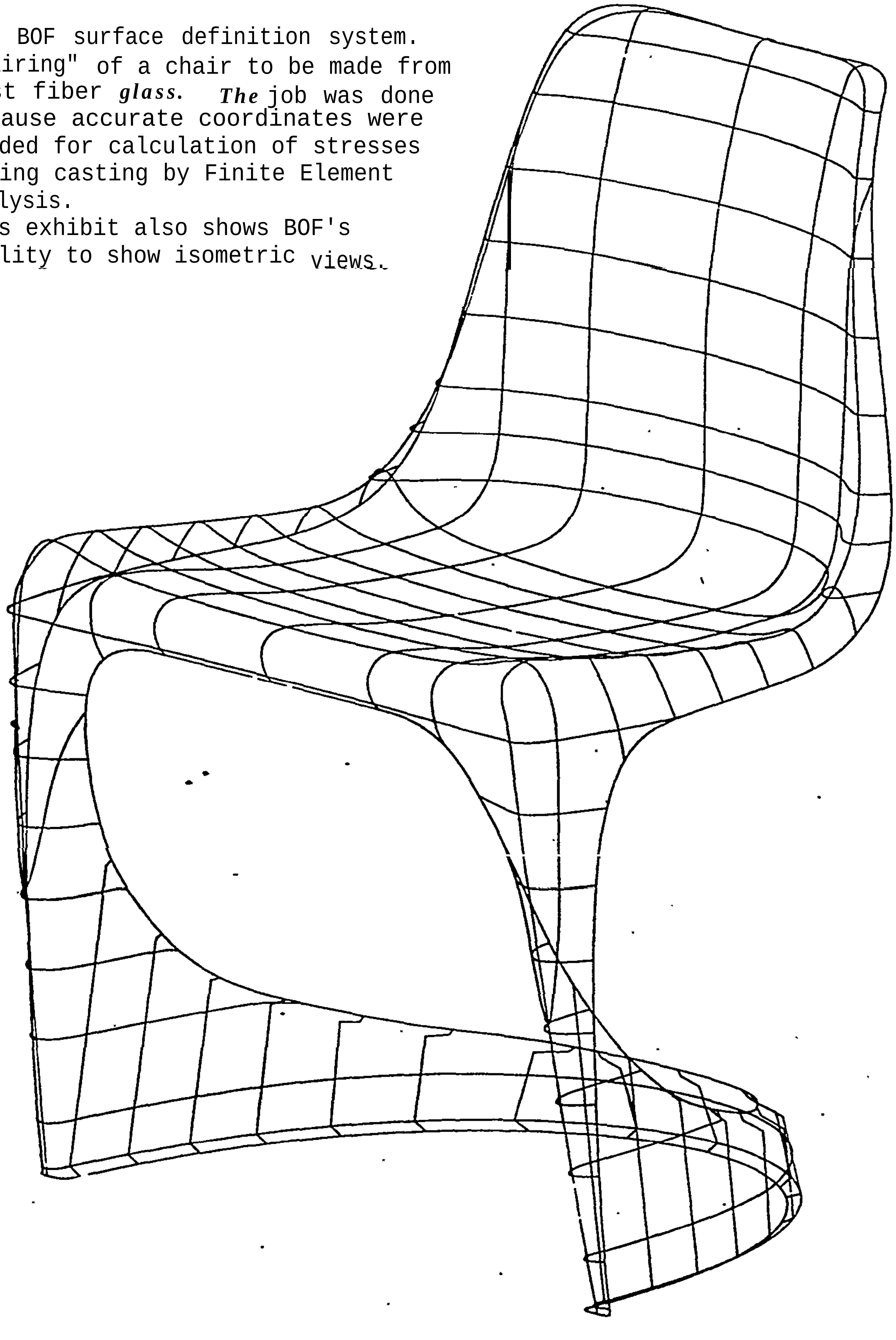


EXHIBIT 9

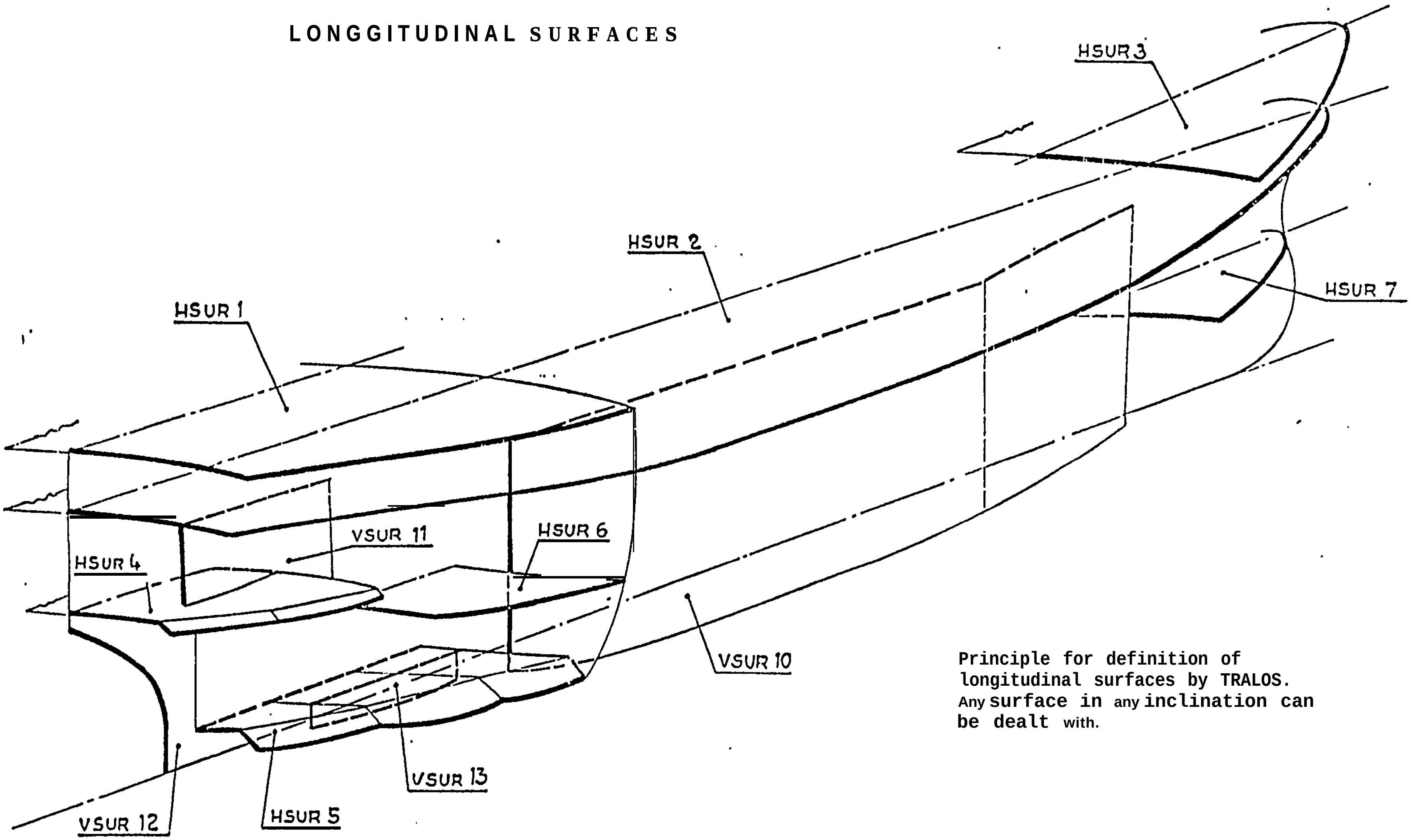


The BOF surface definition system. The bottle surface is defined by rotation of a profile curve.

