INTEGRATION OF MARINE ENGINEERING AND INFORMATION AND COMMUNICATION TECHNOLOGY

INТЕГРАЦІЯ СУДОВОГО ІНЖИНЕРИНГА І ИНФОРМАЦІЙНО-КОМУНІКАЦІЙНИХ ТЕХНОЛОГІЙ

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Abstract. The number of interfirm collaborative agreements in shipbuilding increased dramatically over the last thirty years. The authors consider the issues related to the tight and effective cooperation in shipbuilding, i.e. between ship-owner, ship design company, shipbuilding yard and its suppliers, and classification societies aimed to build competitive vessels in terms of quality and price. The authors have compared two approaches to solve this task realized with the help of information and communication technologies applied in the Norwegian firms. The implications for research and practice are discussed. The avenues for the further research are presented. The study will be useful for practitioners from the maritime industries and scholars.

Keywords: shipbuilding, engineering, interfirm collaboration, information and communication technologies, knowledge management.

References


Problem statement. Composition and structure of the factors of material objects production or provision of services remain the subject of intensive research for a long time. If we abstract from irrelevant details, we can notice that the views of our predecessors on this issue were changing along with the metamorphosis which took place in relationships which accompanied the processes of production and distribution of goods. Their relatively simple forms, even in the emerging machine production conditions, led to the conclusion that the resources necessary for its organization are: the land (with its bowels), objects of labor, means of labor, activities aimed at the transformation of the initial components into the product (the results of the work), ready for final consumption. The development of the commodity-money relations expanded this range due to the real capital and the entrepreneurial initiative.

Transition to a phase of human development, which is called “industrial society” (it was accompanied by the rapid rise of science and technology and their applications in all the areas of human life), forced to re-evaluate the role of technology and management. Management was re-evaluated especially in the context of the exten...
sion of corporations as a highly effective and therefore popular procedural and institutional form of business (though with such danger as managerialism).

The emergence of the microprocessor technology has revolutionized the human world. This revolution was so rapid, deep and diverse in its manifestations that the analysts began to talk about the new information age. However, it was incredibly short in duration, and then it was replaced by the knowledge time\(^ 1\). Although this statement does not seem certain, at least in the statements of the individual researchers, hardly anyone will dare to deny the role of this factor is in the fundamental transformation of the economic panorama of the reality which surrounds us.

Knowledge, — as Reed. R and DeFillippi R.J. emphasize, — is considered to be one of the most important resources which give competitive advantages to the company if they are used effectively [1]. Robert Buckman agrees with them: “The era of companies, focused on knowledge, began. And in this situation the one is ahead who managed to concentrate the unformalized intellectual experience within their organization and figured out how to transfer it from one employee to another” [2, с. 10].

Moreover, in the increasingly globalized world, the companies-producers tend to integrate not only the corporate knowledge but also the external one with their maximum productivity. Actually, it is the work in the developing business networks, which should provide the best adaptability to intensive changes in the closest environment, according to the ideologists of business networks and supporters among entrepreneurs. However, it is possible to achieve this goal due to the use of the tools and procedures that became known as information and communication technologies (ICT).

References analysis. There is an opinion [3, 4], that they help to significantly reduce the expenditures for on-network knowledge management. The experience of the firms that invested heavily in the development and implementation of the software (applications) based on ICT confirms it [5, 6], including the automobile construction and processing industries [7]. It’s beside the point of the construction engineering industry (at least if you trust the testimony of Al-Ghassani [8]). The presence of these contradictions in assessments may indicate that the knowledge management through information and communication technologies is not an easy task and it requires further investigation, especially taking into account the specific features of certain kinds of activities. The shipbuilding is among them where the ship engineering participants also seek to coordinate their activities within the co-projects.

\(^1\) In the context of this publication, the authors consider knowledge to be the ordered set of useful information which facilitate solution of the urgent problem (which arose spontaneously or was formulated by the process or project manager).

\(^2\) In context of this publication, authors name knowledge unformalized common wealth of the minds, enabling to solve the actual tasks (which arise spontaneously or were formulated by the process or project manager).
**The aim of the article.** The desire to examine the impact of the industrial specific features on the use of ICT as a means of the knowledge management motivated the authors to study the topic which is in the title of this article. We hope it will be useful to project designers and will not remain without attention of the developers of corresponding IT-technologies.

