**UDC 004.942**
**МРНТИ 50.51.19**

**DOI: https://doi.org/10.37788/2022-3/72-79**

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# On the application of software development tools in the design of information systems

**Abstract**

*Main problem:* Today, information is not only a data source, but also becomes a resource itself that can be fully processed. The amount of information in modern conditions significantly exceeds the amount that control systems stored a few years ago. The modern development of industry, services, education and other spheres that use information not only as one of the main resources, but also as a means of management, requires ensuring a quick search for the necessary data. For example, considering the educational sphere, it can be seen that information forms the basis not only of educational processes, but also acts as the main resource in the organization of the learning process itself. An example is the working curriculum of the discipline, where the number of hours for studying each topic is indicated, as well as practical tasks and control questions assigned to each topic. In the service sector, for example, information is the main resource in the accounting system, which defines any information processing process as a business process. These tasks are solved by developing an information management system that provides optimal access to information that is strictly structured in accordance with the objectives of the organization or enterprise.

*Purpose:* To analyze and perform the first stages of designing an information subsystem on the example of a real business process using instrumental CASE tools designed to automate the software development process. Demonstrate the full cycle of database design of the information subsystem, starting from the construction of the model and ending with the automatic generation of a real database.

*Methods:* The article discusses the most popular methodologies of CASE tools: IDEF0, IDEF1X. The listed methodologies are designed to automate the process of designing and developing programs. The functional model of the business process is built in the notation of the IDEF0 methodology. The business process information model showing the structure of the information system database is built in the notation of the IDEF1X methodology.

*Results and their significance:* The article provides an example of the analysis and design of the information subsystem «Movement of the library's book fund» using instrumental CASE-tools. The process of designing the database of the information subsystem is carried out in full, for the most popular database management systems SQL Server and MS Access. The described example demonstrates the obvious advantages of using modern design methodologies in order to optimize the main stages of software development, which include analysis and design. As a result, a comprehensive model of the business process «Delivery of the book to the reader» was built using tools based on CASE-methodologies. The model includes two points of view: functional and informational components. In addition, the description of the database development process in the example includes all stages: from building a model to automatically generating a real database. The resulting model, as well as the description of its construction, is a clear example of the use of instrumental CASE tools for system analysts and IT developers.

*Keywords:* information system, analysis, design, instrumental CASE tools, model, IDEF methodologies, database.

## Introduction

The development of integration in the information sphere has led to an increase in volumes, and as a result, to an increase in system requirements for information systems. If earlier it was enough to develop a desktop software tool for automating an employee's workplace with storing a database and the program itself at one employee's workplace, now such a solution is suitable only for small information systems where the allocation of a separate storage in the form of a server is irrational. However, as a rule, the creation of an information system requires the development of client-server data warehouses.

Rationally structured information guarantees the reduction and sometimes complete elimination of risks such as duplication and redundancy of data, and, as a result, an increase in the speed of data access and a decrease in memory resources occupied by the database. Thus, solving the problem of data structuring becomes one of the key tasks of an information system developer.

The professionally designed interface of the information system allows users of the system to significantly reduce the process of adaptation to the process of automation of the main functions of the organization. At the same time, a well–thought-out and implemented functionality of a software tool is a task that needs to be solved together with the customer. And in this case, it is also necessary to solve the problem of the most accurate formulation of the task and a sufficiently clear representation of the entire course of work for

the customer at each stage of software development. Solving the problems of data structuring and interface design can be attributed to the main elements of the design and implementation of the information system being developed. These tasks can be rationally implemented through the methodology of system analysis.

**Materials and methods**

Modern methods and technologies of system analysis make it possible not only to optimize the process of designing and developing an information system, but also to automate individual, and sometimes all stages of software design, using a powerful graphical interface, which allows you to solve the third task: the interaction of the customer and the contractor at all stages of information system development. In particular, such methodologies include CASE-methodologies for software development. There are a huge number of tools for developing graphic objects. From this class, it is necessary to highlight special tools that contain not only a powerful set of graphical tools, but also have functionality that allows you to automate part of the operations. Such tools belong to the class of CASE-tools.

