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Selection and Implementation of a CAD/Software System for Navigator Boats

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SELECTION AND IMPLEMENTATION OF A CAD/SOFTWARE SYSTEM FOR NAVIGATOR BOATS

DESIGN PROPOSAL

Prepared for:

ISE428 Systems Analysis and Design I
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Brian J. Finzel

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1.0 INTRODUCTION

1.1 Company Description

Navigator Boats Inc. manufactures boats in Elmore, Alabama, which is about fifteen miles north of Montgomery. Mike Bonner, president of Navigator Boats, has assembled a team of industry experts which represent more than 100 years of engineering and construction experience. In addition, Mike and his team have built their boats based upon the Coast Guard certified fiberglass hull design, which is becoming a standard in the boat industry. Navigator Boats currently builds yachts, commercial fishing boats, passenger speed boats, and work boats. Navigator employs about 80 employees, has one assembly line, and builds boats up to 60 feet long.

1.2 Company History

Mike Bonner has over fifteen years of experience in the boat manufacturing industry. In addition, he has been a respected leader in the commercial fishing and passenger speed boat industry for over five years.

1.3 Problem Background

Navigator Boats presently can sell more boats than it is capable of manufacturing. Navigator Boats is looking to expand and would like to begin building boats over 100 feet long (about twice their present capability) -- Navigator wishes to add an extra assembly line, doubling their number of employees. However, there is one severe limitation which restricts the growth of Navigator Boats -- Navigator currently performs the entire design process manually with no CAD system. Not only is the design process lengthy, but so are design changes; in several hours, a CAD system could make design changes which presently take several days. In addition, Navigator performs test runs on "custom ordered" boats and an unsuccessful test run may cost Navigator several tens of thousands of dollars -- unsuccessful runs can require more engineering work, a re-distribution of the boat (ie. engine is moved back several feet), and much more time. A CAD system with weight distribution analysis can prevent nearly all unsuccessful test runs. Additionally, Navigator Boats would like to experiment with hull and boat design changes which are presently infeasible, but should become feasible within a CAD system. Finally, Navigator realizes that its future competitiveness hinges on a mastery of technology -- with CAD at the forefront.

1.4 Search For Current Solutions

Most of the other boat manufacturers (which build boats similar to Navigator's) design their boats through a PC CAD system. PC CAD systems are presently the low-investment alternative for the average boat manufacturer. PC CAD systems now have virtually all the capabilities of mainframe CAD systems for only a fraction of the price. However, fully integrated mainframe CAD systems are becoming more available and are significantly cheaper than in the recent past.

2.0 OBJECTIVE

2.1 Problem Statement

Navigator Boats needs a complete CAD system for designing its boats. This system must include 3-dimensional capabilities in hull and boat design. The system should include capabilities in hydrostatics, weight distribution simulation, piping design, wiring design, and HVAC design. In addition, this system must be integrated properly to produce an effective boat design system. Alabama Industrial Development Training (AIDT) is working with Navigator Boats to find a solution. AIDT is a state organization which is interested in helping Navigator to expand its manufacturing capabilities, hire more workers, and increase its overall competitiveness. Charlie Garrett of ACATT (Alabama Center for Advanced Technology Transfer -- a subsidiary of AIDT) is in charge of the project. He can be reached at (205) 461-7550; FAX: (205) 461-8153.

2.2 Design Objective

Navigator Boats needs an economicable CAD system to bring it technologically up to date. This CAD system must improve the efficiency and reliability of Navigator's design process. The main objective is to determine what CAD system combination (of software, hardware, etc.) will both suit the company's needs and provide the most economic benefit.

3.0 SCOPE OF WORK

3.1 Phase I - Gather Information on Software Products

3.1.1 Search for Software Companies

There are companies which specialize in boat design software and various supplemental design software (ie. wiring and electrical systems) -- the difficult task is finding these companies. First, boat design software companies were sought; unfortunately, a library search of boating magazines (such as *Boating* and *Motor Boating and Sailing*) turned up nothing. Next, software catalogs were searched; several companies which specialize in naval architecture were discovered in an Autocad software catalog. This catalog was then searched for companies which specialize in supplemental design software -- several companies which sell plant design and architectural design software were found. These companies sell individual software packages in piping, electrical, HVAC, and other design aspects. It was assumed that these supplemental software systems could be used in designing a yacht (which is basically a house on water).