**Basic material.** Marine Engineering is a knowledge-based intelligent service provided in several stages: a technical design, a conceptual design, a functional design; a transitional design and a detailed design [9]. Different software is used for each of them: AutoCAD, TRIBON, FORAN, NUPAS and others. The main resource, mobilized by the specialized design bureaus, is the engineers knowledge. They are divided into:

- declared (drawings, specifications, other design documentation);
- private (know-how, expert recommendations, not patented innovations, experience gained in the development of previous projects).

The specific features of exchange of each of the designated types of knowledge are obvious: if in the first case it does not cause any trouble, then in the second one it is determined by the need to use special procedures, including the conclusion of specific contracts (for example, the preliminary contract — on the confidentiality of information).

We believe it is possible to pay attention to several distinguishing features of the modern engineering:

1. Application of the computer-aided design systems in the production of specification, as well as the expanding of the range of means for integration of efforts through the information sharing within the network and the knowledge management technologies. [10] In the latter case we are talking about the influence on the formation, accumulation, interpretation, systematization, transmit-receive of knowledge. Also they are needed because:

   - firstly, there is a need to reduce the duration of the design work cycle which escalates in an increasingly competitive environment;
   - secondly, a lot of ship owners, designers, specialists of shipyards reside on the territories which are geographically distant from each other and are in different time zones (for example, Greece – Netherlands – China);
   - thirdly, customer is able to change some requirements of the specification online. They may be needed as a result of the modernization of regulations or mistakes made by the developer which entails making amendments in the already completed design work fragments even on a single-type vessel.

2 Especially if there is a long period between the issuance of specifications and the completion of the designing preproduction (there were cases in which it reached a few years during the global shipbuilding boom) [12].
2. Multicenter approach to organization of design. The need for it is due to the fact that a lot of subjects are interested in successful completion of the ship engineering (Fig. 1). Ideas R. Bronsart, S. Gau, D. Luckau, and W. Sucharowski [11], reflected on the scheme, have developed at the expense of the additional elements: shipbrokers, national and international maritime organizations.

As you can see, the ship owner forms the general conception of the vessel and prepares specification for the design, emphasizing the purpose, the navigation area, the deadweight, the speed, the power plant type, as well as the level of automation of its manoeuvring (the ship as a whole), the composition and the number of crews, the requirements to habitability. At the same time, he takes into account the knowledge of experts of the shipping companies (including the crew members of the vessels of the existing fleet) with respect to the characteristics market of the cargo operations, the area of the world ocean, where the operation is planned. This knowledge is reflected in the decisions on the design features of the case, the performance of equipment and the machinery.

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Supposing, the transfer through the Bosporus and Dardanelles is on course, the width and the draft of the vessel must comply with the limitations of these straits. Similarly, the technical equipment of the assumed ports of call would affect the capacities of the ship loading and unloading mechanisms.

Marketing philosophy of the ship owner also affects the choice of the vessel type, because the same goods such as frozen meat can be transported by refrigerators or container trucks in the tanks fitted with the cooling system. Somebody prefers the specialized fleet in order to benefit from the scale of business and the high professionalism of the teams. Others, seeking to reduce the business risks, order the universal vessels which can serve multiple markets, “tacking” among them in dependence to the current state of the freight rates [13].

The next stage is the announcement of the tender for the production of the project documentation. The suggestions in this regard are sent, as usual, to the several engineering firms. They, in turn, prepare the basic specifications for the vessel, the general plan of arrangement (usually - three types) and, as for the winner of the tender with whom the contract is signed — the working drawings, the registers of orders of the accessory equipment and materials. The architectural design of the vessel is performed together with the general one. Its aim is to develop solutions concerning the visual appearance, the general location of the premises, their planning, equipment and restoration. This part of the work is carried out either by the designer himself or by the specialized design bureau.

2. Cooperative approach to organization of project works. Peculiarity in this is the fact that in the successful completion of the project works there is a significant interest in the broader group of subjects (Fig. 1). The ideas of R. Bronsart, S. Gau, D. Luckau, and W. Sucharowski [11], have been developed at the expense of additional elements: shipowners, national and international maritime organizations.

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2 Especially if the issuance of specifications and the completion of the designing preproduction (there were cases in which it reached a few years during the global shipbuilding boom) [12].
Some shipbuilding companies have engineering units in their structure and thus offer a comprehensive service to the customer (design + construction). Thereby they are able to achieve the economy of time and reduce the cost, because the process of adaptation of the design documentation to the characteristics of the shipyard simplifies (e.g. the carrying capacity of the crane equipment, means of transportation, on which the hull sections are transmitted from the assembly and welding shop to the slipway, size of the outfitting quay, gates of the production areas etc).