The concept of CASE (Computer Aided Software Engineering) is understood as software packages for automating the main stages of information systems development [1], including database design, code generation, testing and other processes. CASE-tools are based on the methodology of designing information systems. CASE-methodologies allow us to describe the model of the future information system from various positions. For example, system design requires building a database structure. On the other hand, to develop the system interface, you will need to accurately represent the functionality of the information system.

One of the current directions of designing information systems that support CASE-methodologies is the IDEF family of methodologies. IDEF (ICAM Definition – definition of the main terms of the ICAM program) methodologies were developed within the framework of the ICAM (Integrated Computer Aid of Factory – integrated computer assistance to production) program. [2] Of the many popular tools based on the IDEF family of methodologies, the most popular is the AllFusion Process Modeler.

AllFusion Process Modeler (BPwin) refers to tools for visual modeling of business processes that do not require writing program code. The tool allows you to optimize the software design process, which allows you to significantly reduce costs already at the first stages of development, eliminate unnecessary operations, increase the flexibility and efficiency of the future information system.

AllFusion Process Modeler supports three standard notations:

– IDEF0 (Functional Modeling methodology);

– DFD (Data Flow Modeling Methodology);

– IDEF3 (modeling of work flows - scenarios).

In addition, the AllFusion Process Modeler tool supports integration with the ERwin Data Modeler program, which allows you to build a future database project in the IDEF1X methodology. In addition, the ERwin Data Modeler tool allows you to automate the process of generating a real database based on a built model, the most popular of which are MS Access, MySQL, SQL Server.

Thus, IDEF methodologies allow us to build an information system model from various points of view: by functionality (IDEF0), by database structure (IDEF1X), by the scenario of the work performed (IDEF3).

**Results**

An example of designing an information system at the stage of system analysis of a subject area using CASE tools is the process of developing a model of the information subsystem «Movement of the Library's book fund». To demonstrate the use of CASE tools and methodologies, the business process «Issuing a book to the reader» is presented.

It should be noted that a business process is understood as a purposeful sequence of functions aimed at creating a result that has value for the consumer [3]. From this point of view, the process of rendering a service, the result of which is the receipt of a book by the reader, can be considered as a typical business process.

Two diagrams are included in the model of the described business process:

– IDEF0 (AllFusion Process Modeler tool);

– IDEF1X (ERwin Data Modeler tool).

The diagrams in the complex allow to formulate the full functionality at the first stages of the analysis and design of the information system, as well as to structure the information in the form of a database. It should be noted that the process of designing the database structure automates the entire cycle, including building a model and exporting it to a real SQL Server database management system.

The IDEF0 functional modeling diagram visually allows you to simulate a sequence of functional blocks connected by information or material flows. Their execution leads to the goal of the described process. The information subsystem «Movement of the library's book fund» includes several business processes. These include the accounting of the book fund, the issuance and return of books by readers, the write-off of outdated books, the issuance of a fine for spoiling books, etc. In the example, an example of building a business process model «Issuing a book to a reader» will be considered.

The graphical interpretation of the descriptive model IDEF0 at the upper level is presented as a contextual diagram describing the business process in the «first approximation».

Input information flows: a catalog (list) of books, as well as data about readers. The output stream is the goal: the material flow «Book» or the information flow «E-book». At the same time, the document can also be a

material flow of a real business process, or it can also act as an information flow in the projected information system.

The mechanisms of the process include: library staff and readers.

The control flows in the business process under consideration should include instructions on the rules for issuing and returning books, as well as the library's work schedule. These flows will determine the rules, conditions and limitations of the business process in question.

Figure 1 shows the only functional block of the top level of the diagram, which includes the business process, as well as all information and material flows, control actions and mechanisms of the described process.