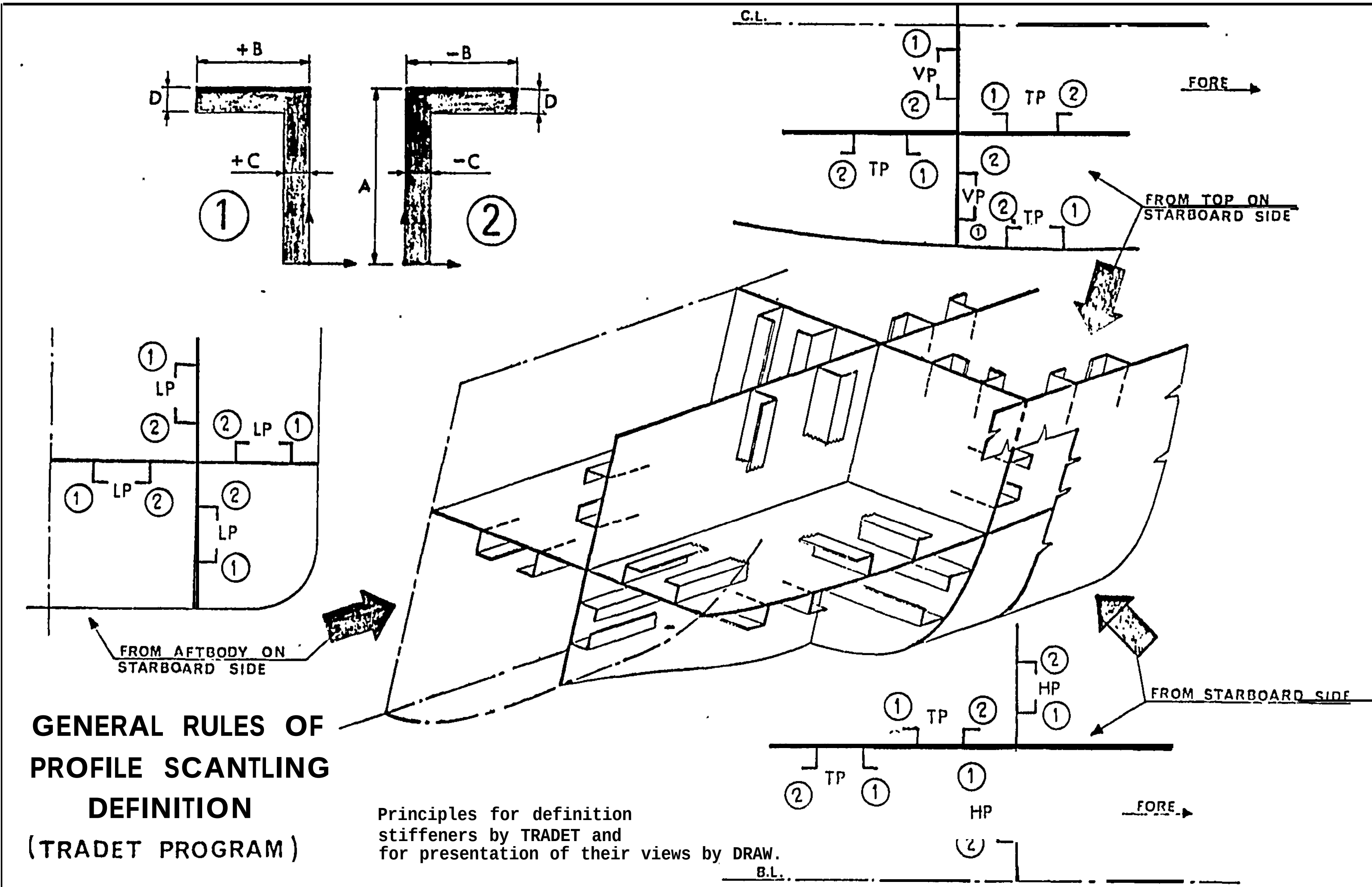
The BOF surface definition system. "Fairing" of a chair to be made from cast fiber glass. The job was done because accurate coordinates were needed for calculation of stresses during casting by Finite Element Analysis.
This exhibit also shows BOF's ability to show isometric views.



LONGGITUDINAL SURFACES



Principle for definition of longitudinal surfaces by TRALOS. Any surface in any inclination can be dealt with.

