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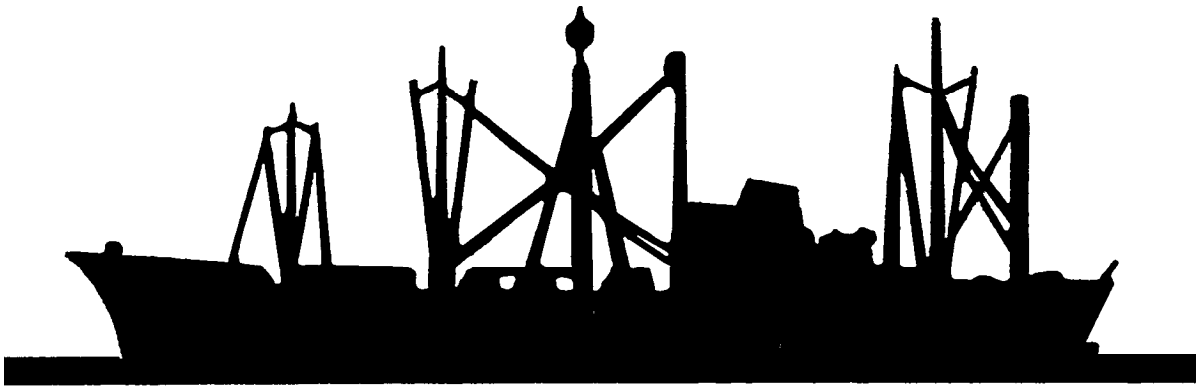

INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

IREAPS

THE AUTOFIT CAD/CAM SYSTEM FOR PIPING ENGINEERING: OPERATIONAL EXPERIENCE AND DEVELOPMENT STATUS

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ABSTRACT

AUTOFIT is built up around a main database that includes all information necessary for piping design and detail engineering. The system is also prepared to interface other tasks and functions as: analyses, planning, shop automation and including other engineering disciplines (steel structuring, material control, purchasing, quality control).

AUTOFIT meets the modern needs for communication through a flexible command processor. Here the user can choose his own user interface such as language, screen configuration, several ways of giving input, or degree of interaction.

1. INTRODUCTION

AUTOFIT is an abbreviation for 0UTOmatted outFITting and the name of a computerbased technical information system for piping engineering.

The system is partly in use and under development and will finaly cover the total piping engineering disipline, from system schematics (P&I-diagrams), via Layout(Arrangements) to generation of production information (Isometric drawings e.t.c.) .

2. THE PEOPLE e. EHINE) THE SYSTEM

The idea of AUTOFIT was created in machinery departments in the 'AKER GROUP OF SHIPBUILDERS AND OFFSHORE CONTRACTORS' in the middle of the 1970's.

Sinse the Aker Group allready was involved in successful system development through a joint-venture between several research institutiones in Norway(SIAG) , nothing was more natural than starting the development of this new system for piping engineering.

3. THE AUTOFIT C0NCEPT

AUTOFIT is estabished on a product module for the total piping engineering disipline and built around a main database that includes all informations necessary for piping design and detail engineering.

The system is also prepared to interface other tasks and functions as: analyses,planning, shop automation and not to forget other engineering disiplines(steel structuring, material control, purchasing, qua1ity control).

It is very important to mention that AUTOFIT is made to gain not on1y the ship problem, but also the more complex nature of petrochemical and chemical plants whether onshore and offshore.

AUTOFIT meets the modern needs for communication through a flexible command prosessor. Here the User can choose his own user interface such as language, screenconfiguration, several ways of giving input, degree of interaction e.t.c.

4. THE AUTOFIT SUE SYSTSTEMS

Figure 1 shows the major tasks involved in the total process of piping design and production engineering, including material take-off.

Done in the conventional way, these tasks may be devided into three rather logical phases:

- functional desisn resulting in a P&I diagram with all assosiated information in the form of drawings, lists, E.t.c.

