An E-Commerce Platform for Engineering Services in Shipbuilding

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Abstract

We present intermediate results of a long-term project to develop an Internet platform that offers engineering assistance in naval hydrodynamics. Customers are able to use, for instance, prediction tools online, get quotations for standard orders and may look-up the progress of larger projects. These services on demand are a natural extension of e-business. But while trading goods over the Internet is almost standard, offering engineering services shows some specifics which by now are not fully understood. They are mostly unique and consist of multiple parts, require more information exchange and the corresponding order specifications are more comprehensive. This leads to problems that require new approaches and solutions in areas like application architecture, application development and integration, security and IT operations.
This paper describes vision, development and implementation of the platform as well as experiences of customers.

1. Introduction

In general a shipbuilding project involves a large number of engineering services requiring by 15-20% of the total cost not mentioning – in particular for international contracts – the considerable costs for transactions and negotiations concerning order specification, transfer and return of ship data, discussions of results etc. Often these costs multiply since engineering services are ordered repeatedly with small changes and variations of requirements, ship plans, framework with respect to size and speed of the ship such that the overall contract spans several months.
Reducing these costs is a major objective for all companies and institutions participating in a project. A promising strategy is to transfer certain business processes on the Internet and to reduce the time needed to perform certain services eventually aiming at a turn-around time of 24 hours for selected standard services.

Table I: Characteristics of e-commerce systems for products and services

product-oriented e-commerce systems	**e-commerce systems for engineering services**
ad hoc ordering	intensive exchange of information precedes ordering
simple description and presentation of orders	description of orders by large data collections
short-term contact between seller and buyer, often anonymously („one-click shopping“)	long-term cooperation of business partners to perform services
different and comfortable payment functions	payment functions are less important
elementary products with few attributes	structured services consisting of many different subtasks
standardized mass-produced goods	almost unique services („one customer, one product, one process“)
stable quality guaranteed by brand (independent of seller)	varying quality (depending on service provider)
dominating paradigm: shopping cart	no paradigm known

2. E-Commerce of goods versus services

There are different e-commerce systems both for B2B- and for B2C-relations, e.g. for trading hard- and software, books, CDs, second-hand machines, in the wood market and many more. Moreover, tailored applications for customer relationship management, supply chain management and business intelligence are available. However, all these systems only support electronic

trading of physical objects that are mostly branded goods, world-wide known and available anytime and anywhere at equal conditions and quality.
Only very few experiences are available for electronic sales and marketing of the product „service“ in particular of a unique service as it is in the case of engineering services. Available e-commerce solutions are often restricted to calls for tender based on simple questionnaires. Table I shows typical characteristics of e-commerce systems for products versus services.
The problems to be solved are manifold. For shipbuilding industry among the problems to be managed are the following:

- large data collections that describe the object of investigation
- different data formats constrain easy data exchange
- coupling of different IT-systems of contract partners
- iterative communication procedures towards the final product.

However, considering the development towards a service society in the 21st century it is essential to process complex services by electronic media in order to profit from cost reductions.

3. Vision of the E-Commerce Platform for Engineering Services in Shipbuilding (ePING)

The research and development in the field of ship hydrodynamics is one major activity of ship model basins. Their knowledge and experience is hidden in countless procedures, tools and technologies. The vision underlying our present efforts is to offer parts of this know-how via Internet in order to improve customer support. The added value of purchasing technology and know-how as a service is becoming increasingly interesting to the shipbuilding industry. Buying engineering knowledge as a service would allow many small and medium-sized enterprises to obtain best-of-breed integration solutions faster and cheaper, avoiding usual disruptions and expenses caused by continuous upgrades of software. Moreover, engineering services on demand can reduce the complexities and headaches associated with integrating new technologies.
The project ePING is a joint work of Potsdam Ship Model Basin (SVA), a non-profit company, and University of Potsdam and aims at conceptual development, feasibility, design and implementation of an e-commerce platform (B2B) for project-related communication, ordering, processing and billing of engineering services for shipbuilding.
The following typical scenarios illustrate main visionary features of the system as well as possible cost reductions.