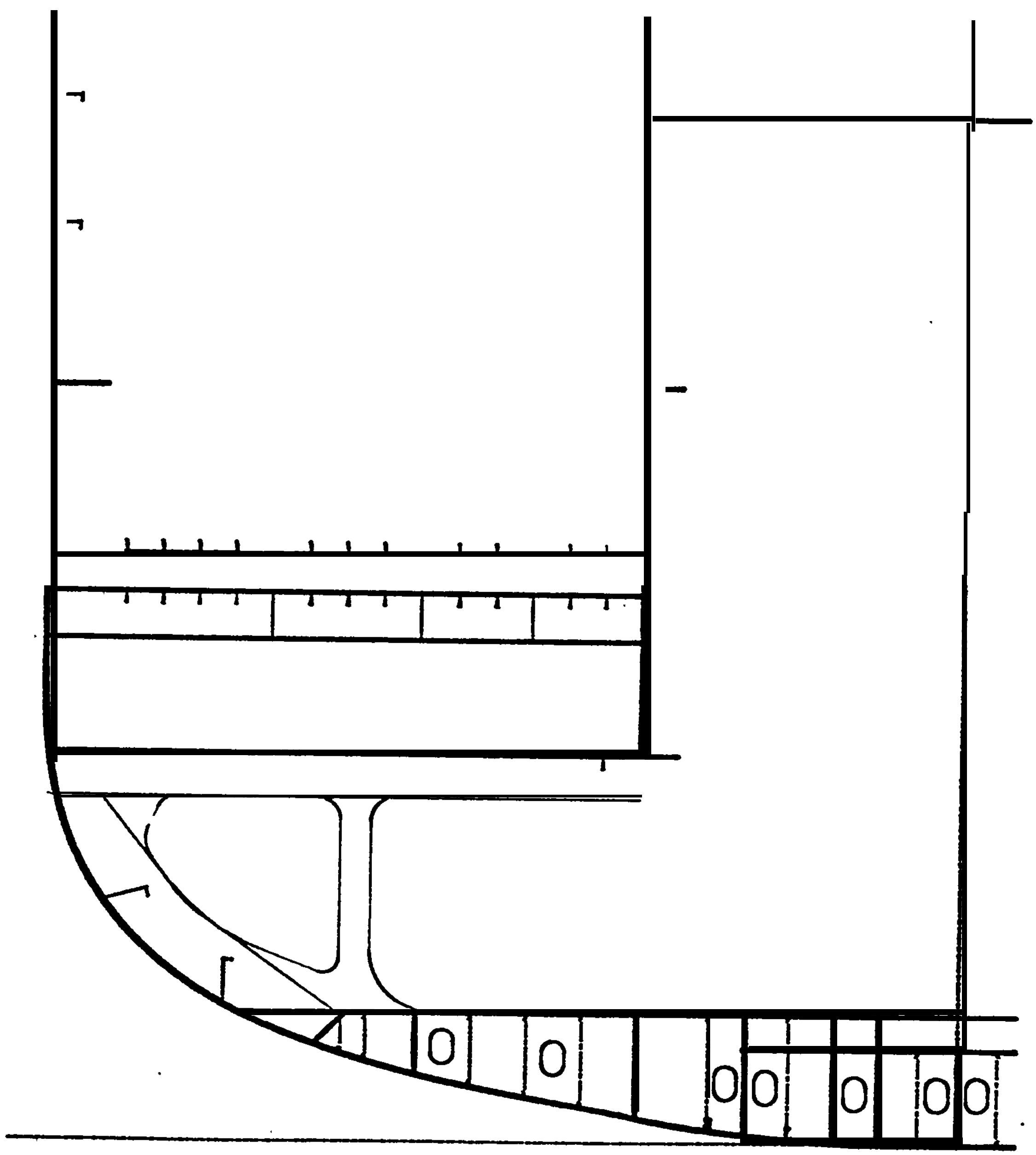


GENERAL RULES OF PROFILE SCANTLING DEFINITION
(TRADET PROGRAM)

Principles for definition
stiffeners by TRADET and
for presentation of their views by DRAW.

EXHIBIT 13

Transverse scantling drawing generated by DRAW based on data loaded by TRALOS and TRADET. Free web frame countours and manholes are based on ALKON data.



A transverse bulkhead drawing generated by DRAW for TRALOS and TRADET data, on a Calconep platter, in the scale shown.