- lay-out design using either orthogonal arrangement drawings or building a small scale physical model, both visualizing the final arrangement

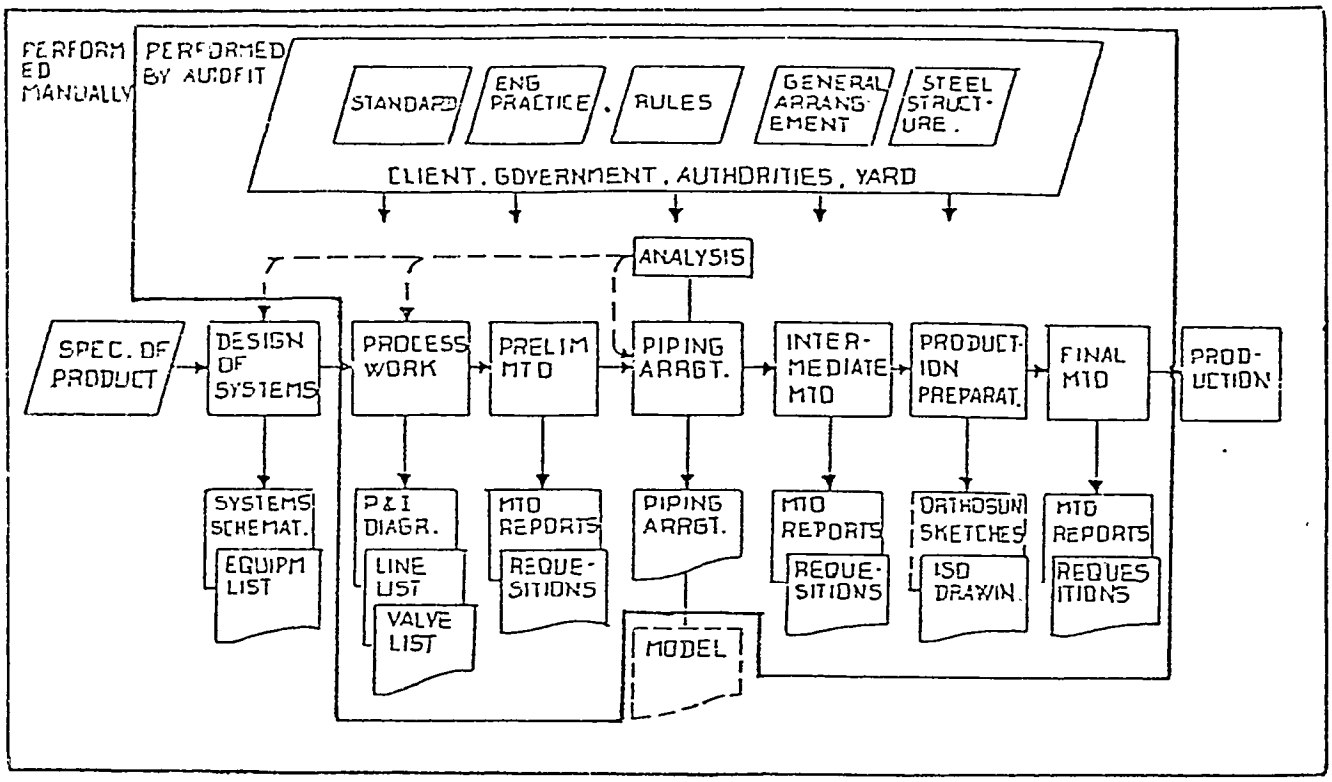

Fig. 1. Process diagram for the total engineering

- Both phases involves a variety of calculations and analyses.

- preparation of work shop documentation such as isometrics, piece drawings, material lists, e.t.c.

In-I parallel with these tasks, the designer has to do material take off.

The figure indicates the tasks of conventional process which are included in the computerization. It appears that design of flow diagrams or system schematics are assumed to be done manually.

Figure 2 shows a general view of AUTOFIT, devided into main functions or sub- systems, which correspond very closely to the sub-division of work just described.