Scenario 1: Public area with anonymous access.
By publications in a journal or on the Internet a shipowner got aware of SVA. In order to obtain an overview of SVA’s services the shipowner uses the e-commerce platform – anonymously at first. He is able to use certain simple services with small input and output data sets. He enters the specification of the task and the data into a service form and sends it unencrypted to the SVA server. The system processes the job immediately using available technical algorithms (numerical procedures, CFD etc.) and returns results to the customer by email or displays them in a browser. Billing may be possible on a pay-per-use basis. Erroneous or incomplete as well as non-standard jobs are recognized, if possible, and rejected with an error message.

Scenario 2: Closed area for registered users with password protection.
A shipyard and SVA have established a long-term business relation. The shipyard is registered in the e-commerce system and uses its services on a regular basis. The customer, still in a planning stage of a new ship, wishes to use the engineering competence of SVA for a standard problem in ship design (e.g. wave resistance). He is also interested in a competent report in order to be able to quickly compare different variants of the ship with respect to cost-benefit ratio. The customer uploads relevant data to the SVA server and at the same time specifies his task as precisely as possible using a questionnaire. Data transfer is encrypted. The system classifies the task, checks data and task specification for completeness, correctness and consistency, preprocesses the task (decryption, data conversion and completion), assigns it to an SVA engineer as supervisor and starts – as far as possible – corresponding technical procedures. After a final check by the engineer the results are e-mailed to the customer. The customer may request a status report during all processing stages. Faulty, incomplete or non-standard tasks are recognized, if possible, sorted out and fed into the traditional working routines. Billing may be done on a pay-per-use or fixed-rate basis.

Main steps on ePING's road-map are:

- definition of a framework for processing engineering services, analysis of requirements in co-operation with pilot customers
- modeling by analysis and classification of typical business and service processes
- identification and definition of services and processes that may be standardized, structuring of these services based on few elementary service components that may be combined to complex services
- definition of a framework in which these basic building blocks may be further developed to tradable (branded) products of well-defined quality and functionality
- development of a concept for an e-commerce platform for project-related communication, ordering, processing and billing of services, research on suitable data exchange formats, protocols and security standards
- development, implementation and testing of the platform starting with simple and free services for a group of users among the customers of SVA; development of interfaces and conversion modules for the software systems (numerical algorithms, prediction tools, CFD) used by SVA
- transfer of main business and service processes to the e-commerce platform, evaluation and further development of proposed standards.

Fig. 1 shows the architecture of such a system.