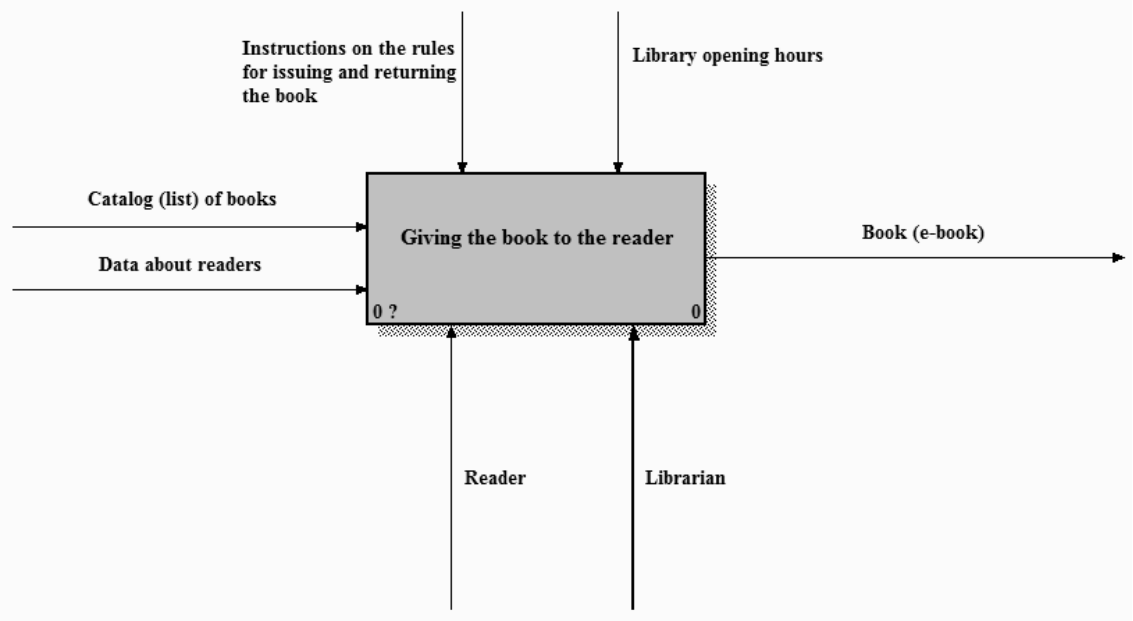


Figure 1 – Context diagram IDEF0 (top level)

The lower level of the diagram provides a detailed description of the business process as a sequence of functional blocks connected by information or material flows. Figure 2 shows the lower level of the functional business process modeling diagram in the IDEF0 methodology.

