DESIGN OF GEOGRAPHIC INFORMATION SYSTEMS

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Introduction. The process of designing geographic information systems has a significant impact on the functionality and level of tasks to be solved. The basic principles, approaches, methods and techniques for designing geographic information systems are presented.

Aim. The work includes consideration of GIS design, reasons for failures of the first GIS, the main problem of modern GIS, the need for GIS design, external and internal GIS design, software development, GIS organizational environment, structured design model, formalized GIS design methodology, information products combining submissions, database design, verification and approval.

Materials and methods. The process of designing geographic information systems has a significant impact on the functionality and level of tasks to be solved. The design of a viable GIS includes the selection of tools, the definition of objects and their relationships, the choice of research area and data evaluation.

The first GIS (1960s) were created as university experimental systems or intra-corporate systems. *The main causes of failure. The first GISs were that they did not work as analytical systems, often gave erroneous results and had very low performance and, moreover, were often poorly designed as software systems.*

The main problem of modern GIS is the mismatch of software capabilities and consumer needs in data, analysis, training, recognition. The importance of designing geographic information systems is determined by their high complexity. Geographic information systems are among the most complex commercial software systems.

The main components of the design process include external and internal issues of GIS design. General GIS design includes system design with technical and organizational design issues, etc. software design.

System design of geographic information system considers the interaction of individuals, groups of people and hardware within the organization, taking into account the impact of the system on people, the nature of their work and the functioning of the organization.

Geographic information systems fundamentally change the work of institutions specializing in the analysis of spatial data.

The peculiarities of GIS implementation are the need for additional staff training, the cost of purchasing software and hardware, changes in information flows and structure of the institution, increasing attention to data integrity and quality, increasing the relevance of security and quality control measures within the institution.

Technical design or internal issues cover tasks related to system and database functions. The main technical issues are the proper functioning of the system, the availability of staff with appropriate training, the possibility of changing the system due to changing needs.

The main organizational issues are the adequacy of funding for long-term operation of the system, the ability to obtain information at an affordable price, the need to involve third-party experts to adapt software, adequacy of support from software providers, the possibility of legal liability for errors in analysis. within the performed analysis.

The purpose of software development is to create programs that successfully solve or help solve problems that were previously performed manually. Before starting the implementation of GIS, it is necessary to determine the needs of the user, including the needs of analysis and training, compliance of analytical methods with the overall objectives of the institution. Before you start writing code, you need to prepare information about the data structure and model; programs that have the necessary analytical capabilities at a minimum cost; the system that best meets the goals of the institution and staff training requirements.

Among the first ideas in the field of systems design was the idea of the project life cycle. This idea is to determine the methodology of implementation, which

ensures the successful completion of work, including the definition of subtasks and the order of their implementation. The project life cycle is its basis, and most decisions are made by the manager. The project life cycle provides benchmarks to support the right decisions at the right time. Among the first methods of implementing the project life cycle was a linear model of system design. The main stages of the linear model of software system development include the definition of user requirements, definition of functional needs, system analysis, detailed design, testing of individual modules, subsystems and the system as a whole. The linear model provides an orderly movement from the analysis of requirements to the commissioning of the information system. Problems with the application of a linear model of systems design are related to the need to complete each stage before the next; the difficulties of almost every implementation and the inability to anticipate all possible problems before the start of the project; possible changes in financing that will require adjustment of system requirements and possible changes in the functions of the system by the customer and / or developer.

The organizational environment of GIS includes internal and external participants. Internal participants are users, operators and sponsors of the system. External participants are GIS vendors, application developers and systems analysts.

The structured model of the design process includes software development and system design (organizational and technical with system functionality and database).

Simplified GIS design model includes initial presentation (consideration of system implementation), conceptual presentation (requirements definition and database design), detailed presentation (mapping to a specific GIS package: database and application development) and system implementation.

Conceptual design allows you to plan further development and change of the system. The concept should be flexible to take into account further changes in purpose, data availability, staffing and management requirements. Independence from a specific GIS package is essential. The functionality and viability of the system can be largely determined by the availability, cost and quality of data to solve problems.

Data and relationship requirements models include a data needs model (the

availability of certain data determines which analysis can be performed) and an application needs model (the system is determined by the analysis it must perform).