3.1.2 Decision on Companies to Contact

There are only a few companies which specialize in boat design software; consequently, all of these companies were called. In contrast, there are many companies which sell supplemental software systems. Only those companies which specialize in a variety of products and sell adequate, low-priced software packages were called. Higher priced software packages are generally more complex and are targeted for sophisticated design purposes.

3.1.3 Contacting Software Companies

It is imperative that a company understands the needs of its customers, especially if it wishes to satisfy a customer's needs. Therefore, it was explained that Navigator Boats presently did not utilize a CAD system in the design of its boats, but that Navigator wished to do so. Furthermore, boat design software companies need to know the types of boats which Navigator builds. The other companies (selling supplemental software) need to know that Navigator has access to boat design software and may need additional software to design other aspects of the boat. After discussions with the salespeople, the software companies agreed to send literature explaining the capabilities of any of their pertinent software packages.

3.2 Phase II - Analyze Information From Software Companies

The following information was received from the software companies. There are a total of four companies which sent literature and a brief description of the pertinent software packages from each company is given. Navigator Boats needed a short, but complete synopsis of the available products.

Coastdesign, Inc. (Marine Software)

Coastdesign sells three lines of hull design and hydrostatics programs which are different in configuration, depending upon design and budget requirements. Coastdesign's hull design modules (AutoBOAT Enhanced, AutoYACHT, and AutoSHIP) offer many advantages over conventional CAD packages. All three programs feature 3D lines generation with automatic updates in all three orthographic views (ie. body, plan, and profile). Up to 120 stations (and an unlimited number of buttocks and waterlines) may be defined -- with up to 200 segments per curve. Other key features include:

* hull reduction normal to the surface (to account for skin thickness)
* transom definition and broken sheer lines
* simultaneous (and independent) display of all three views with or without hidden line removal
* display of Surface Normal and Gaussian curves (to aid in assessing "fairness" and "buildability" of a vessel)
* bow and stern rounding
* 1/2 angle of entrance and deadrise display
* curves of areas display
* multiple surfaces definition
* stretch and shrink functions
* output of offset tables in decimal feet or feet-inches-eighths
* output of preliminary hydrostatic characteristics
* export to third party CAD programs through 2D and 3D DXF files, where templates can be plotted for full scale lofting or NC tapes generated

Coastdesign's hydrostatics programs AutoHYDRO I, II, and III are Microsoft Windows based hydrostatics and stability analysis programs which read in geometry files created within AutoBOAT, AutoYACHT, or AutoSHIP, and support complete model definition (ie. tanks, compartments, and appendages). AutoSHIP Builder, Coastdesign's solid modeling program for ship production, is a Microsoft Windows based program used to create the internal structure of a vessel. Once a hull has been created using AutoSHIP, the hull can be read into AutoSHIP Builder where individual structural components can be created.

AutoBOAT

AutoBOAT is Coastdesign's entry level hull design program. It features a window pull-down menu, making a user-friendly interface. Some of its key features include the following:

* draws profile, plan, and body views of a hull on-screen
* tilt and rotate capability
* zoom and pan capability
* calculates all normal hydrostatics parameters
* develops cylindrical transoms at any angle
* links through to CAD programs such as Generic CAD, AutoSKETCH, and AutoCAD

AutoYACHT

AutoYACHT supports a variety of IBM compatible MS-DOS computers with many different graphics boards (including HI-RES boards) and various plotters. Master curves can be entered from the keyboard or a digitizing pad. Some of its key features include:

* all the capabilities of AutoBOAT
* draws profile, plan, and body views and any 3D views of the hull with hidden lines removed on screen or plotter
* automatically produces offset tables in feet-inches-eighths or decimals
* reduces hull size, normal to surface, for lofting purposes
* re-sizes hulls with stretch/shrink command

AutoSHIP

AutoSHIP is the world's most successful hull design and fairing program. It is very easy to use, yet full of features required by professional naval architects. Some of its key features include:

* all the capabilities of AutoBOAT and AutoYACHT
* extra high super resolution
* support for dual screen
* ability to generate up to 200 segments per curve
* shell expansion module
* hull shading
* display of surface curvatures
* input "target" section area curve
* geometry file editor allowing output of a GF file for working with AutoHYDRO
* WED - a dedicated weight editing program which permits 3D entry of weights, grouping, and a neat printout

* **Geometry File Editor**
  - edits hydrostatic files consisting of station offsets
  - allows visual editing with a 3D screen display or spreadsheet style text mode editing
  - input of station offsets from keyboard, digitizer, or AutoSHIP report
  - output in GF, DRA, or OFE format
* **AutoHYDRO I**
* **Shell Expansion Module**
  - produces 2D shell expansion drawings required for ABS, Lloyds or other classification societies
  - produces expansion along station lines
  - mapping of waterlines and buttocks to expansion
  - mapping of plane intersections
  - mapping of chines and rabbet line
  - generates a DRA file which can be plotted out or transferred to a CAD program

AutoHYDRO

AutoHYDRO is a Windows 3 based modern, fully interactive hydrostatics/stability analysis program specially developed to fulfill the designer's need for a fast, flexible, and reliable tool. It features an easy-to-use windows interface, a WYSIWYG (what you see is what you get) graphics screen, and an extensive use of menus, examples, and on-line help functions to make the system intuitive. AutoHYDRO is extremely powerful and can be used for all types of vessel configurations. It is designed to work with files created automatically using AutoSHIP, although input can be made through a keyboard or digitizer.

AutoHYDRO I

AutoHYDRO I is an intact stability program with built-in digitizing functions. It can read files from AutoBOAT, AutoYACHT, and AutoSHIP. Some of its capabilities include:

* calculates stability, displacement, and flotation parameters at any angle of heel, trim, or loading
* plots 0-180 degree stability curve on the plotter
* hydrostatics property tables
* righting arm tables including "dynamic stability"
* cross curves and curve on forms onto a printer
* U.S. or metric units

AutoHYDRO II

AutoHYDRO II includes capabilities such as:

* ability to set loads in tank
* perform damage stability calculations
* produce tank sounding tables
* calculate tank capacities
* spreadsheet style load editing
* ability to model up to 50 objects such as tanks, appendages (positive and negative), moonpools, thrusters, deckhouses, shafts, bulbs, sponson, rudders, superstructures, and other components

AutoHYDRO III

AutoHYDRO III includes capabilities such as:

* all the capabilities of AutoHYDRO I and II
* longitudinal strength and deflection calculations
* IMO Subdivision index
* MAXVCG calculations
* grain heeling
* ability to model up to 200 objects

AutoSHIP Builder

AutoSHIP Builder can read hulls created in AutoSHIP and then create individual structural components. Other key features include:

* can parametrically define transverse frames, floors, bulkheads, longitudinals, sole plates and decks, and non-orthogonal members
* parts may be edited to reflect doorways, hatches, lightening holes, etc.
* all internals have attached attributes including material, specific gravity, thickness, group, and zone designation
* structural sections can be defined and pulled along extrusion paths established along the hull or on defined bulkheads or decks
* estrusion paths can be defined as linear in plan, profile, or girth
* extrusion scantlings (and their associated cutouts) and insertions can be edited or added to the extrusion library to accurately reflect shipyard standards
* generate shell expansion drawings
* export DXF files of individual parts to NC burners or to third party CAD programs for dimensioning, etc.
* report generated includes output relative to all defined parts in terms of part name, specific gravity, lcg, tcg, vcg, and area in square length units

* parts can be sorted according to structural type (ie. bulkhead, frame, deck, etc.) and to group and zone
* all weights are summarized to give totals according to classification and lightship

Intergraph (Concurrent Ship Design)

The Intergraph Ship Design System is an integrated suite of products which support the complete ship life cycle, from conceptual design through fabrication, maintenance, and modernization. For the design process, the system provides the following real-time functions:

* a solid model topology engine
* specification-driven component placement
* design rule checking
* associative parametric construction
* graphic management of errors

Full associativity between design disciplines and the constraint system allow designers and engineers to develop the ship design concurrently. Users can move easily between related applications because Intergraph's design software is based upon integrated wireframe, surface, and solid modeling operations. In addition, all applications feature the same easy-to-learn graphical user interface.