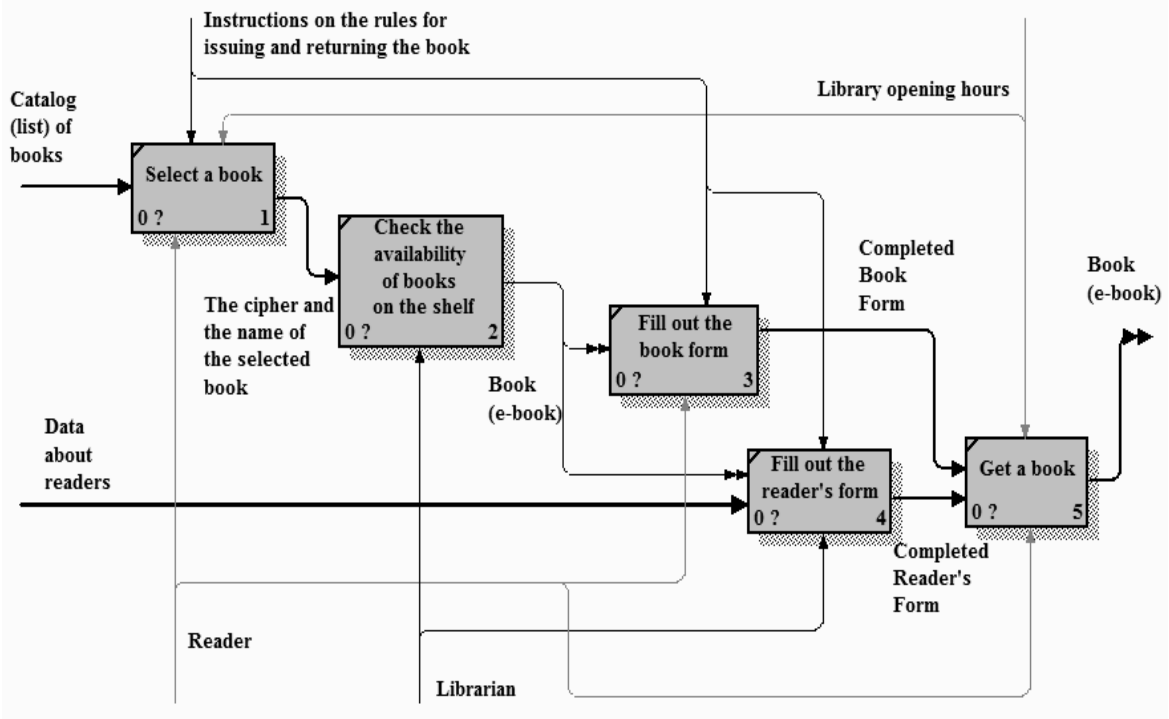


Figure 2 – Diagram of functional modeling of a business process in the IDEF0 methodology (lower level)

As a result of the analysis of the business process model, it is possible to determine the «weak links» of the real business process. In particular, when developing an information system, the consequence of an unsuccessfully completed second block should be taken into account: the book is not available (for example, due to write-off or non-return by another reader). In this case, it would be rational to take into account in the projected information system the possibility of returning the user to search for a book, or logging out of the system. In the IDEF0 diagram, such transitions are difficult to implement, because this methodology does not specify the dynamics of the business process, but only describes the relationship of the process functions through information or material flows. At the same time, it is the information flows that form the basis of the database of the information system. Thus, already in the IDEF0 diagram, it is possible to give the first recommendations on structuring information flows stored in the format of entities (tables). So, it is clearly seen that at least three tables are required: data on readers, data on the librarian (employee), as well as a catalog of books.

To develop a database model of the projected information system, the methodology of semantic (informational) modeling of the IDEF1X ICAM family was chosen. The ERwin Data Modeler program is selected as a tool.

Figure 3 shows a logical database model in the methodology of ER diagrams.

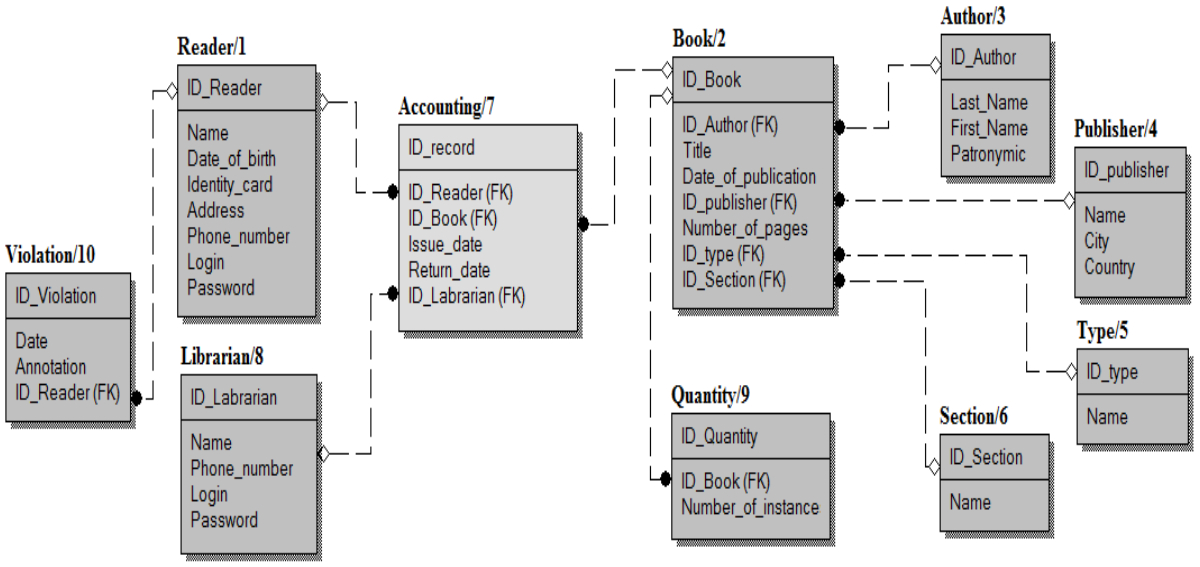


Figure 3 – The business process database model in the IDEF1X methodology

The use of CASE-tools for automating the process of designing and implementing an information system can be clearly demonstrated by the example of building a real database using a built model in the ERwin Data Modeler environment.