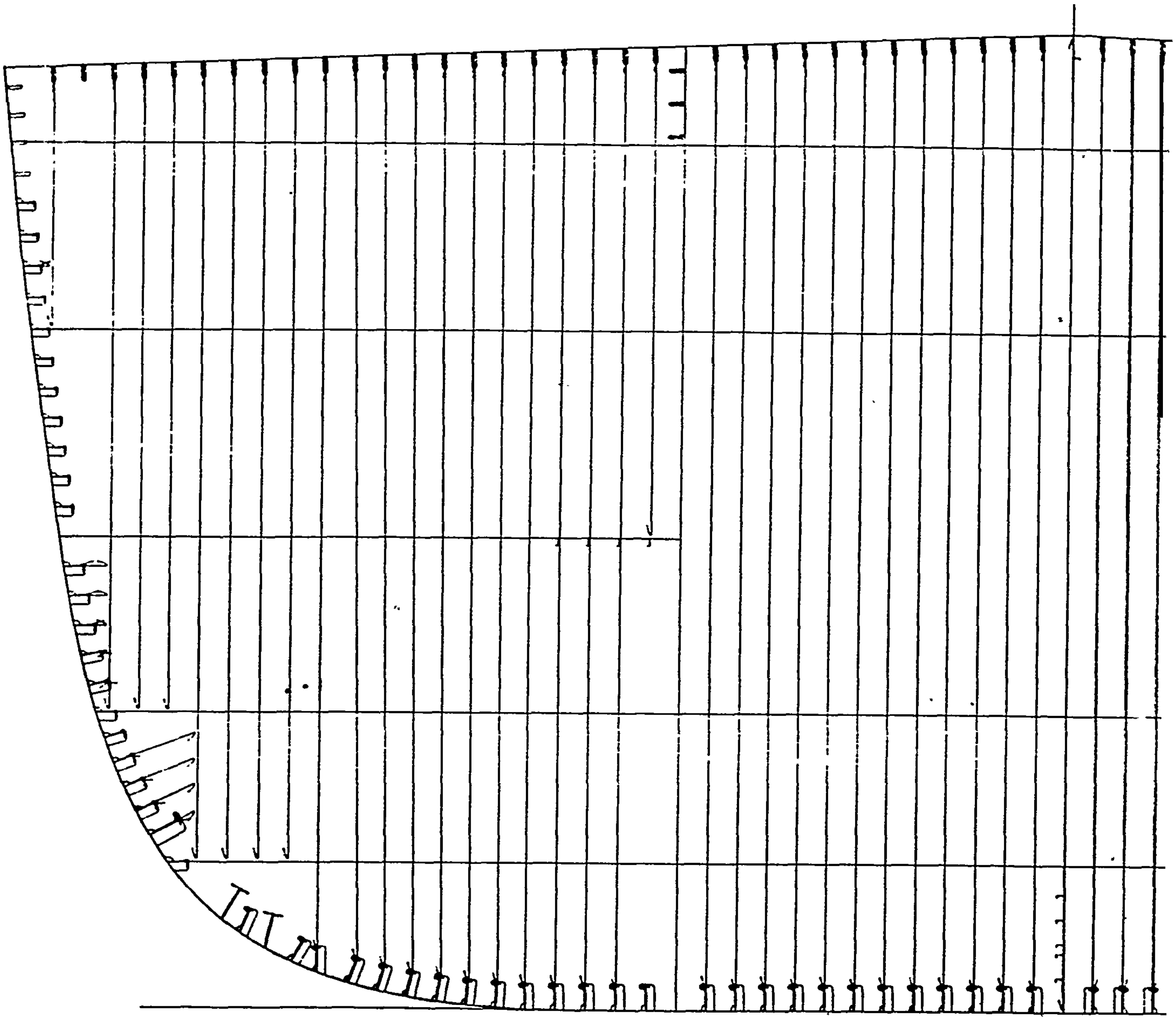