At each stage within the design process, different aspects of ship design build on a shared database to generate, refine, and manage the master model. First, the faired hull model can be created using Intergraph's advanced non-uniform ration B-spline (NURBS) modeling functions. As the designer adds decks, bulkheads, and longitudinals, the resulting compartments are bounded associatively to reflect changes in all related data. The system also provides interfaces to stability analysis programs.

Intergraph's structural design package includes capabilities for placing and datailing beams, plates, and stiffeners with full associativity between model elements maintained throughout design. Drawings for structural layout, fabrication, and assembly can then be generated directly from the 3D model. Using data from the structural model, users can create flat patterns, nest the patterns on stock, and generate toolpaths and programs to cut the parts.

Users can place equipment selected from online, user-definable libraries within the central database and once the equipment is selected, foundations can be designed with the structural design package. Working from the 3D structural model, automated routines create the analysis mesh with a variety of options. Users can apply constraints and forces directly to the geometric model

and then solve the resulting finite element model, using Intergraph's built-in solver.

With the comprehensive routing package, users can design HVAC, piping, and electrical raceway networks using a single interface. Online parametric libraries facilitate routing and adherence to specifications while interference checking between equipment and distributive/structural systems highlights problems early. The system also provides an automated interface for extracting piping fabrication drawings. Outfitting and furnishings can be designed in place or created with components from online parametric libraries.

Applications Development, Inc. (Plant Design Software)

The PRO-SERIES is designed for productive, integrated AutoCAD based plant design for inexpensive workstations and personal computers. Some of the benefits offered by PRO-SERIES include:

* reduced drawing and delivery time
* increased drafting productivity
* increased accuracy in design and purchasing
* improved design quality
* standardized drafting

PRO-PIPE

PRO-PIPE is a specification driven piping design package for the creation of scaled orthographic drawings and 3D models using U.S. or metric measurements. Some of its major features include:

* on-line catalog of over 30,000 manufacturer specific components
* ANSI catalog
* automatic isometrics and bill of materials
* automatic 3D models from orthographic drawings
* automatic section drawings
* automatic pipe and elbow routing
* tablet router feature for faster component insertion
* assembly generator

PRO-ISO

PRO-ISO creates unscaled isometric piping diagrams using the same on-line catalog for specifications as PRO-PIPE. Important features include:

* bill of materials generator with a user definable schedule
* assembly generator
* automatic pipe and elbow routing
* tablet router
* back annotation
* automatic dimensioning
* pipe hangers and supports with load rating information

PRO-ELEC

PRO-ELEC is an unscaled electrical drafting package for one-lines, motor diagrams, and ladder diagrams. It includes an extensive library of switches, relays, transformers, fuses, and other components which can be customized to specifications.

PRO-ELEC PLANS

PRO-ELEC PLANS is a scaled electrical drawing and estimating package. It creates conduit routing, lighting, power and control, instrumentation, alarms, and other scaled drawings. Also, it contains a library with more than 200 electrical symbols, a bill of materials generator, and automatic drawing routines for background equipment.

Softdesk, Inc. (CADD Application Software)

Softdesk is the world's largest developer of applications software for AutoCAD. Since Softdesk software solutions are modular and integrated, only required software modules need to be purchased. Because each module is integrated and works inside AutoCAD, files and information can easily be exchanged.