The first example shows the creation of a database in the MS Access database management system. It should be noted that modern versions of this system still allow using this platform as a data warehouse for corporate information systems, including client-server applications. The IDEF1X model is used as the basis for building the database.

To solve the problem, the following algorithm should be performed.

Step 1. Create a new empty database in MS Access, without tables and data.

Step 2. Convert the database model to the «physical» model format by sequentially selecting the menu commands: Tools – Reverse Engineer..., and set the database type.

Step 3. When going to the next window (the «Next» button), specify the name and full path to the empty database created at the beginning of the algorithm execution and complete the step by clicking the «Connect» button.

Step 4. Execute the Tools – Forward Engineer – Schema Generation command. In the dialog box that opens, run the command «Generate...».

In the case of a correctly constructed model, a database with automatically constructed tables and relationships between them will be created in MS Access. Figure 4 shows a data schema that shows the relationships between tables that are completely identical to the relationships of the database model. At the same time, the structure of tables, key fields, as well as the types of relationships between tables, were built by the instrumental CASE tool automatically, strictly according to the specified parameters of the IDEF1X model.

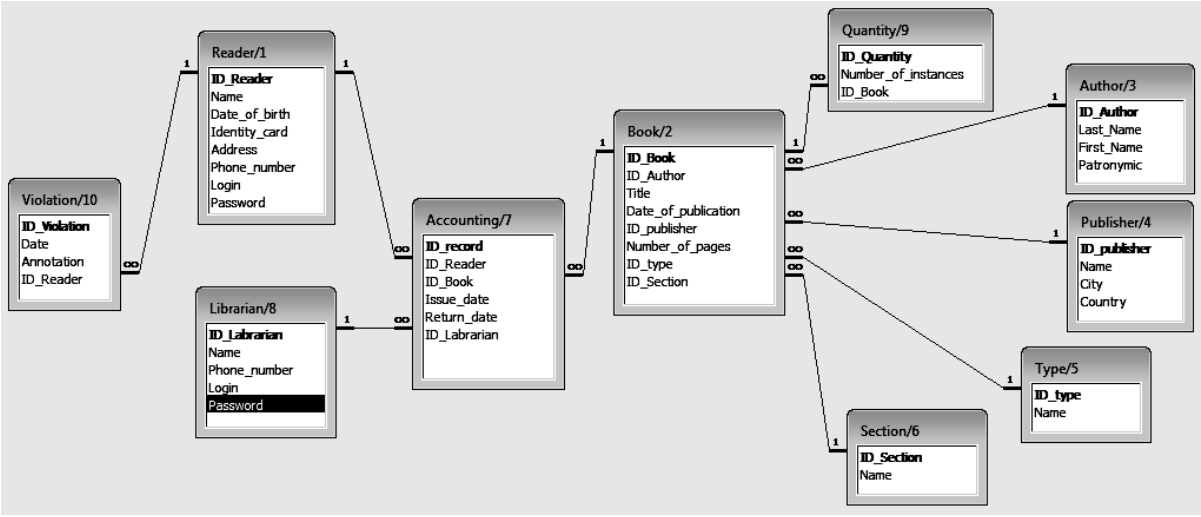


Figure 4 – Data schema in MS Access as a result of automatic generation based on the IDEF1X model

The second example demonstrates the process of automatic database generation in the SQL Server environment based on the IDEF1X model of the described business process «Book Delivery to the reader».

One of the most popular database management systems, SQL Server, will be used as a repository of real data. Instrumental CASE tools allow you to automate the process of building a real database structure using the IDEF1X model. To do this, you need to run an algorithm that differs from the sequence of actions discussed in the previous example. This difference is justified only by the peculiarities of working in the SQL Server client-server system.

The algorithm of automatic database generation in SQL Server based on the IDEF1X model in the ERwin Data Modeler environment can be briefly represented by the following sequence of steps.