The need for knowledge exchange increases when the construction of the vessel is performed by several enterprises on terms of outsourcing [14]. Currently it is a very common practice. For example, by order of the Italian oil gas company Eni, the largest of its subsidiary enterprises Saipem was performing the design and construction of the deep-water semi-submersible Scarabeo 8 platform for its subsequent operation in the North Sea. So, the case with the upper deck (without deck structure) was produced in Russia (Severodvinsk), from where it was towed to Italy (Fincantieri shipyard) [15].

From time to time Ukrainian shipbuilders also get the job according to the similar schemes. As we can see, the western companies tend to save money, taking care of their own staff, too. Is not it the reason for absence of the orders for complete vessels in the country? If so, the revival of the industry is involuntarily associated with the formation of national shipping companies, the development of other kinds of activities that fall under the category of "the economy of the sea". Focusing on the marked realias, we have identified the shipyards in Fig. 1 as an independent subject. Let’s add to it the exchange of knowledge got orders of complex equipment and materials. Together with it, it is performed architectural design of the vessel. Its task consists of the development of solutions concerning the external view, the general location of the rooms, their planning, equipment and finishing. This part of the work is performed either by the designer, or by a specialized design bureau.

Fig. 1. Knowledge Exchange among the Subjects Involved in Marine Engineering:

Shipyard-builders of ship hulls — верфи-строители корпуса судна; Ship-broker — судовой брокер; Ship owner — судовладелец; Ship testing tank — опытный бассейн; Suppliers of materials and marine equipment — поставщики материалов и судового оборудования; Information and communication system — информационно-коммуникационная система; Shipyards which perform the fitting-out — верфи, выполняющие достройку; Engineering firms — инжиниринговые фирмы; International and national marine organizations — международные и национальные морские организации; Maritime Registrar — классификационное общество

Fig. 1. Обмен знаниями между субъектами, причастными к судовому инжинирингу:

Shipyard-builders of ship hulls — верфи-строители корпуса судна; Ship-broker — судовой брокер; Ship owner — судовладелец; Ship testing tank — опытный бассейн; Suppliers of materials and marine equipment — поставщики материалов и судового оборудования; Information and communication system — информационно-коммуникационная система; Shipyards which perform the fitting-out — верфи, выполняющие достройку; Engineering firms — инжиниринговые фирмы; International and national marine organizations — международные и национальные морские организации; Maritime Registrar — классификационное общество
by the experts of the ship testing tanks where the hydro-mechanical characteristics of the ship models are being tested, as well as their seaworthiness and buoyancy.

The owner selects a Maritime Registrar which inspects the design process performed by all the developers and oversees the construction quality at all the stages (through its offices located in the world’s major shipbuilding centers). At the same time, relying on the recommendations of shipbuilders, he is negotiating with the suppliers of materials and component products (at times their number is more than a few hundred) [16]. The physical parameters of the equipment and instruments if we do not mention their technical characteristics, tend to have a significant impact on the decisions taken by the designers.

In recent decades, the influence on the process of shipbuilding of the International Maritime Organization has grown. Its responsibility is the ensuring of the maritime transportation safety and environmental pollution prevention. The cause of this pollution is ships and other floating objects. Since its foundation (1959), its specialists have developed more than 40 conventions, nearly 1,000 codes and recommendations. Among them, there are such conventions as the “Convention on Tonnage Measurement of Ships”, “Convention for the Safety of Life at Sea”, “Convention on the Prevention of Pollution from Ships” etc. The information they contain is particularly important in the preliminary stages of design.

Let’s add that beside the exchange of knowledge outside, a large part of it falls on communications within the engineering organization: between the units of hull structures, machines and mechanisms, pipelines, electrical equipment, 3D graphics, production drawings (Fig. 2).

To analyze the strengths and weaknesses of ICT platforms that have proliferated in practice, we used the method of comparison of the experiences of two Norwegian companies. One of them is small and specializes in commercial and naval ships, sharing its received orders with subcontractors. The second company – the multifunctional one – accumulated a considerable experience of construction projects for full-scale ships. If that is so, the reconstruction of the shipbuilding industry is accompanied by the creation of national shipbuilding companies, the development of new types of vessels, the improvement of the shipping industry, the introduction of new technologies, the modernization of the equipment, the use of 3D graphics, production drawings (Fig. 2).