Civil Pipeworks

Civil Pipeworks is an AutoCAD based software package which provides design and drafting of pipe networks in plan and profile. With only minimal input of information, pipe networks are graphically represented and the more cumbersome tasks associated with pipe design are performed automatically. Users can draw and edit pipe networks simultaneously and institute global changes automatically. Other important features include:

* designs, draws, and edits plan and profile views simultaneously
* performs global revisions which are automatically reflected in plan and profile views
* conforms to any drafting style

Plumbing

Plumbing is instrumental in the layout of a piping system. It offers utilities and symbols needed to create plan and riser diagrams. Other important features include:

* extensive library of piping layers
* symbols for valves, pipe fittings, and control diagrams
* fixture symbols in plan, elevation, and 3D
* fire protection menu including sprinkler heads, valves, and labeling tools
* inserting valves (with or without flanges) will automatically break a pipe line
* fixture schedule and legend are generated automatically from the drawing

Electric

Electric is a comprehensive application package for the creation of lighting, power, fire, communication, and control drawings. It provides automatic power totals during the wiring process with breaker overload warning, and automatic panel schedules with power totals and lengths shown. Other key features include:

* light and power symbols, including power values automatically totaled during wiring
* 3D capabilities including light fixtures, junction boxes, and conduit
* automatic generation of panel schedules from the drawing
* complete library of lighting, power, fire, communication, and control symbols
* bill of materials and a legend are generated automatically from the drawing

HVAC

HVAC provides high-end functionality and power with many options for creating heating, ventilation, and air conditioning plans. It includes symbols, programs, and tools for creating plans and diagrams in 2D, 3D, or both. Other important features include:

* fittings parametrically drawn to user specifications
* round, rectangular, and flat oval ducts and fittings available in double line, 3D, or with intelligent single lines which convert to double line and/or 3D later
* draw supply, return, exhaust, and other duct systems on seperate layers automatically
* diffusers, taps, and take-offs can be placed on any surface of any duct, including vertical stacks
* diffusers, ducts, and fittings can be tagged automatically during creation or later in a drawing session
* editing tools for changing the size, shape, and orientation of the single line drawings
* automatic generation of bill of materials

3.3 Phase III - Discussion of Software Options With Navigator

The methods by which Navigator Boats manufactures its boats will determine which capabilities it desires in a CAD system. Only Navigator Boats completely understands the methods of its business and what impact new capabilities may have. Also, Navigator Boats is looking to make the investment and the final decisions are up to them. On the other hand, Navigator Boats is not up-to-date on CAD technology (otherwise they would not be seeking help) and AIDT and its representatives need to explain to Navigator the various capabilities that a CAD system can offer. The information gathered on the available software products needs to be discussed with Navigator. This discussion should include the options, their impact and limitations, and their required investment in terms of software costs, hardware costs, and additional costs (such as training or the need for a salaried professional designer). This initial discussion between AIDT and Navigator Boats was scheduled for Wednesday, December 2.

3.4 Phase IV - Preliminary Analysis of Hardware Systems

The first step in analyzing hardware systems is to become familiar with the capabilities and limitations of current hardware systems. This "familiarizing" will involve a considerable amount of research effort in understanding hardware systems, how they work, and how they can be utilized. Next, specific information (ie. costs, capabilities, requirements) needs to be gathered about present hardware systems on the market. In addition, information on accessories (such as printers) needs to be gathered.

3.5 Phase V - Software Evaluation

Once Navigator Boats has determined which software systems to implement, this software must be obtained (demos or purchased software) and evaluated. AIDT's employees need to become familiar with the software (and Navigator's design needs) and then determine how Navigator can best implement the software. In more basic terms, the "nuances" of the software need to be determined and summarized.

3.6 Phase VI - Comparison of Hardware Systems

Once harware system technology has become researched and specific information on hardware systems (with their related accessories) has been gathered, alternative hardware choices need to be compared. Obviously, this comparison should only include those hardware systems which are both compatible with the software and powerful enough to fully utilize the software. The hardware comparisons should relate costs, capabilities, and limitations of the hardware and related accessories.

3.7 Phase VII - Final Presentation to Navigator Boats

All the information on hardware (and accessory) choices and software evaluation needs to be presented to Navigator. Now Navigator can decide which hardware system and what accessories to purchase. The implications of implementing the complete CAD system and the results of the software evaluation should be discussed with Navigator.

3.8 Phase VIII - Economic Evaluation of CAD Implementation

3.8.1 Gather Pertinent Information From Navigator Boats

A complete economic analysis requires a complete knowledge of the present economic condition. Detailed information about Navigator Boats (such as labor rates, productivity, design and manufacturing times, past expenditures, and other common expenditures) is necessary to begin the economic evaluation of the impact of a CAD system.