Step 1. Translate the database model into a «physical» model that is maximally compatible with real databases.

Step 2. Create a new database in SQL Server that does not contain tables and data.

Step 3. Set the database type: DataBase – Choose DataBase – SQL Server.

Step 4. Execute the Tools – Forward Engineer – Schema Generation command.

Step 5. In the dialog box that opens, run the «Generate...» command, and then set the server name, database, and access password (if it is installed in the SQL Server settings).

As a result of performing all the steps of the algorithm, a real database structure will be created in the SQL Server environment, as shown in Figure 5.

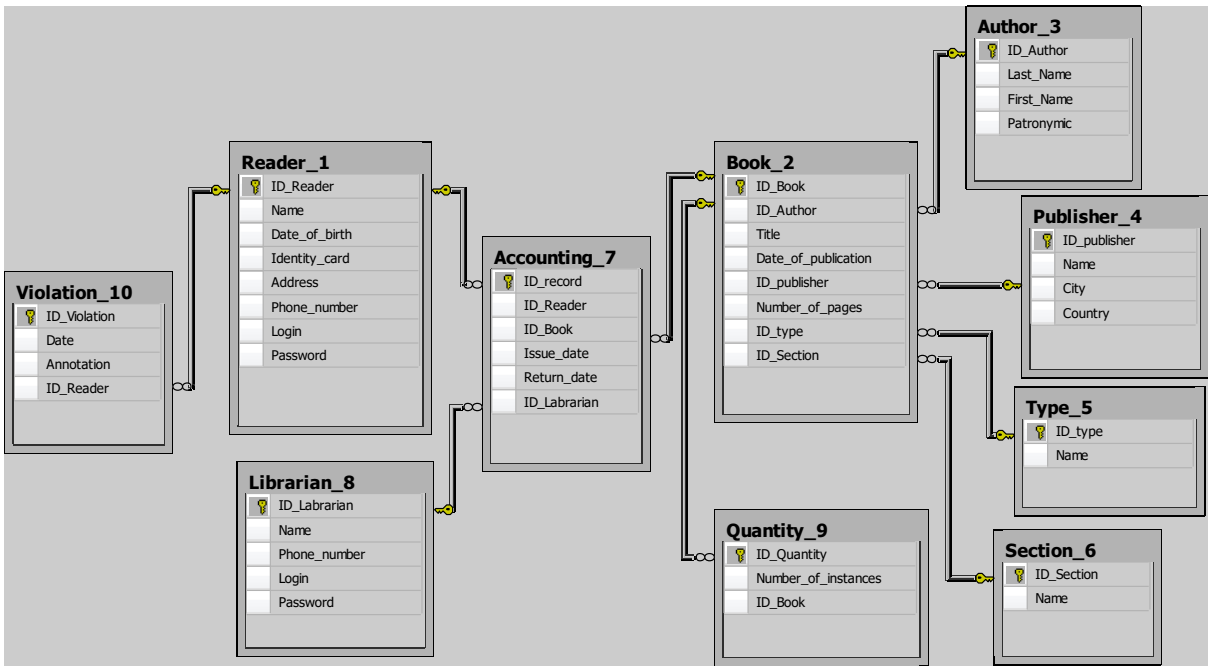


Figure 5 – Data schema in SQL Server as a result of automatic generation based on the IDEF1X model

As can be seen from the database diagram, the relationships between tables, automatically constructed by the instrumental CASE tool, strictly correspond to the specified parameters of the IDEF1X model.

**Discussion**

The given example of constructing functional and information models of one of the business processes of the projected information system « Movement of the library's book fund» using instrumental CASE-tools clearly demonstrates the advantages of automating the design process over the traditional approach of software development. In particular, even at the stage of designing an information system, diagrams represent business process models. This allows designers to demonstrate as clearly as possible both the structure of the future information system and its functionality. At the same time, automation tools can significantly reduce the design time of an information system, especially if the model structure contains a large number of objects. So, for example, if the database model has a sufficiently large number of tables, then creating them «manually» will take a significant part of the time allotted for design. The design process in the traditional way becomes more complicated if you need to make changes to an existing database. These problems can be solved with the help of tools based on the use of CASE technologies.