Knowledge Exchange within the Organization:

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Fig. 2. Knowledge Exchange within the Organization:

Рис. 2. Обмен знаниями внутри организации:

SHOPS — отделы; Hull structures — корпусных конструкций; Machines and mechanisms — машин и механизмов; Pipelines — трубопроводов; Electrical equipment — электрооборудования; Production drawings — рабочих чертежей
perience in the ships design: fishing, research, passenger, bulk ships as well as container carriers, tankers, refrigerators, tow boats. The company has a wide network of branches in the country and in other countries (Bulgaria, Brazil, India, China, Poland, Russia, Serbia). The expansionist aspirations abroad arise from a number of motives:

firstly, they became a response to the growing demand for engineering services, accompanied by employment of professionals in countries with the relatively (compared to Norway) low payroll rate [17];

secondly, to enter the new markets of design (tankers in particular);

thirdly, the desire to bring their offices nearer to the shipyards where the main customers of working documentation build ships. In this case, a high level of understanding between people who speak the same language (by the way, detailed drawings are made in it), familiar with the national technical standards, who finally have a common cultural background.

Initial information for the analysis was obtained by the following methods: the survey (the semi-structured personal interview, the questionnaire) of the project managers, the observation (during the visit of the head offices) and the data systematization which are available on the Internet (for the purpose of triangulation). The methodology developed by Eisenhardt was used in the data processing [18]. On the basis of initial impressions, it became apparent that the effectiveness of the IT-compatible tools of knowledge exchange is crucial for the productive design. Two kinds of them were identified:

universal ones — are used in the process of design of ships and other engineering structures;

created to meet the needs of a particular designer company on the original platform.

Let’s consider the advantages and the disadvantages of each of them, appealing to the experience of the firms mentioned above. The first one is based on the standard system of “Education” in its work which was created for the educational institutions, and subsequently became widespread in business structures and some non-governmental organizations in Norway. This tool has a user friendly interface that allows one to combine multiple functions of the knowledge management.

For example, each page contains a list of relevant experts with the contact information (phone number, email address) which substantially simplifies business communications. According to the functional principle their

Для анализа достоинств и недостатков платформ ИКТ, которые получили распространение на практике, был использован метод сопоставления опыта двух норвежских фирм. Одна из них относится к категории небольших и специализируется на коммерческих и военно-морских судах, разделяя полученные заказы с субподрядчиками. Вторая — многофункциональная — накопила значительный опыт проектирования судов: рыболовецких, исследовательских, пассажирских, навалочных, а также контейнеровозов, танкеров, рефрижераторов, буксиров. Компания располагает развителённой сетью филиалов внутри страны и в других государствах (в Болгарии, Бразилии, Индии, Китае, Польше, России, Сербии). Экспансионистские устремления за рубежом обусловлены несколькими мотивами:

во-первых, они стали ответом на растущий спрос на инжиниринговые услуги, сопровождающимся наймом специалистов в странах с относительно (по сравнению с Норвегией) низким уровнем оплаты труда [17];

во-вторых, для проникновения на новые рынки проектирования (в частности, танкеров);

в-третьих, стремлением приблизить свои офисы к верфям, где основные заказчики рабочей документации строят суда. В этом случае достигается высокий уровень взаимопонимания между людьми, говорящими на одном языке (на нём, кстати сказать, изготавливаются детальные чертежи), знакомыми с национальными техническими стандартами, имеющими, в конце концов, общий культурный фон.

Первичная информация для анализа получена следующими методами: опрос (полуструктурированное личное интервью, анкетирование) руководителей проектов, наблюдение (во время посещения головных офисов) и систематизация данных, доступных в Интернет (с целью триангуляции). При обработке полученных данных использовалась методика, разработанная Eisenhardt [18]. Уже на основе начальных впечатлений стало очевидным, что эффективность совместимых ИТ-инструментов обмена знаниями играет ключевую роль для продуктивного проектирования. Были выявлены два их вида:

универсальные — находят применение при проектировании не только судов, но и других инженерных сооружений;

созданные с целью удовлетворения потребностей определённой фирмы-проектанта на оригинальной платформе.