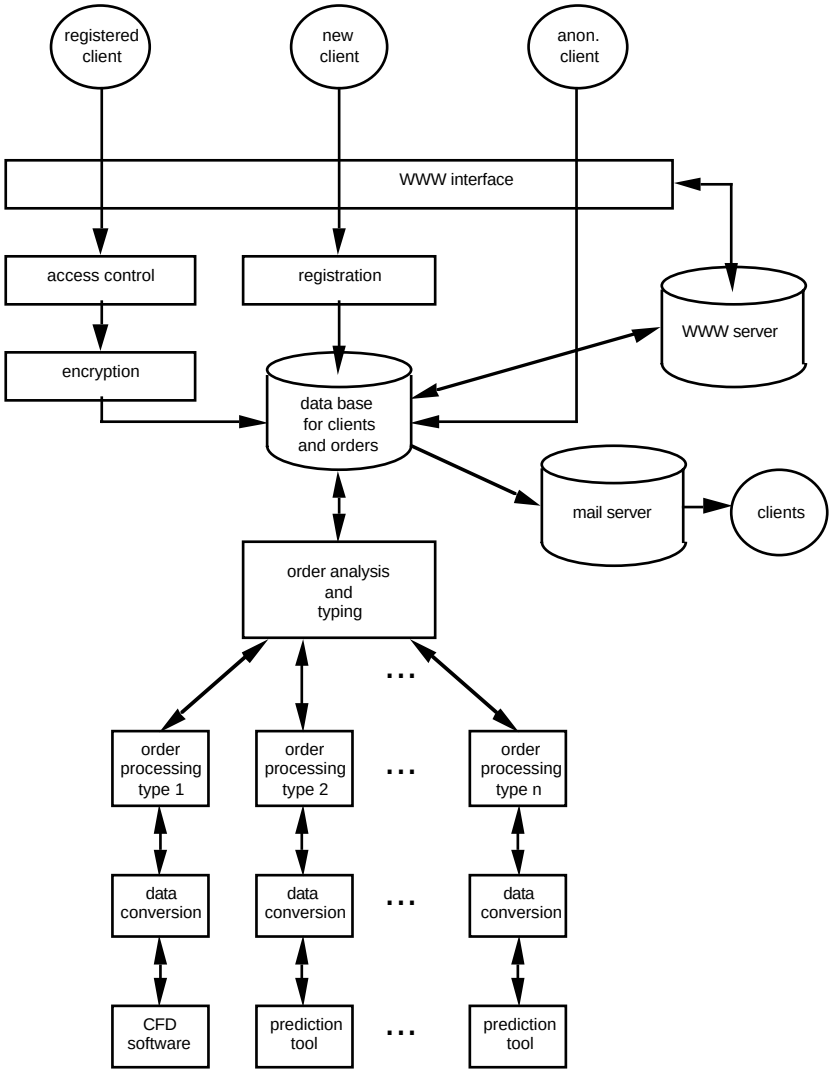

Fig. 1: Architecture of an online platform for engineering services

The project is prototypical in the sense that considerations on system architectures, structures and techniques may be carried over in part to other engineering services, e.g. in architecture, structural analysis of buildings, test engineering, plant construction.

3.1. Online ordering of engineering services in shipbuilding: A drawback

An essential issue in Fig. 1 is the module for task analysis, classification and typing. The corresponding problems in the fields of pattern matching, text analysis, data mining, knowledge presentation and acquisition etc. are subject of current research in computer science and widely unsolved yet. An overview is given in *Domeyer (2002)*.
Fortunately, in this particular case of engineering services for shipbuilding order classification and typing are not so essential since the number of orders per year is relatively small and most orders to SVA are neither anonymously given nor completely specifiable in advance nor to be billed electronically. But on the contrary before ordering most customers directly get in touch with the appropriate SVA department and try to communicate to an SVA expert on their specific tasks or inquiries. So when these person-to-person discussions eventually lead to a formal order, the task is already classified and assigned to the appropriate engineers.
Table II lists sources and channels of orders to SVA in recent years.

Table II: Sources for orders to SVA (2001-2002)

regular customers by long-lasting business relations	40 %
customer visits (genuine order acquisition)	10 %
recommendations	10 %
follow-up orders	20 %
new customers via Internet inquiries	3 %
new customers via presentation on fairs	2 %
new customers via lectures or publications	5 %
unknown, miscellaneous	10 %

A second issue which makes it very difficult and also obsolete to classify orders automatically is that in recent years orders have become more and more unique and non-standard. These tasks need preliminary development of models, concepts and technologies which may or may not end up in official orders. This long process of negotiations can hardly be supported online.
And thirdly, in particular in an early stage of product development, a customer wishes to confidentially talk to a competent partner eventually ending up in a joint concept to realize the task. This customer is not helped by a standard web form or a computer-generated response.
It follows that currently complex engineering services in shipbuilding neither may be sold over the Internet in a customer-friendly way nor would be much appreciated by customers due to extensive person-to-person communication needs.

3.2. Engineering assistance and value-added services over the Internet

Considerations in the previous section have encouraged us not to attempt to replace traditional communication, ordering and processing but to focus on assisting both customer and SVA engineer in typical problems and information and service needs which may be easily performed over the Internet. Consequently, the objective has to be to improve service processes in order to generate added-value and to satisfy customers.
Which service and information processes in shipbuilding generate added-value when transferred to the Internet? By analyzing SVA's business processes as well as customer surveys on using the Internet as an additional communication platform we came to the following conclusions:
The processes of ship model basins are based on deep customer relations lasting for several months, or even years if follow-up projects are involved, and are dominated by extensive communication between customer and SVA engineer where access to two categories of services is frequently required by customers: *Information on demand* and *computation on demand*.
Information on demand covers all information that describes the framework, environmental conditions, concerned engineers and development stage of the project. Distribution of this information over the net is very efficient and quick access to all relevant data gives customers an added-value and reduces communication with SVA engineers.
Computation on demand concerns services which offer online procedures for complex calculations in ship design. There are at least two advantages: Firstly, the software is available for differ-