**Conclusion**

To achieve the goal of demonstrating the use of instrumental CASE-tools for automating the design of software systems, tasks were set, the first of which is the task: to show, by the example of designing a real business process "Giving a book to the reader" of an information subsystem, the use of an instrumental CASE-tool for functional modeling AllFusion Process Modeler (BPwin), which does not require writing program code. The second task was to demonstrate the process of completing the full cycle of database construction, starting from the design of the model and ending with the automatic generation of a real database using the ERwin Data Modeler CASE tool. As a result of the analysis and design, two diagrams were obtained describing the business process from two points of view: functional and information models. As a result of the design, two algorithms were formulated for automating the process of building the structure of a real database in MS Access and SQL Server environments based on the IDEF1X model using the capabilities of automatic generation of an instrumental CASE tool. The given example of designing a business process demonstrates the advantages of using CASE tools in order to optimize the process of developing software systems.

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### Ақпараттық жүйелерді жобалау кезінде бағдарламаларды әзірлеудің аспаптық құралдарын қолдану туралы

Бүгінгі таңда ақпарат тек деректер көзі ғана емес, сонымен бірге толық өңдеуге болатын ресурсқа айналып отыр. Қазіргі жағдайда ақпараттың мөлшері бірнеше жыл бұрын басқару жүйелері сақтаған көлемнен едәуір асады. Ақпаратты негізгі ресурстардың бірі ретінде ғана емес, басқару құралы ретінде де пайдаланатын өнеркәсіптің, қызмет көрсету саласының, білім беру және басқа да салалардың қазіргі заманғы дамуы қажетті деректерді жылдам іздеуді қамтамасыз етуді талап етеді. Мысалы, білім беру саласын қарастыра отырып, ақпарат тек оқу үрдістерінің негізін ғана емес, сонымен қатар оқу үрдісін ұйымдастырудағы негізгі ресурс болып табылатындығын көруге болады. Мысал ретінде пәннің жұмыс оқу бағдарламасы болады, онда әр тақырыпты зерттеуге арналған сағат саны, сонымен қатар әр тақырыпқа бекітілген практикалық тапсырмалар мен бақылау сұрақтары көрсетілген. Қызмет көрсету саласында, мысалы, ақпарат бухгалтерлік есеп жүйесінде негізгі ресурс болып табылады, ол ақпаратты өңдеудің кез-келген үрдісін бизнес-үрдіс ретінде анықтайды. Аталған міндеттер ұйымның немесе кәсіпорынның міндеттеріне сәйкес қатаң құрылымдалған ақпаратқа оңтайлы қол жеткізуді қамтамасыз ететін басқарудың ақпараттық жүйесін әзірлеу арқылы шешіледі.

Мақалада CASE құралдарының ең танымал әдістемелері қарастырылады: IDEF0, IDEF1X. аталған әдістемелер бағдарламаларды жобалау және әзірлеу үрдіссін автоматтандыруға арналған. Бизнес-процестің функционалды моделі IDEF0 әдіснамасына негізделген. Ақпараттық жүйенің мәліметтер базасының құрылымын көрсететін бизнес-процестің ақпараттық моделі IDEF1X әдіснамасына негізделген.

Мақсаты - бағдарламаларды әзірлеу үрдісін автоматтандыруға арналған аспаптық CASE құралдарын қолдана отырып, нақты бизнес-процесс мысалында ақпараттық ішкі жүйені жобалаудың алғашқы кезеңдерін талдау және орындау. Модель құрудан бастап нақты дерекқорды автоматты түрде құруға дейінгі ақпараттық ішкі жүйенің мәліметтер базасын жобалаудың толық циклін көрсетіңіз.