Рассмотрим достоинства и недостатки каждого из них, апеллируя к опыту обозначенных выше фирм. Первая в своей работе опирается на стандартную систему «Обучение», созданную в своё время для учебных заведений и, в дальнейшем получившую распространение в бизнес-структурах и некоторых неправительственных организациях Норвегии. Этот инструмент имеет удобный интерфейс, позволяющий совмещать несколько функций управления знаниями. Например, каждая страница содержит список
participants are divided into three categories:

a) administrator who manages the project from its beginning to the end in compliance with all the legislation and corporate regulations;

b) design engineers who perform the tasks within their professional specialization. They are entitled to perform the corresponding operations within the project to which they are “connected”;

c) observers. These are the people representing the interests of the shipyard, shipping company, Maritime Registrar. Showing a natural interest in the results of the design, they can download the necessary documents in the “read-only” mode.

“Forum” in real-time provides opportunities to discuss the issues arising in the design; intensive exchange of unique knowledge about the design features of the shipyard, the marine and industrial equipment offered for delivery, the experience gained in the construction of other vessels. The “References” section contains information about national standards, regulations, international regulations, and other useful information. Finally, the storage of the developed drawings is organized in a systematic way. It allows using them in the future.

In the second company the knowledge exchange is organized simultaneously on exogenous and endogenous levels. Top management pays close attention to the improvement of the knowledge management procedures and the development of the collaboration culture within the corporation. The main and the regional offices are equipped with the videoconferencing equipment and the systems of information protection. Here the Kronodoc Solutions tool is in use. Firstly, it allows handling of the large streams of information which tend to increase; secondly, it allows creating, sharing and spreading knowledge from internal and external sources; thirdly, it allows assigning efforts of the staff rationally and saving a lot of money by reducing the number of paper media.

Moreover, with its help it is possible to avoid conflicts arising from the creation of a drawing (as it has happened many times in the past). When an engineer works with the document, other stakeholders do not have access to it. The completed work is to be verified by the administrator and only after its positive evaluation it is placed on the website of the project for the revision of the ship owner and the shipyard specialists. The recipient gets their written comments and suggestions via e-mail. Making amendments opens the way for the drawing to a Maritime Registrar. The “approved for production” reso-

соответствующих специалистов с контактной информацией (номер телефона, адрес электронной почты), что существенно упрощает деловые коммуникации. Их участников по функциональному признаку разделяют на три категории:

a) администратор, управляющий проектом с момента его начала и до завершения с соблюдением всех законодательных норм и корпоративных регламентов;

b) инженеры-конструкторы, выполняющие задания в рамках своей профессиональной специализации. Они наделены правом осуществлять соответствующие операции в пределах проекта, к которому они «подключены»;

в) наблюдатели. Это пользователи представляющие интересы верфи, судоходной компании, классификационного общества. Проявляя естественный интерес к результатам проектирования, они могут скачивать необходимые им документы в режиме «только для чтения».

“Форум” в реальном масштабе времени открывает возможности для обсуждения вопросов, возникающих при проектировании; интенсивного обмена уникальными знаниями относительно конструктивных особенностей верфи, судового и производственного оборудования, предлагаемого к поставке, опыта, накопленного при строительстве других судов. Раздел «ссылки» содержит сведения об национальных стандартах, нормативах, международных правилах, иные полезные сведения. Наконец, обеспечено хранение разработанных чертежей в систематизированном виде, что позволяет обращаться к ним в будущем.

На второй фирме организован обмен знаниями одновременно на экзогенном и эндогенном уровнях. Топ-менеджмент уделяет пристальное внимание совершенствованию процедур управления знаниями и развитию культуры сотрудничества внутри корпорации. Главный и региональный офисы оснащены оборудованием для проведения видеоконференций и системами защиты информации. Здесь используют инструментальную разработку, получившую название Kronodoc Solutions. Она позволяет, во-первых, обрабатывать большие потоки информации, имеющие тенденцию к увеличению; во-вторых, создавать, совместно использовать и распространять знания из внутренних и внешних источников; в-третьих, рационально распределять усилия персонала и экономить немалые средства посредством сокращения числа бумажных носителей.

Более того, с её помощью удаётся избежать конфликтов, возникающих при создании того или иного чертежа (как это не раз бывало в прошлом). Когда инженер работает с документом, иные заинтересованные стороны не имеют к нему доступа. Завершённая работа подлежит проверке администратором и только после его позитивной оценки размещается на веб-сайте проекта для ревизии судовладельцем и специалистами верфи. Их письменные замечания и предложения адресат получает по электронной
lution is the actual resolution to produce the ship hull parts and sections; to carry out assembly operations and other works.

