

AN EXPERT SYSTEM FOR SUPPORTING THE PRODUCTION OF PLEASURE BOATS

*Tomasz GONCIARZ
Parker Poland Sp. z o.o.*

*Marcin PERZYK
Warsaw University of Technology*

Abstract:

Expert systems can be defined as computer programs, whose main task is to simulate a human expert, usually in a narrow field of expertise. Possible applications of modern information technology are very extensive, ranging from medicine, geology and technology to applications in the field of economic and financial decision support.

The purpose of this paper is to present the practical application of an expert system that supports the process of managing the production of yachts and has a high suitability for use in this application.

Using the expert system described in the paper reduces the time during the design and production preparation process.

Key words: expert systems, information technologies, production of yacht

INTRODUCTION

In the highly competitive situation of the yacht market, it is obvious that success will reward those companies that are better able than the competition to make the right decisions in a timely and efficient manner. Large companies can afford to employ a numbers of highly qualified professionals to respond properly at any time and take the right decisions. In addition, a financially strong company can afford to purchase custom-written and highly advanced software that constantly analyzes the main functions of the company.

Small and medium-sized enterprises are in a different situation where budgets are much slimmer and it is difficult to compete with larger corporations. It makes sense for these small and medium sized entities to, look for other ways to improve their competitiveness. Among the alternatives are expert systems that can successfully support work in even the most esoteric of yacht disciplines, such as hull design and construction.

Expert systems are capable of computational, qualitative, descriptive and explanatory functions.

An additional advantage of expert systems is the ease of use, in a process which boils down to a series of questions and answers between the computer program and the user, in which the system receives relevant information, not only from the user but also from external sources of knowledge, such as spreadsheets, and other calculation tools.

In yacht building, the time required for the production of an individual boat is often less important than a focus on extremely high quality, providing exceptional comfort and luxury to the owner and his or her guests with state of the art furnishings and equipment. This equipment will include electronic and hydraulic systems providing the ability to control and maneuver the vessel in adverse conditions with a little or no stress and with a very small crew.

Very often the reputation of the boat building company is the determining factor in setting the boat's final price and producing the order to proceed with design completion and construction.

A common practice of boat manufacturers is to select individual items of equipment from recommendations in catalogs, which may well be weighted to specify all items to be "safe" in terms of strength and power output, but which may also be unnecessarily heavy and expensive. This has the potential for increasing the final cost of the vessel, and in some cases such as diesel engines for bringing about premature failure as a result of excessive low power and low temperature operation.

Conversely, selecting under-sized or under-powered components will lead to frequent breakdowns, early replacements, and in extreme situations, may endanger the lives and safety of the people on the vessel.

Yacht manufacturing costs are also greatly affected by excessive expenditures for labor to install over-sized equipment, well intended to ensure the safety of the yacht and ensure the comfort of its use. A fully developed expert system will optimally choose, customize and calculate the required materials and equipment for safety, comfort and cost control. In other words, the information provided by such an expert system will significantly affect all costs, causing the final price of the to be much lower while maintaining the desired comfort and capabilities required in the completed yacht. In addition, the use of this expert system will mean that production will be smooth and efficient.

THE PRODUCTION PROCESS OF THE EXPERT SYSTEM

An expert system is a computer program, which contains knowledge about a specific and usually narrow field. The system has a capability to solve problems comparable with that of a human expert in the same field of knowledge

– it is a computer software designed to solve problems that require specialized knowledge. Expert systems belong to the field of artificial intelligence, which is the study of issues including fuzzy logic, evolutionary computation, neural networks, artificial life and robotics. Artificial intelligence is a branch of computer science, the object of which is to study the rules of human behavior and intelligence, to create formal models of that behavior and human thought processes and, as a result, to create computer programs that simulate the behavior and intellect of humans [4, 7].

The starting point to development of the expert system is analysis of the process of preparation of production [5].

The main idea is to create programs, when a knowledge and reasoning techniques are introduced, can generate answers similar to those that would be provided by a highly experienced human being. In effect, you will use the system to access the human expert's knowledge and experience through the user interface of the computer or other device running the program. The user of this service asks questions and receives answers and explanations presented in various forms, such as:

- text,
- video,
- sound,
- photo,
- figure,
- scheme.

The benefits of using expert systems include [6]:

- saving money. In the long run they are much less expensive than human experts, especially in helping to solve problems that require the most expertise
- a lack of experienced people in the field;
- they work faster, do not get tired, they are more reliable than people;
- they are consistent, objective, accurate;
- they analyze large amounts of data, using computer capabilities of requires a computer;
- they are useful for solving complex problems in areas where there is accumulated empirical information ;
- they are able to answer questions by presenting information in an intuitively understandable way. Expert system users do not need to understand the inner working of the systems;
- they save time;
- they are always available;
- they are easy to use.