Мақалада аспаптық CASE құралдарын қолдана отырып, «Кітапханадағы кітап қорының қозғалысы» ақпараттық ішкі жүйесін талдау және жобалау мысалы келтірілген. SQL Server және MS Access дерекқорларын басқарудың ең танымал жүйелері үшін ақпараттық ішкі жүйенің мәліметтер базасын жобалау үрдісі толығымен аяқталды. Сипатталған мысал талдау мен дизайнды қамтитын бағдарламалық жасақтаманы әзірлеудің негізгі кезеңдерін оңтайландыру үшін заманауи дизайн әдіснамаларын қолданудың айқын артықшылықтарын көрсетеді. Нәтижесінде CASE-әдіснамаларға негізделген аспаптық құралдарды қолдана отырып, «Оқырманға кітап беру» бизнес-үрдісінің кешенді моделі жасалды. Модель екі көзқарасты қамтиды: Функционалды және ақпараттық компоненттер. Сонымен қатар, мысалдағы мәліметтер базасын құру үрдісінің сипаттамасы модель құрудан бастап нақты дерекқорды автоматты түрде құруға дейінгі барлық кезеңдерді қамтиды. Алынған модель, сондай-ақ оның құрылысының сипаттамасы жүйелік талдаушылар мен IT-әзірлеушілерге арналған аспаптық CASE құралдарын қолданудың жақсы мысалы болып табылады.

Түйінді сөздер: ақпараттық жүйе, талдау, жобалау, аспаптық CASE-құралдар, модель, IDEF әдіснамасы, деректер базасы.

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**О применении инструментальных средств разработки программ при проектировании информационных систем**

Сегодня информация представляет собой не только источник данных, но и сама становится ресурсом, который может быть подвергнут полной обработке. Количество информации в современных условиях значительно превышает тот объем, который хранили системы управления еще несколько лет назад. Современное развитие промышленности, сферы услуг, образовательной и других сфер, использующих информацию не только как один из основных ресурсов, но и как средство управления, требует обеспечения быстрого поиска нужных данных. Так, рассматривая образовательную сферу, можно видеть, что информация составляет основу не только учебных процессов, но и выступает основным ресурсом в организации самого процесса обучения. Примером может служить рабочая учебная программа дисциплины, где указывается количество часов на изучение каждой темы, а также закрепленные к каждой теме практические задания и контрольные вопросы. В сфере услуг информация является основным ресурсом в системе учета, что и определяет любой процесс обработки информации как бизнес-процесс. Перечисленные задачи решаются разработкой информационной системы управления, обеспечивающей оптимальный доступ к информации, строго структурированной в соответствии с задачами организации или предприятия.

В статье рассматриваются наиболее востребованные методологии CASE-средств: IDEF0, IDEF1X. Перечисленные методологии предназначены для автоматизации процесса проектирования и разработки программ. Функциональная модель бизнес-процесса построена в нотации методологии IDEF0. Информационная модель бизнес-процесса, показывающая структуру базы данных информационной системы, построена в нотации методологии IDEF1X.

Цель статьи - провести анализ и выполнить первые этапы проектирования информационной подсистемы на примере реального бизнес-процесса с использованием инструментальных CASE-средств, предназначенных для автоматизации процесса разработки программ. Продемонстрировать полный цикл проектирования базы данных информационной подсистемы, начиная от построения модели и заканчивая автоматической генерацией реальной базы данных.

В статье приведен пример анализа и проектирования информационной подсистемы «Движение книжного фонда библиотеки» с использованием инструментальных CASE-средств. Процесс проектирования базы данных информационной подсистемы выполнен в полном объеме, для наиболее востребованных систем управления базами данных SQL Server и MS Access. Описываемый пример демонстрирует явные преимущества применения современных методологий проектирования с целью оптимизации основных этапов разработки программного обеспечения, к каковым относятся анализ и проектирование. В результате построена комплексная модель бизнес-процесса «Выдача книги читателю» с применением инструментальных средств, базирующихся на CASE-методологиях. Модель включает две составляющие: функциональную и информационную. Кроме того, описание процесса разработки базы

данных в примере включает все этапы: от построения модели до автоматической генерации реальной базы данных. Полученная модель, а также описание ее построения является наглядным примером применения инструментальных CASE-средств для системных аналитиков и IT-разработчиков.

Ключевые слова: информационная система, анализ, проектирование, инструментальные CASE-средства, модель, методологии IDEF, база данных.

**Date of receipt of the manuscript to the editor:** 2022/08/12