- DIAGRAM - contains all functions up to comlete P&I diagrams with assosiated information. The subsystem will also build a topological flow-structure in the database.

- LAYOUT - contains functions for arranging eqipments and pipelines. The sub-system will store geometry data in the database and generate arrangement drawings and views.

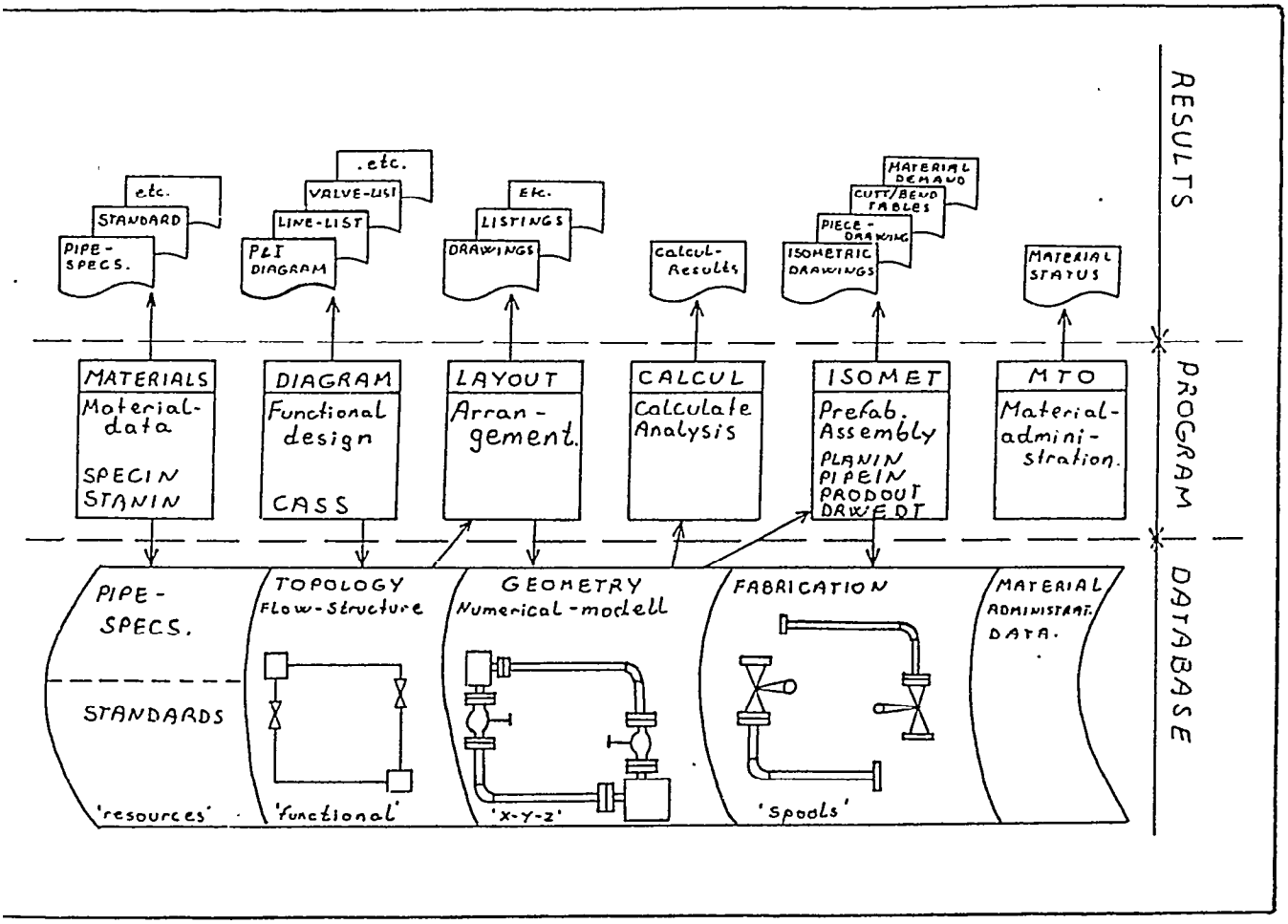

Fig. 2. AUTOFIT-sub-systems

- I SOMET - contains functions for specifying production information and generating production documents such as isometric drawings, material lists e.t.c.