Model of an expert system for supporting the production of recreational crafts

Recreational craft, to which expert systems can be applied, include sailing yachts, displacement-hull power boats and planing power boats. These vessels have a long tradition, a variety of applications and a large variety of design solutions.

The presented expert system can address, among other things, issues such as the calculation of the maximum speed of the boat and the required engine power to attain that speed, the choice of power train components, exhaust systems, the selection of steering and thruster devices to control and maneuver the boat, and help to resolve many other questions and problems. The conclusions and explanations are provided in narrative and quantitative form with diagrams, drawings, photographs, films and sound. The expert

system is designed in such a way that it can be easily expanded by the input of new information and knowledge. For example, as new technology develops, the system engineer or programmer can update or extend the data base and programming of the expert system.

This particular system has been written in such a way that it can be easily reprogrammed for application in fields other than yacht construction because all of the substantive knowledge is contained in discrete, and therefore interchangeable, data files, assembled in application related data bases. Each database corresponds to a specific chapter of the Main Menu, to be used in solving problems in the business or other field to which the data base applies. With this architecture, the expert system design can easily be applied to other disciplines by switching data bases (sources of knowledge), using appropriate access paths in the main control unit of the system and changing the contents of the menu control block [1, 2, 3, 8]. Of course, new data bases must be adequate for the scale of the problems they are intended to address, and must be formatted to be compatible with the central programs of the expert system.

The expert system is built basing on:

- the first author's experience,
- consultations with other programmers, systems analysts and engineers,
- information from the marine design offices and their naval architects,
- interviews with people working directly in manufacturing,
- observing and interviewing the production workers,
- conducting interviews with experts,
- conducting interviews with sales personnel ,
- conducting interviews with customers – end users/ owner of the yacht or other product,
- search in the materials sector, including catalogs and websites.

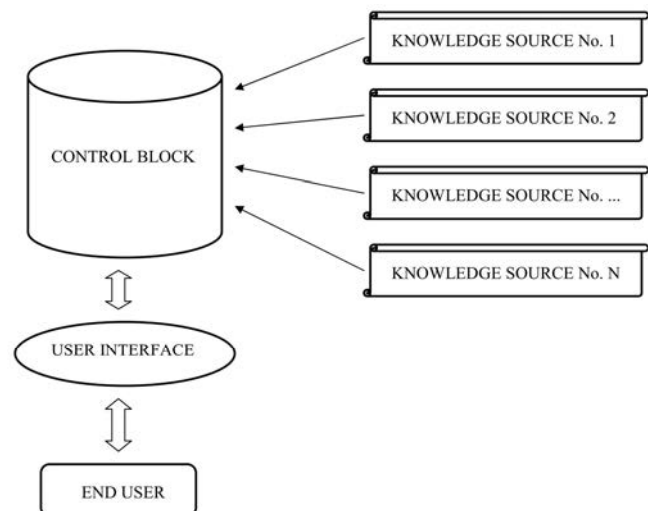


Fig. 1 Schematic diagram of the expert system presented

Described expert system has been built as an application of the PC-Shell computer tool, an independent tool for construction of expert systems [6]. It combines various methods of solving problems and knowledge representation. It can be used in any field, hence the range of its applications is very wide. The PC-Shell is mainly predisposed to solve the problems of the diagnostic and classification and interpretation of data (Fig. 1) [6].

Program's presentation (Fig. 2)



Fig. 2 The expert system welcome screen

In Fig. 3 a view of the function which enables the calculation of the required engine power for the boat is shown. The user selects from the Main Menu functions „Engine power calculator” and enters values such as the length and width of the hull at the water line, draft and number of engines. After clicking the Calculate button the required engine power for the boat N_e is returned.

User can get additional explanations from the expert system which may help him/her even at the stage of the application process. Those function is called „WHAT IS IT ?” (Fig. 4).