The spiral model includes activity levels (initial, conceptual and detailed) and design tasks (information gathering, information organization, information analysis) and consists in performing such steps of the design process: 1st - information from the client is used to determine the purpose of the institution as a declaration of products and services; 2nd - definition of GIS functionality with clarification of spatial information products for users; 3rd (parallel to 1) - analysis of development constraints including budget and further project support, time to achieve the end result, availability and cost of data for the project; 4th - comparison of user needs with existing restrictions; 5th - adjusting the goal to resolve conflicts in the formation of a balance of needs and constraints to determine the possibility of implementation; 6th - performance of preliminary analysis of the cost of sales and returns; 7th - preparation of a report on the limitations and feasibility of implementation; 8th - assessment by the customer of the possibility of implementation.

Costs include funds for data acquisition, hardware acquisition, software acquisition, software maintenance, staff training and operations, data entry, premises, and more. And the distribution of costs includes initial investment and operating costs.

GIS information products are the results of software analysis. A set of software products can be compact and structured, and a set of software products can be permanently variable. Design errors are usually due to the lack of prior study of the system, so the result may be either redundant or insufficient functionality.

Local ideas about what and how GIS should be performed are then combined using the pairwise grouping of similar users or groups method. The most common needs will determine a set of priorities that compare to the main tasks. Detecting contradictions between views is eliminated in different ways, and combining views into groups can take place in several iterations. The final decision on determining the general representation rests with the administration.

Database design includes definition of study area, scale, resolution, level of detail, classification, coordinate system, projection, software selection. The field of study is often determined on the basis of a formal decision. It may be based on political, administrative, physical, etc. boundaries and reflect financial and data constraints.

The scale is determined by the best available data, better more details than less. For raster data, the amount of data increases rapidly as the raster cell size decreases. Large amounts of data significantly slow down the performance of analytical tasks. The result of solving these problems may be due to additional external factors.

When designing a GIS, it is necessary to consider not only the available data, but also the classification system that meets the requirements of modeling. The use of detailed classification gives the user more information. Classification is more than just choosing the right level of detail. It must be possible to carry out a harmonized classification.

The coordinate system is determined by the size of the study area and the available data. Transforming projections introduces additional errors into the data. The characteristics of the earth's surface that must be preserved affect the choice of coordinate system. Spatial and temporal compatibility are very important for the correctness of the decision-making process.

Choosing acceptable software is always difficult. The choice of data model is based on the types of analysis determined by spatial information products. Many modern GIS support multiple data models and use a set of analytical modules. The choice of hardware platform and peripherals is determined by financial constraints, accuracy requirements, learning conditions and personal preferences.

From the point of view of operation, the design methodology is determined by the quality of the results obtained from the implementation of GIS. GIS must solve problems correctly and in a timely manner. The product must meet the needs of the institution, based on the needs of individual users.

Results and discussion. The basic principles, approaches, methods and techniques for designing geographic information systems are presented.

Conclusions. The paper considers the design of working GIS, the causes of failures of the first GIS, the main problem of modern GIS, the need for GIS design, external and internal issues of GIS design, software development, GIS organizational environment, structured design model, formalized GIS design methodology, GIS information products combining submissions, database design, verification and approval.

Literature

1. Геоинформатика: Учеб. для студ. вузов / Е.Г. Капралов, А.В. Кошкарев, В.С. Тикунов и др.; под ред. В.С. Тикунова. – М.: Издательский дом «Академия», 2005. – 480 с.

2. ДеМерс Майкл Н. Географические информационные системы. Основы.: Пер. с англ. – М.: Дата+, 1999. – 489 с.

3. Скворцов А.В. Геоинформатика: Учебное пособие. – Томск: Изд-во Том. ун-та, 2006. – 336 с.

4. Pasichnyk O. Basics of programming for geoinformation systems // Topical issues of modern science, society and education. Proceedings of the 8th International scientific and practical conference. SPC “Sci-conf.com.ua”. Kharkiv, Ukraine. 2022. Pp. 226-229.

5. Технології комп’ютерного проектування: конспект лекцій для здобувачів вищої освіти (ОР «бакалавр») спеціальності 122 «Комп’ютерні науки» / О.А. Пасічник, Р.В. Сорокатий, Т.К. Скрипник, Е.А. Манзюк. – Хмельницький: ХНУ, 2021. – 136 с.

6. Основи об‘єктно-орієнтованого програмування: навч. посіб. для студ. ВНЗ / Сорокатий Р.В., Пасічник О.А., Скрипник Т.К. – Хмельницький: ХНУ, 2019. – 175 с.