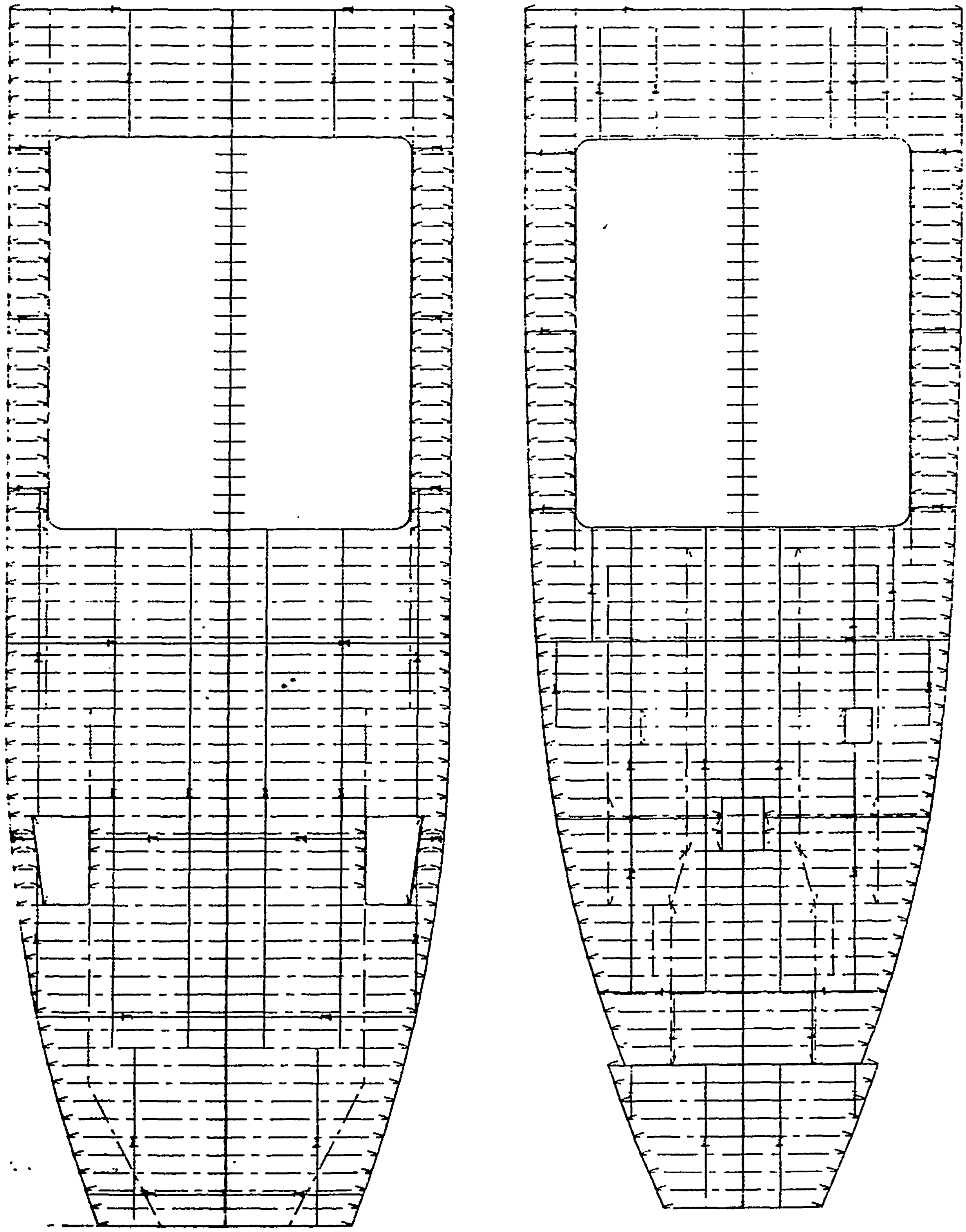