ent computer platforms with small requirements on resources (standard browser and Internet access) while there is only one copy to be maintained (ASP=application service providing). Secondly, part of the know-how of SVA which is hidden in countless small and medium-sized single-user programs covering specific problems on ship design, often written from scratch by an SVA engineer and mostly roughly documented not only turns into a marketable asset but also becomes fully available on the intranet. While employees of the company gain full access to all tools in-house, external users, of course, only have partial access.
These two application fields have been selected to be covered by our platform ePING in the first stage and will promise a considerable additional benefit for ship model basins and their customers.

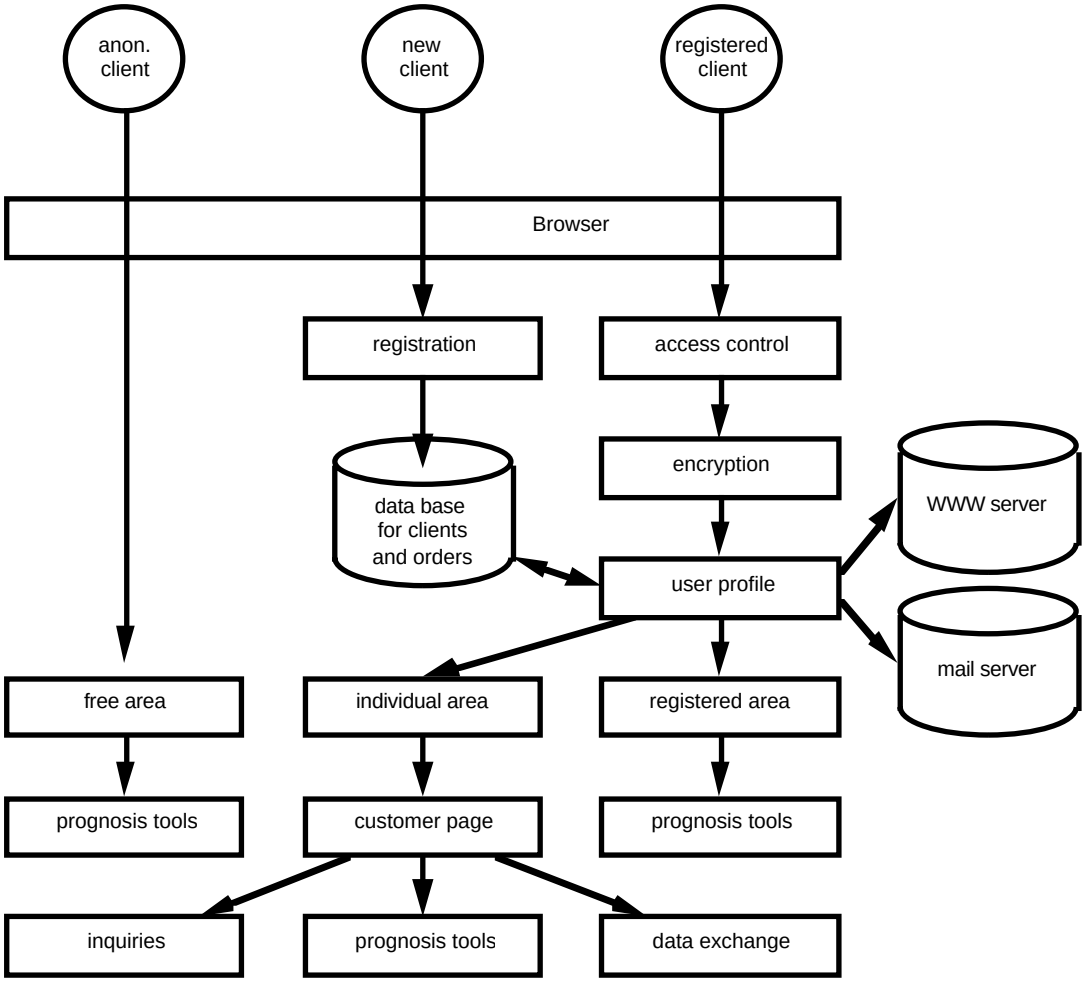

Fig. 2: Architecture of the ePING server

4. Realization

Our revised system concept (Fig. 2) includes the considerations above and experiences and is oriented towards SVA's corporate strategy. The collection of various procedures, methods and communication possibilities form the platform's backbone and is available via the SVA homepage http://www.sva-potsdam.de.
One of the trends in e-commerce is personalized access to information *(Finkelstein (1999))* where customers gain access to specific information relevant for their purposes which may be realized by different user profiles that allow different views onto SVA's business activities. This paradigm of individual communication and services based on user profiles guided the architecture of our platform. So the online platform distinguishes three user domains which are specified in the following subsections.

4.1. Offerings for anonymous customers

This domain offers well-known and established prognosis tools in ship design in order to demonstrate the functionality of ePING. Access is free of charge and meant as an initial offer for users who are from time to time faced with design tasks and search for quick and competent answers to their problems. We expect anonymous clients to keep in touch with the platform and change to registered users eventually becoming long-term customers.
Data transfer between client and server is unencrypted and can be monitored by a third party.

4.2. Offerings for registered customers

For registered customers a password-protected working area with a limited amount of server storage is set up. Users may define in their personal profile in which language (English, German) they wish to communicate. Furthermore they can decide how results computed by available tools are handled: Shall data be deleted immediately at session end or be kept for future look-up or processing.
Registered customers receive additional benefits: encrypted data transfer between client and server, mail service, background information, access to extended features of tools (e.g. graphical editing of results), contact persons etc. Use of the registered domain is also free of charge but users have to leave some personal and corporate data (name, address, phone, email) which, however, are only used for server administration purposes.