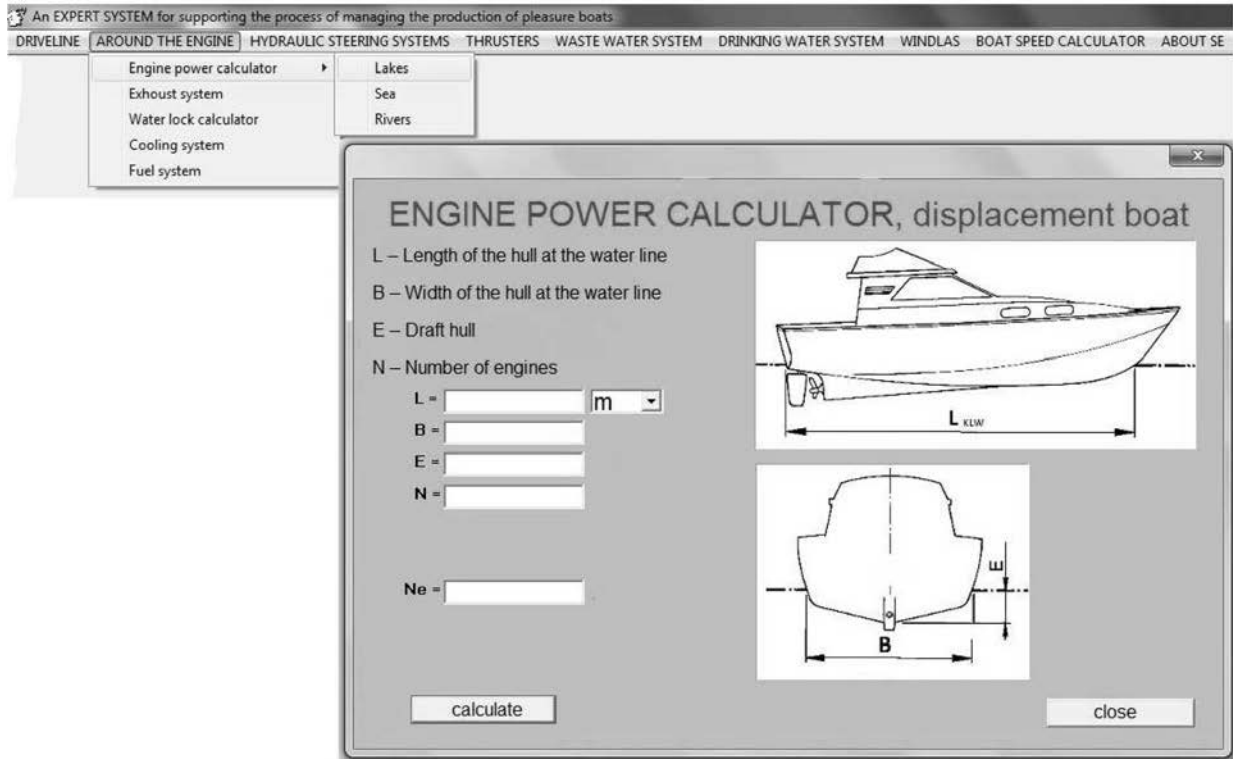


Fig. 3 Main Menu and the Engine Power Calculator dialog box

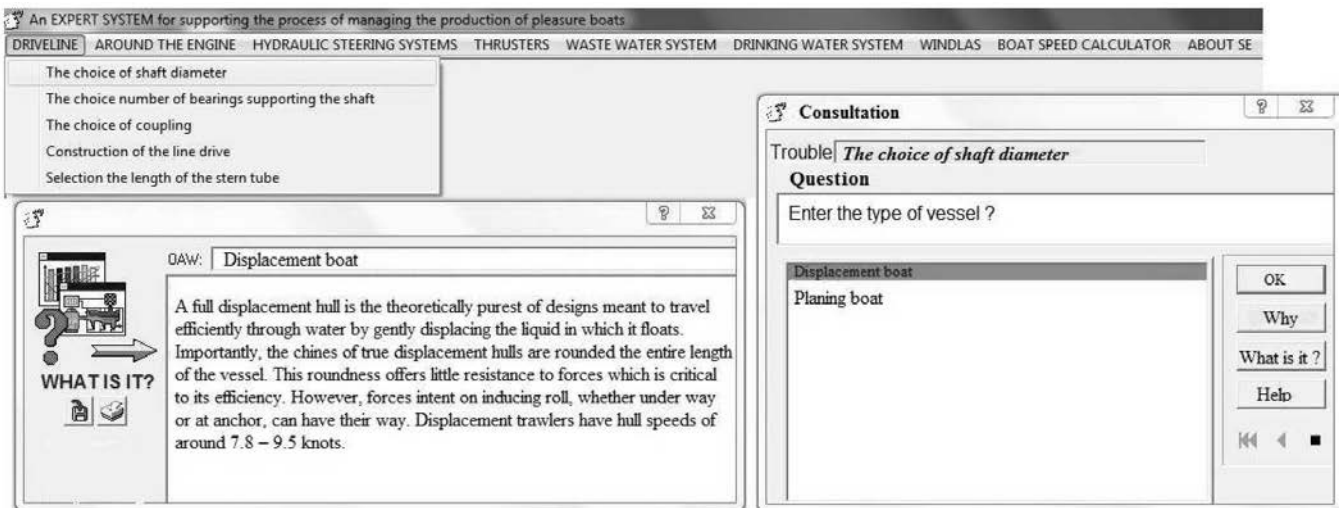


Fig. 4 Menu and additional explanation window „WHAT IS IT ?”