EXHIBIT 15

Structural plans of 2 decks generated by DRAW from TRALOS and TRADET data. All information on the drawings are generated automatically.



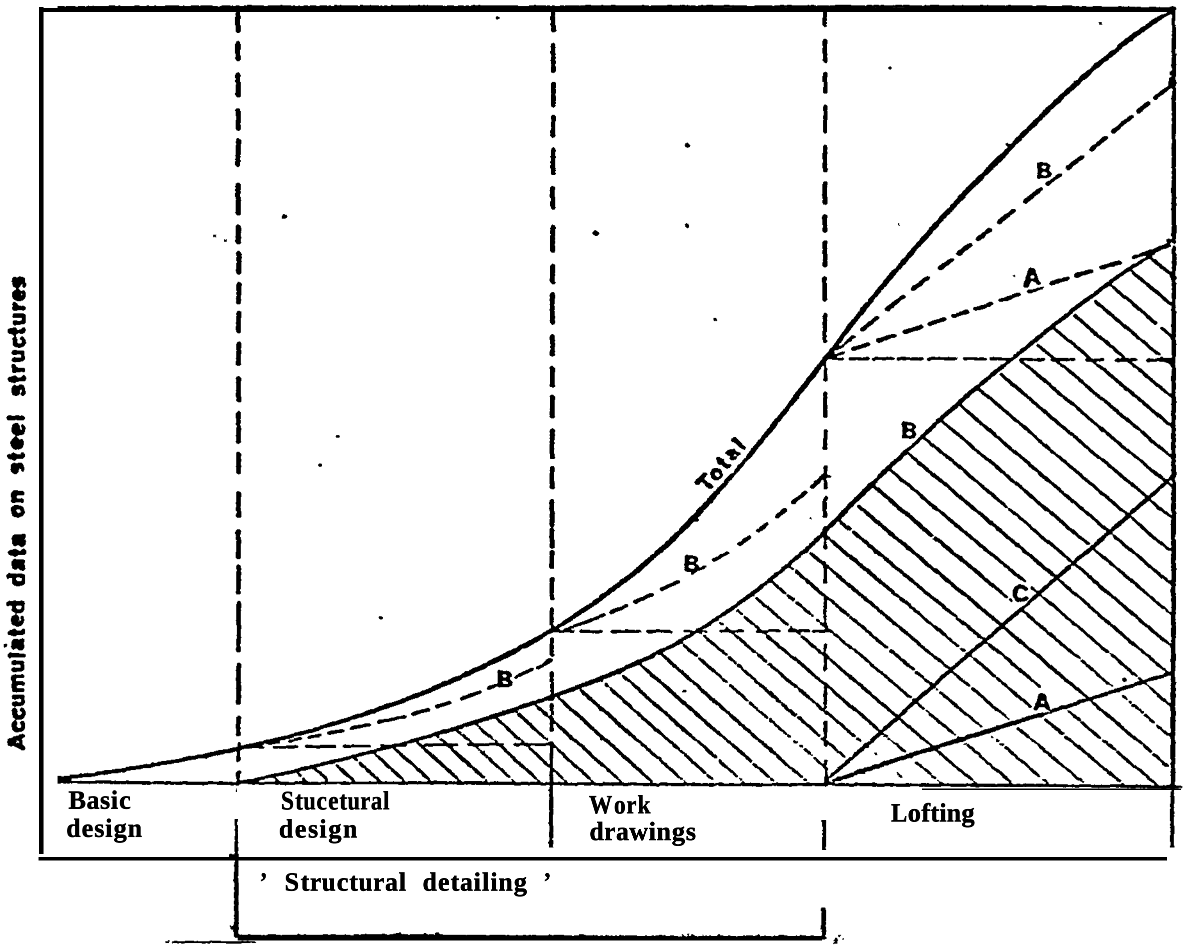


EXHIBIT 16

This diagram (which-has no scale) symbolizes - the.accumulated growth of data generated as consequence of an increasing degree of detailing of steel structures down stream from early design to production. Note that in the AUTOKON context "structural detailing" indluces both structural design and work-drawings.

The curve "total" represent the total amount of data to be generated, the other curves the "share" of these data processed by AUTOKON. The dotted lines indicate the extent of computer processing in each "department". The full lines are resulting accumulated curves.

A - using AUTOKON for traditional lofting (part coding and nesting of plates).

B - integrated use of AUTOKON-79 starting as early as possible.

C - using AUTOKON-79 purely for lofting.

The curves may also be regarded to represent: number of drawings and man hours.