4.3. Offerings for individual customers

Working in the individual domain is only possible after a written license agreement. Customers may use additional software applications or access SVA's data bases with report data, publications or hydrodynamic formularies and are charged a license fee.
The target group of this service are customers with a long-term business relation to SVA. For a limited time the user leases a software tool either in order to solve a particular problem, for instance, or to become acquainted with the product prior to buying or permanently leasing it from SVA.

5. Applications

5.1. Open water diagram for SVA high speed propeller series

In a recently finished research project systematic tests of high-speed propellers have been carried out in the towing tank and the cavitation tunnel at the SVA leading to polynomial coefficients in an analogous manner like Wageninger propeller series, *Heinke, Lamprecht, Schulze (2003)*.
Open water diagrams for high speed propellers without cavitation may be simply and quickly computed using the online platform. In the registered area of ePING a form has to be filled out with the required input data and sent to the SVA server. The server checks the data, computes the result and sends it along with the open water diagram back to the customer.
Open water diagrams with further parameters may be computed in the individual domain. The method allows a calculation of high-speed propeller characteristics with variable propeller parameters as well as predetermined operation parameters like cavitation or oblique inflow. The server calculates the propeller characteristics for given propeller data and the optimum propeller for given working points.

5.2. Automatic tender preparation for standard model tests

If one carefully analyses the process of preparing a standard offer, one may identify activities which are time-consuming and error-prone, if done manually, but can be formalized and thus automated.
Preparing an offer can be hierarchically subdivided into substeps depending on particular conditions and parameters. Possible substeps are defining the model size, searching for propellers in stock, number of model tests etc. Specification of a suitable model scale needs considering additional influencing factors: propeller diameter, milling cutter dimensions, towing tank geometry, experiment types etc. Different model scales imply variable production costs of the model. For an

automatic price calculation it is essential to take these costs into account. The individual service items may be matched with the price data base and the customer data base and completed to a first standard-service offer. Of course, the price is preliminary and should be fixed in a counseling interview.
Currently, most of the procedures are used as often as possible by SVA staff members who with additional access rights to price information's can prepare formal offers.