- CALCUL - interface between the product model and various calculation programs.

- MT0 - material administrator.

- MATERIALS- functions for handling of standards and pipe-specifications. I.e. preloading of inportent data to be utilized by the other sub-systems.

the subsystems are supposed to be integrated (with each other), i.e. one sub-system generate data to be used by the next. However, it is fully possible to use the subsystems individually as stand alone systems. ISOMET may then be used without going through the two previous phases, DIAGRAM and LAYOUT.

4.1. DIAGRAM

DIAGRAM is the name of *the* subsystem in AUTOFIT dealing with the making of P&I diagrams(schematics). The final version of this subsystem will, in addition to the drawing of diagrams, also build the nucieous of numerical prsduct model in the database for further use in the subsystems LAYOUT and ISOMET. DIAGRAM has been devided into these. modules.

- CASS - generate p&I diagram drawings
- GENBAS - based on the graphical representation made by CASS, this module will build the nucleous of product. model in the database.
- EQUIPIN- description of equipment in the database.
- TRANSP - too1 for calculating transport demand in the pipesystems. This is essential data for the dimentioning of pipes and armature.
- CADCON - calculation of pipe-dimensions and selection of standard pipes and fittings according to the pipe-specifications.
- CADARM - selection of armatur according to pipe-specification.
- INSTRM - definition of instrumentation to the database,

These modules are implemented as sets of commands under the command processor and thus occur as one executable program.

4.2. LAYOUT

This is the module of the AUTOFIT concept that handels the piping layout problemes. From the DIAGRAM module we get the piping design topology, that in LAYOUT can be expanded with space geometry.

In this new module we have not only converted the old drafting means as drawingboard and pencils, but also integrated completely new tools based on functional drafting design.

Through the introduction of computers we namely have got new design possibilities that will not be efficiently used by just copying traditional layout prosedures and methodes.

The main objects for LAYOUT is to GENERATE THE GEOMETRY of piping systems so that they can became as FUNCTIONAL AS POSSIBLE, EASY TO BUILD with a MINIMUM OF MATERIAL COSTS and a MINIMUM OF DESIGNHOURS AND TIME.

Starting with these global objects, the design process was structured, more specific objects were formed, and boundaries were taken into ccnsideration. The mapping process from the objects to the new consept will not be discussed here. I will just mention some of the objects and boundaries:

- The layout module shall be able to use the informatinon generated by DIAGRAM.
- The LAYOUT module shall be able to generate all the geometry for a piping system.
- The LAYOUT module shall generate necessary information for ISOMET .
- The LAYOUT module can be used independently of the other AUTOFIT modules.
- LAYOUT shall handle a dynamic information process from estimated to exact information.
- It must be possible to use the system independently of the time when the different information is available.
- The design process must be structured into tasks, in which the designer, with help of the system, has the fully view.
- -The easiest way of producing a piping system shall be the easiest way of designing it.
- The easiest way of designing a piping-system shall ensure low material costs.
- Functional, operative and safety requires must easily be taken care of in ehe layout process.
- Many designers shall be able to work with the same project.
- All decisions shall be taken by the designer, or if he/she desides, by the system.
- The input information shall be a minimum.
- The input information shall be given to the system with a minimum of time.
- The input information shall be given into the system in the same form as it is available for the designer
- The structuring of the design process shall ensure an optimum solution, and each task shall be optimalized within the boundaries of the structure.
- Every stage in the design process shall be faster using LAYOUT than a 3-D model or a drawingboard. -np;If wanted, it shall be possible to take out parts of a project and handel them manually.
- It must be possible to change all kinds of information.
- Change of information shall influence on a minimum of the designed system.