Assessment of the expert system in terms of its usefulness

An evaluation of the expert system in terms of its concept, design and usability was made by testing it in three independent companies in the marine industry. The first two are leading Polish manufacturers of boats, which for many years have engaged in the commercial production of recreational crafts. They make mass market products and also custom, one of a kind, products. These products go to the Polish market as well as for export. The third company, which tested the expert system, is a marine engineering firm providing boat building services, maintenance and the installation of equipment to yacht owners and operators. This very special enterprise enjoys a great reputation in the yachting industry.

The staff of these three companies, the expert system was tested by a selected group of experts and specialists who, on a daily basis, work in manufacturing, in pre-production, and as designers and technicians responsible for the assembly process.

In the selection process of the experts, the competence of each candidate was carefully vetted. The experts invited to participate in the study did not know each other and had not previously interacted. Each expert was required to devote minimum of twenty hours to testing. In these independent tests, the expert system received very high marks and positive recommendations from all the companies in which the product was tested.

Inter alia, the expert system was used in the design and production of a new model displacement-hull motor yacht, which is intended for recreational boating on inland and coastal waters.

Responses obtained from the expert system were checked and compared with the professional literature by the people who tested the program.

The system was found to be a highly useful program due to its following characteristics:

- easy to find information,
- interface transparency,
- speed of responses,
- the program includes extensive knowledge.

The tested expert system has helped to shorten the pre-production phase of the manufacturing process and result-

ed in a dramatic reduction in final vessel costs by optimizing the selected equipment package. It has made a unique contribution to manufacturing efficiency.

CONCLUSIONS

The knowledge of a single expert may not be as extensive as the information contained in a traditional written book. However, it is easier to search for the information in an expert system than in literature and, as a consequence, a person can work more efficiently. An expert system is an alternative to written instructions and other information sources. The expert system discussed in this paper is well developed and highly practical. It streamlines the pre-production processes, as has been demonstrated by the manufacturers who have tested the program.

REFERENCES

- [1] Buchalski Z.: Computer Advisory-Decision System for the Logistics Services Support. *Polish Journal of Environmental Studies*, Vol. 18, No 3B, 2009, s 53-57.
- [2] Buchalski Z.: Knowledge Management of Expert System Based on the Symbolic Representation of Natural Language Sentences. [w:] Borzemski L., Grzech A., Świętek J., Wilimowska Z. (red.): *Information Systems Architecture and Technology*. Oficyna Wydawnicza Politechniki Wrocławskiej. Wrocław 2006, s. 75-85.
- [3] Buchalski Z.: Zarządzanie wiedzą w podejmowaniu decyzji przy wykorzystaniu systemu ekspertowego. [w:] *Bazy danych. Struktury, algorytmy, metody*. WKŁ. Warszawa 2006, s. 471-478.
- [4] Koch C., Tononi G.: Test for consciousness. *The World of Science*. No 7 (239), 2011, pages 32-35.
- [5] Knosala R. i in.: *Zastosowania metod sztucznej inteligencji w inżynierii produkcji*. WNT. Warszawa 2002, s. 2.
- [6] Michalik K.: Integrated package of artificial intelligence Aitech Sphinx 4.5. Aitech Intelligent Laboratory. Katowice 2006, pages 1-8.
- [7] Mulawka J.: *Systemy ekspertowe*. WNT. Warszawa 1996, s. 20.
- [8] Tkaczyk W.: *Inżynieria Wiedzy*. Akademicka Oficyna Wydawnicza EXIT. Warszawa 2010, s. 113.

mgr inż. Tomasz Gonciarz
Parker Poland Sp. z o.o.
ul. Reniferowa 88, 03-289 Warszawa, POLAND
e-mail: tomasz.gonciarz@parker.com.pl

prof. dr hab. inż. Marcin Perzyk
Warsaw University of Technology,
Faculty of Production Engineering
Institute of Manufacturing Processes
ul. Narbutta 85, 02-524 Warszawa, POLAND
e-mail: M.Perzyk@wip.pw.edu.pl