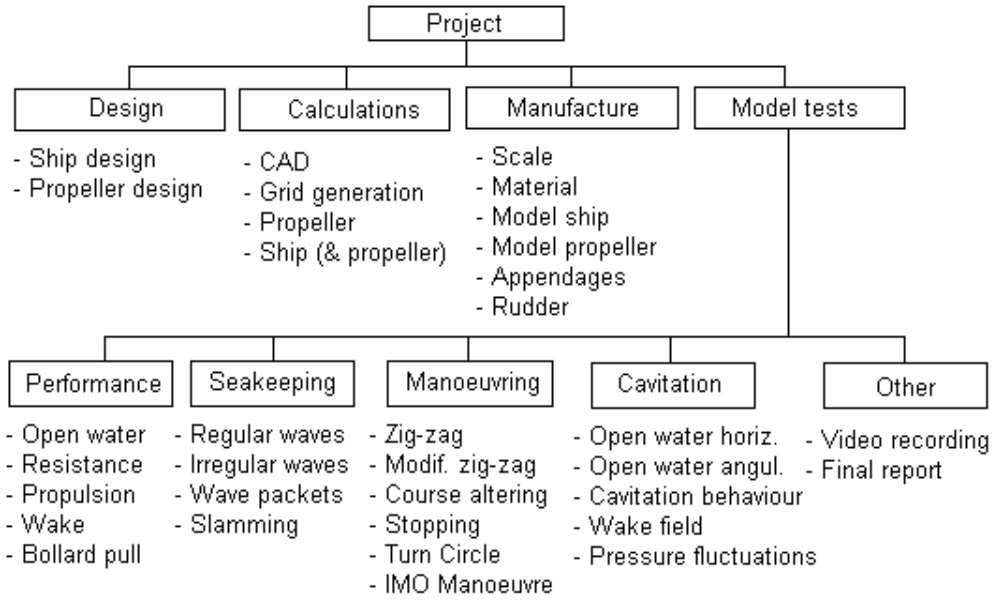

Fig. 3: Backbone network for standard offers

5.3. Wave resistance prediction

While procedures with few input data are particularly suitable to be processed on the Internet platform, most ship design tools need detailed geometry descriptions, extensive parameter specifications and a considerable computation time. Moreover, for a fine ship grid a graphical interaction is required.
Figure 4 shows how to use the ePING platform in these cases. The customer applies a local preprocessor to convert his CAD data into a ship grid (1). He enters calculation parameters into a web form and sends grid and parameters over an encrypted connection to the SVA server (2). The server software checks the data and starts the computation. In his individual area the customer may look-up a progress indicator and, immediately after the calculation finishes, find a graphical report (3) or the full result in a file from which further images (4) can be generated using a postprocessor.
In general a customer would probably not appreciate such a procedure which seems complicated at first glance but rather he would order a full calculation. However, the process becomes useful if the customer has already computed results and wants to quickly repeat the calculation for only slightly modified operation conditions (e.g. different velocity) or for small geometry variations. In these cases the customer receives precise information faster and less expensive.
Basis of the wave resistance prediction method is the potential (Rankine source) code „Kelvin", *Söding (1993, 2000)*. „Kelvin" applies the „patch method" to determine the wave resistance by satisfying the body and the nonlinear free surface conditions using sources distributed within the body and above the discretized part of the free surface.
Figure 5 shows a typical wave pattern computed by „Kelvin".