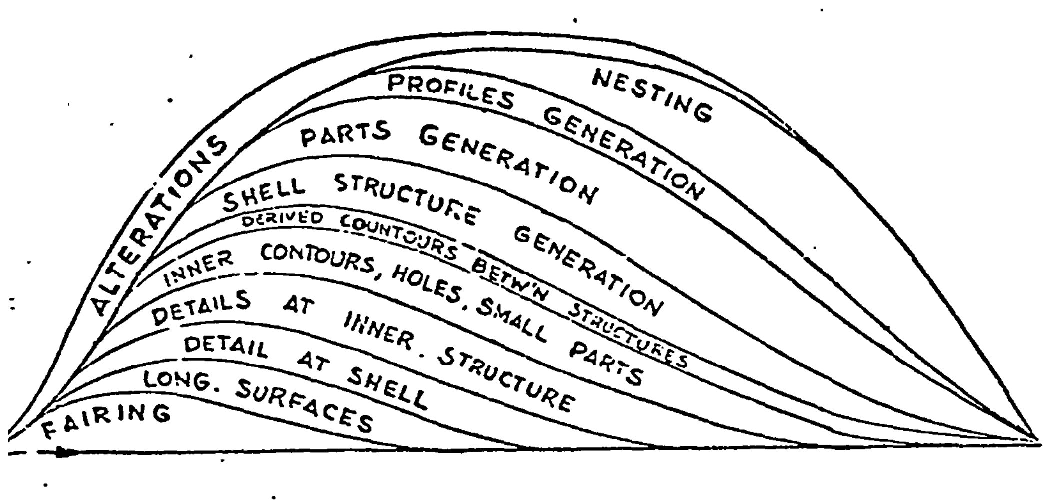


EXHIBIT. 17

This diagram indicates how the various AUTOKON-'79 tasks may be prepared in parallell, irrespective of the fact that the various system modules are processed in a certain sequence. The resulting curve is an expression of work load as function of time.

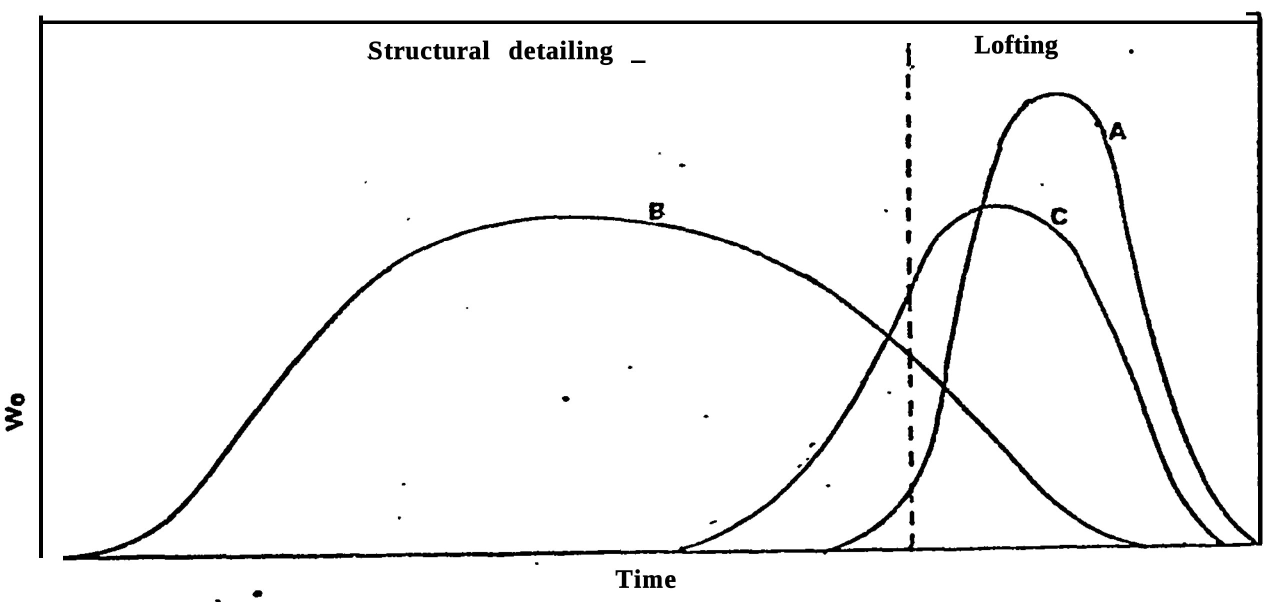


EXHIBIT 18

The curves .A), B) and c) symbolized AUTOKON work load as function bf time, corresponding to the alternative use of AUTOKON as shown in fig. 2. Use of AUTOKON-79 means shift of work, smoothing of peak load and reduction of lead time. The change of pattern from 'A) to B) is striking.

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