The platform has a library of previous projects for the use within the firm. The opportunity to re-apply the knowledge gained in previous periods significantly shortens the period of the design drawings development for the new customers, as well as the period of approval of the documents by the Maritime Registrar. It should be noted that the developers provided the high level of security of Kronodoc: the full access to files is available only in the offices of the company. The rights of access to the information base to the other interested parties are limited.

In addition to the engineering functions, the product performs a number of administrative functions. For example, the “Staff work time logging” application is used to record the number of hours which employees all over the world spend to perform their duties. The automatic registration of the actual logon and logoff is checked. Thus, the accounting department receives the information required for the payroll accounting (including overtime hours), and the management department is able to control and plan the activities of employees. It is noteworthy that the vast majority of the respondents (74%) who participated in the interviews praised the quality of the mentioned tool, describing it as the tool which is well designed and easy to use.

The comparative analysis of the experience of modern ICT technologies application in marine engineering led to the conclusion that both the surveyed firms seek to maximize the impact of the knowledge exchange among their employees and members of the “supply chain”. The choice of software products which help to achieve this goal, is, of course, influenced not only by the financial resources (68%), but also by the internal architecture of each of them (71%). If the organizational structure is simple, the standard relatively simple knowledge management tool is preferred. The arguments in favor of his choice are as follows: the ease of administration (60%) and use (80%), the low initial investments (58%) and the expenditures for current maintenance (62%).

The multinational company (with the matrix internal structure\(^1\)) faces many big challenges. In particular, they

\(^1\) This is a characteristic feature of enterprises specializing in the development of projects which require a non-standard combination of the diverse knowledge, competencies and skills taken from the internal and external environment with the high speed of the information exchange.

\(^2\) Это — характерная черта предприятий, специализирующихся на разработке проектов, для которых требуются нестандартные комбинации разнообразных знаний, компетенций и навыков, извлекаемых из внутренней и внешней среды с высокой скоростью информационного обмена.
are determined by the extensive branch network (46%),
the number of employees (51%), the international client
base (38%), the burdensome travel expenses (47%) (in-
cluding the geographic dispersal of local offices, build-
ing locations, headquarters of the ship owners). It creates
additional risks causing the well-known concern among
the owners (74%) and managers (81%) as the results of
surveys show. Isn’t it surprising that under such cir-
cumstances the knowledge management tools are com-
plicated and become more customer oriented, and the
IT-department staff gets bigger? Only the major market
players can cope with such an additional “burden”.

Despite the discussed differences, ICT technologies
were harmoniously integrated into the process of the
knowledge management and significantly improved the
efficiency of marine engineering in both of these exam-
pies. It refuted the fears expressed by our predecessors
[19 and others], about the allegedly negative impact of
the mentioned tools on the knowledge management of
the firms and a significant increase in the complexity of
the design works. If it does happen, it is compensated by
the rise of the quality of the engineering solutions.

CONCLUSION. 1. The entry of mankind in an
era of knowledge economy has historically coincided
with the transformation of the world into a single global
system in which there is a relatively free movement of
goods, people, capital, and, of course, information as the
embodiment of the gained practical experience as well as
the results of cognitive activity. The worsening of con-
frontation on the market caused by globalization, includ-
ing marine engineering, pushes the firms, specializing in
providing this kind of intelligent services, to find ways
to strengthen their competitive positions.

2. The means of achieving this goal is integrating
of businesses efforts, regardless of their location, orga-
nizational and legal form of business. The criteria for
selection of the best from among the many claimants
are: the economic effectiveness of outsourcing and the
professional competence of specialists (the quality of
their knowledge), as well as their ability to modernize
and expand.

3. The increase of intra- and inter-organizational
knowledge management, the reduction of the expenses of
coordination of marine engineering and the design qual-
ity growth involve the use of information and communi-
cation technologies, which refute the incredulous looks
about them as the undertaken studies showed. The stan-
dard tools are better for the small firms with relatively
simple needs in industrial cooperation. On the contrary,
the platforms which are being developed specifically for cases of the simultaneous knowledge management on the endogenous and exogenous levels, the customers dispersal, the significant amounts of information being processed at the same time, show their advantages.

Список литературы


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✧ полувековые традиции научных исследований
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