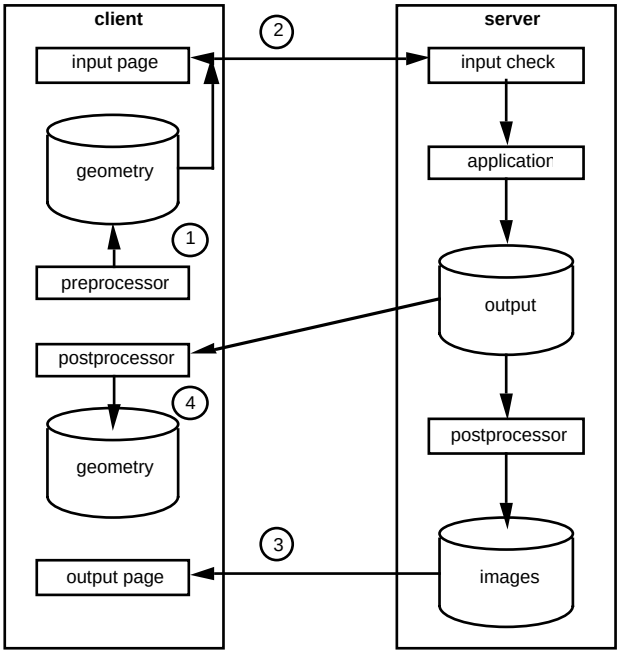

Fig. 4: Simplified online calculation scheme

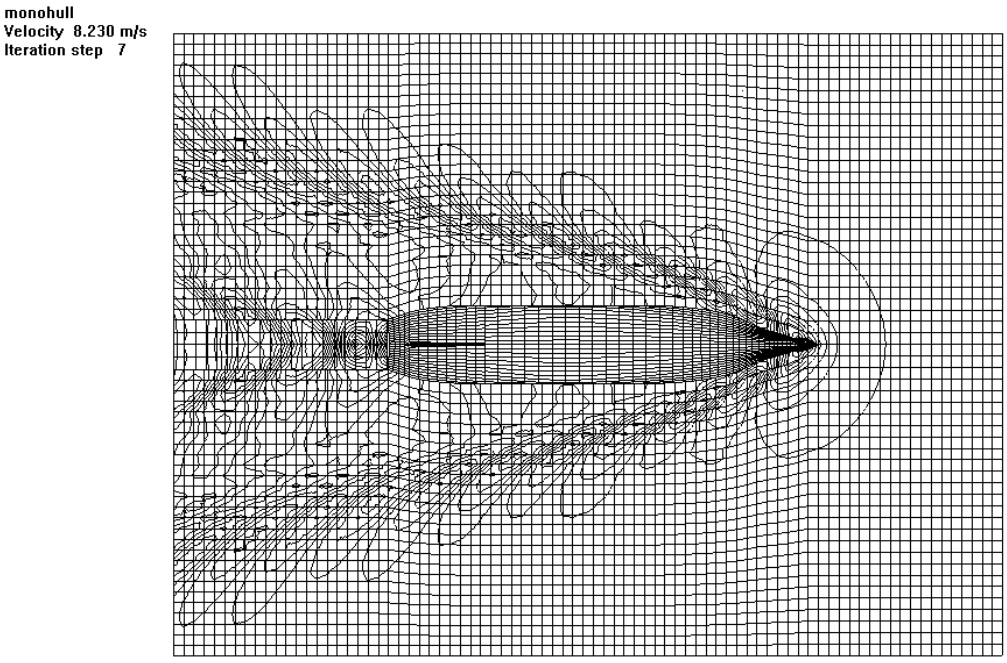

Fig. 5: Wave pattern for a fast monohull

6. Data security

The online platform takes into account the current security standards. If necessary data will be encrypted in the registered and in the individual domain during the transport. All data are taken as confidential, are not passed to a third party and are only used for the intended purposes. The data are stored in a standard data base system and protected against incidental or deliberate manipulations, loss, destruction or access of unauthorized persons. Stored data can be retrieved or deleted according to the applicable law at any time. The security measures will be improved according to the technological development.

7. Technology and Tools

ePING is implemented on an Apache server with SSL, a firewall and a MySQL database. The web pages are written in HTML, Javascript and PHP. Incoming user data are redirected to the appropriate software tools and the results presented to the user. Cookies are used, if necessary, in order to store a session identification during the connection to the server.
The online platform now runs for more than a year in a stable state and is permanently extended by new functions.

8. Concluding remarks

If members of the shipbuilding community succeed in using the Internet to offer prompt and customer-oriented engineering services on demand it will give them a considerable competitive advantage and guarantee their position in the market. By providing methods of calculation and hydrodynamic engineering knowledge on the Web SVA makes a first step in this direction.

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