- It must be possible to create alternative solutions in all steps in the layout process with a minimum of efforts.
- The designed piping system shall be without inteference between pipes, instrumentation and surroundings.
- The LAYOUT-module shall produce the following output:

  i) geometric information to ISOMET. block model drawings.
  ii) other information for building block model.
  iii) arrangement drawings in projections or isometrics with desired degree of detailing.
  iv) information for building 3-D detailed model
  v) information to the material take-off system at every topical stage with estimated or exact data.

- LAYOUT shall use the same hardware configuration as the other AUTOFIT modules.
- The first version of the LAYOUT module shall be ready within a year.

The new LAYOUT concept is allready satisfying most of these objects, and by furthur derailing with assistance from a group of designers we hope to satisfy the rest within a year. The consept has ensured that the need of computer programs is realistic. Having worked with functions long enough in the design process, we realised that most of these could be coverd by using existing programs in a new way and in new combinations.

The main sub-modules of the LAYOUT module are:

4.2.1. STRUCTURING MODULE

TAKING THE COMPONENTS, PIPLINE TOPOLOGY AND DIMENSIONS from DIAGRAM, the designer is able to create alternatives for the structuring and choosing the best from analyses for each of them. This module is allready on the market.

4.2.2. GENERATING OF SURRONDINGS

The surroundings of the piping structure must be brought into the database in an efficient way.
The new drafting modules in the AUTOCON-system, AUTOPART/AUTODRAW, will care for most of these functions.

4.2.3. GENERATING OF COMPONENTS

This module consists of methodes for transfering manufacturers data into a 3-D database.
Digitizing tecnics and a 3-D grafic component generator will here be used

4.2.4. LAYOUT AND ROUTING

Almost the same programs that are mentioned before will be used in this matter.

4.2.5. INTEFERENCE CONTROL

All kinds of mathematical and visible control has to be available.

4.3. ISOMET

ISOMET is the name of the subsystem in AUTOFIT dealing with the generation of production information, such as:

Isometric drawings.
i) Material summaries.
ii) Cutting and bending information.
iii) Pipe sketches.

In the total AUTOFIT concept this sub-system will use the information stored in the product model by the previous subsystems DIAGRAM and LAYOUT. However, ISOMET may also be operated as a stand-alone-system. The description of pipe-lines will then have to be lifted from drawings or a physical model and fed *into* the database. A first version om has existed for some years and been used in some projects for generating of isometric drawings. This version is basically batch oriented and runs on a UNIVAC computer. The next version will be ready for piloting during this summer. It will be interactive and running on a local computer. The folloving will be a description of this new version.
The sub-system will consist of five modules: SYMIN, PLANIN, PIPEIN, PRODOUT and DRWEDT(fig.)

- SYMIN is a program for defining drawing symbols in the database. The symbols may be rotated and sheared in order to be used directly in the making of isometric drawings.
- PLANIN is a program for definition of reference planes,lines and points. These data are used in the PIPEIN program for positioning items relative in space.
- PIPEIN is the program for defining pipelines if ISOMET is operated as a stand-alone-system or for adding production information to the pipelines defined in LAYOUT. The program will build datastructures which is able to hold complex pipe-structures.The commands available for manipulating pipelines may be grouped as follows:

  i) Administration of SYSTEM, LINE and SPOOL.
  ii) Selecting items according to pipe-specifications and standards.
  iii) Positioning of items geometrically.
  iv) Manipulating default values.
  v) Adding special data to items.

vi) Positioning along pipeline to make updatings.
vii) Controlling the screen picture if in graphical mode.
viii) Establishing relative references(in branches,etc.)
ix) Establishing production units(spools).
x) Displaying various informations from the database.
xi) General commands for preceding in manuscripts. etc.

- The data stored by PIPEIN will contain position of all items, length of all pipes and bending angels of all items requirering change in directions.

- PRODOUT is the program for extracting data from the datastructure made by PIPEIN and produce various production information. The program will have commands for (fig. ss):

i) Administering drawings:define,delete, etc.
ii) Administering drawing contents: adding/removing information in drawings.
iii) Generating of production information according to defined drawings: isometric drawing, material lists, etc.
iv) Certain abilities to influence on the graphical picture: measurments, shading, texts, etc.