3.8.2 Analysis of CAD System Implementation Costs

First of all, implementation costs include the purchase prices of all software, hardware, and other necessary equipment. Also, any direct or indirect incurred costs (ie. training) which go along with the introduction of a CAD system must also be considered.

3.8.3 Analysis of CAD System Implementation Savings

Savings must result from the introduction of a CAD system; otherwise, no investment would be made. Present information on Navigator's expenses and productivity should help to estimate future reductions in expenses and improvements in productivity. Research into the productivity impacts other companies experienced while making similar transitions may be beneficial.

3.8.4 Determine Economic "Big Picture"

All the information on costs and savings must be synthesized to estimate the actual economic benefit of introducing a CAD system into Navigator Boats. A long-term economic analysis will yield estimates of the payback period, initial savings, and long-term savings.

4.0 MANAGEMENT PLAN

4.1 STAFFING

Jeff Sica and Charlie Garrett of AIDT are in charge of the CAD implementation project -- they are the principal contacts between Navigator Boats and AIDT. In addition, Brian Finzel has been temporarily hired to perform most of the background work for the project.

4.2 SCHEDULE

NOTE: Week 1 begins on Monday, December 7
Week 14 ends on Friday, March 12
Week 14 and any remaining time are left to finish report
Periods (within the bars of X's) align with week numbers

	WEEK													
SCHEDULE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
PHASE I	completed													
PHASE II	completed													
PHASE III	completed													
PHASE IV	X.XX.XX.XX.XX.X													
PHASE V					X.XX.XX.XX.XX.XX.XXX.XX									
PHASE VI						X.XX.XX.X								
PHASE VII												X.XXX.XX		
PHASE VIII									X.XX.XXX.XXX.XXX.XX					

4.4 BUDGET

COST ESTIMATE (November 1992 - March 1993)

	TOTAL PROJECT COST
A. SALARIES AND WAGES	
1) Mr. Jeff Sica and Mr. Charlie Garrett ($20/hour)(75 hours) = $1500	$ 1500
2) Mr. Brian Finzel Free temporary worker	$ 0
TOTAL SALARIES AND WAGES	$ 1500
B. FRINGE BENEFITS	
1) 21% of salaries and wages	$ 315
TOTAL SALARIES, WAGES, AND FRINGE BENEFITS	$ 1815
C. SUPPLIES & MATERIALS	
1) Phone Calls	$ 50
2) Supplies	$ 10
3) Software Demos	$ 100
TOTAL OPERATING EXPENSES	$ 160
D. TRAVEL	
1) 2 trips for 2 people	$ 250
2) 1 trip for 3 people	$ 350
TOTAL DIRECT COSTS	$ 2575
E. INDIRECT COSTS	
1) 25% of total direct costs	$ 644
TOTAL ESTIMATED COSTS	$ 3219

4.3 MANPOWER

	MANHOURS		
	BRIAN FINZEL	AIDT SUPERIORS	TOTAL
PHASE I	10	2	12
PHASE II	30	5	35
PHASE III	0	16	16
PHASE IV	40	2	42
PHASE V	10	10	20
PHASE VI	30	3	33
PHASE VII	8	32	40
PHASE VIII	50	5	55
TOTAL	178	75	253

Attachment 2

THE HONORS PROJECT PROPOSAL

PROPOSED TITLE: CAD System Selection For Boat Design

STUDENT: Brian Joseph Finzel

STUDENT #: 074003 PHONE: (205) 883-4600

ADDRESS: 6822 Chadwell Rd. Huntsville, AL 35802

THIS PROJECT FULFILLS REQUIREMENTS FOR THE UAH HONORS PROGRAM & DEPARTMENTAL & COURSE CREDIT IN Industrial Engineering

PROPOSAL APPROVED BY:

PROJECT ADVISOR: _____ DATE: 2/8/93

DEPARTMENT CHAIR: _____ DATE: 2/8/93

DATE PROPOSAL RECEIVED IN HONORS OFFICE 2/8/93

DATE PROPOSAL APPROVED BY HONORS COUNCIL _____

SIGNATURE OF HONORS DIRECTOR _____