- The definition of the drawing(drawing content) will be stored on separate files and will later be modified and used to generate new output.
- The grafical and tabulary output may be stored on files for later manipulation by the program DRWEDT.
- DRWEDT is a general program for editing of drawings. In ISOMET it will perform the following tasks.

1) Make “cosmetic” changes to the pictures made by PRODOUT in order to make the drawing clearer.
ii) Merge the graphical part of the drawing with the material list and drawing frame in order to make a complete drawing.

- The program is totally interactive and is operated via a graphical screen.
- The final result may look like the drawing shown on fig. ss.

- MATERIALS. Pipelines consists , to a large extent, of prefabricated items;, such as elbows: tees, valves, reducers,gaskets,etc. Each of these different item types have their own properties and for each type a variety of sizes exists. To store and maintain information about all these articals the program STANIN has been made. Data is stored in standard headings and dimension tables.

- The heading contains general information about a standard and the dimension tables contains the geometric data about the various sizes within a standard. Due to the different properties of the item types, nine types of dimension tables has been defined. One dimension table may be shared between several standard headings and thus saving work in definition and saving space in the database.
- In order to control the selection of standards for a particular pipe-system in a project, a pipe-specification program is made. The use piping specifications is commonly used in the oil/offshore industry, but not commonly used in shipbuilding. From the specification the engineerer will decide which standard to be used when selecting material. To store and maintain pipe-specifications in AUTOFIT the program SPECIN has been developed.
- The main reason for these two programs (STANIN and SPECIN) is to automate the selection of material in the subsystem DIAGRAM . LAYOUT and ISOMET. However the programs may stand alone and thus be useful in systemating material data, providing material cataloges(STANIN), piping-specification-drawings and documents(SPECIN).

5. DEVELOPMENT STATUS

In addition to what is mention allready I will give a short summary of the developing status for each of the AUTOFIT subsystems:

- DIAGRAM exist in its first version and is planned to be completely finished in the beginning of 1982.
- LAYOUT is under development. Piloting of the first version will start within a year.
- ISOMET exists in its first version and is running into production for several yardnumbers in the Aker Group. A new version is ready for piloting,
- CALCULE which is the name of the interface between the database and certan calculating programs(f.ex. stress analyses, has to be adapted to the type of calculation program you are linking up to.
- MTO that takes care of material control matters is runned by the material 'administration program MAPLIS, that is another SIAG development. MAPLIS is today in full I production in all yards in the Aker Goup.
- MATERIALS (STANDARDS AND SPESIFICATIONS) are ready and in production.

6. OPERATIONAL EXPERIENCE AND-USER'S NEED

Submodules of the AUTOFIT concept have been taken into production as stand-alone versions on several yardnumbers in the AKER GROUP
I myself started out piloting the ISOMET module in 1977. The year after this system was used in regular production, first 0n the machinery room of a boat for the Norwegian Navies Coast Guard and later on a Production Compression Platform for the Valhall field in the North Sea. I mention these two projects because I know them very well beeing in charge of them as project leader.
Even though the piping problem for a ship and a offshore plant should be very much the same, we all know from experience that they are very different when it comes to administration, and this then influence the engineering procedures.
Let me just mention some subjects that. may indicate this:

i) different needs and rules for project control
ii) different need of spesifications
iii) different need of documenting the work
iv) different procedures for approving design and production documents.
v) different ways to enforce design decisions

When implementing a computer tool in solving the piping problem we must choose or develop a system that handles all these different needs and ways, and that is able to be adjusted and expanded with very little effort.
The main case 1 would like to mention when judging a new piping design system, is the systems possibilities to handle the increasing range of new revisiones and changes in the piping structure.
we hope that the new version of the ISOMET module of the AUTOFIT consept is going to handle this very well, espesially because it is developed just to take care of this problem.

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