# THE LIFE CYCLE OF AN INFORMATION SYSTEM

Information systems belong to the class of artificial systems: they are created and operated by people, which means that throughout the entire period of the existence of IP it is possible to plan the phases of its life, influence the development and functioning of the system, i.e., manage its life cycle.

**The life cycle of an information system** is a set of stages and stages that IP passes from the moment a decision is made to create it until the moment of termination of operation.

The United States Institute of Electrical and Electronics Engineers (IEEE), which is developing internationally recognized standards, gives the following definition: **Information systems life cycle** - the period of time that begins from the moment a decision is made about the need to create an information system and ends when it is complete decommissioning.

**System life cycle:** development of the system in time over time, from concept to decommissioning.

**Life Cycle –** development of a system, product, service, project or other human-made objects, starting from the concept development stage and ending with the termination of use.

In the life cycle of the system, it is customary to distinguish phases characterizing the state of the IP in time. Several different phases of the IP life cycle are chronologically distinguished, for example: nucleation, growth, maturity, aging, death.

The life cycle of information system is characterized not only by phases, but also by stages, structure and models of life cycle (Fig. 11.1).

**IS LC stage** – The information life cycle is characterized not only by phases, but it is a logically completed part of the system life cycle, which is characterized by a certain current state of software and hardware, a set of phased work stipulated by the regulations, and the corresponding results fixed in the compiled documentation.

**Stage:** a period within the life cycle of a system related to the state of the system or directly to the system.

**Stage "Design" -** an assessment of the economic, technical, strategic and market fundamentals of future actions to create information system. Market analysis, economic analysis, forecasting, feasibility analysis of design decisions, compromise analysis, technical analysis, assessment of total costs over the life of the system are carried out. Specifications are compiled for supporting systems for

the design, coding, implementation, operation, maintenance and decommissioning of information system.

Phases LC

Stages LC

Structure LC

Models LC

Foundation IS

Idea

Agreement processes

Cascade model LC

Development

Aging IS

Production

Process of company

Iteration model LC

Death IS

Integration

Project processes

Spiral model LC

Application

Stopping the application

Technical processes

Life cycle of information system (LC IS)

Fig. 11.1. Information System Life Cycle Features

The output of this stage is the formalized requirements of the customer, the concepts of the functioning of the information system, the model of the life cycle, the assessment of the feasibility of the project, preliminary system requirements, approximate design solutions in the form of drawings, models, prototypes, etc. The requirements for human resources are formulated, preliminary design schedules are drawn up. An approximate cost plan for information system throughout the entire life cycle is drawn up. A decision is made to move to the next stage of work or to terminate the project.

**Stage "Development" -** designing an information system. System requirements and design solutions are detailed, the hardware, software and operator interfaces are defined, analyzed, designed, manufactured, integrated, tested and evaluated, the requirements for production, training and support tools are determined.

In this case, modeling of production, economic, financial situations and, in general, business processes is carried out, the formulation of tasks and their solutions is formalized. For these purposes, high-tech tools are used, such as specialized design automation systems (CAD) or universal CASE-technology. Schemes and models of design decisions are visualized in the form of flowcharts and other illustrations.

At the development stage, guarantees and evidence are provided (validation and verification) that all customer requirements are taken into account and fulfilled, and the system is able to realize its mission, current and future goals at all stages of the life cycle.

The results of the development phase are:

* system architecture, consisting of elements of software and hardware, people and their internal and external interfaces (diagrams, drawings and models of hardware; design software documentation; interface specifications; maintenance procedures; features of IS removal and cancellation, etc.);

* the system itself in its final form or its prototype;

* documentation (on validation and verification, production plans; work instructions; operator training manuals, etc.);

* plans (costs for the subsequent stages of the information system life cycle IC; the functionality of the supporting systems necessary for the subsequent stages of the life cycle; plans and criteria for completing the next stage - the stages of information system production, etc.

**Stage "Production" -** coding (implementation, manufacturing) and testing of information system**.** Each of the previously highlighted modules is programmed in a language appropriate for the application. Written software modules are tested, debugged, and for this, adequate testing tools are selected. The necessary supportive and supportive systems are also manufactured and tested. If necessary, the manufacture, assembly and adjustment of the technical equipment included in the system is carried out.

This stage can intersect with both the previous stage (development), and with subsequent.

**Stage "Implementation" -** the implementation of a complex of multi-stage work on the setup, commissioning, testing and launch of information system. The customer is shown all the functionality and characteristics of the manufactured information system in accordance with each paragraph of the technical specifications for the development of information system. The last stage ends with the signing of the act of acceptance of the product, which means the complete readiness of the information system for its practical operation.

From the point of view of the information manager, an important element of this stage is the delivery to the customer, together with the information system, of a set of special means of maintaining the system in working condition, forming the information **service system**, which includes:

* testing tools (tests, monitoring, diagnostics) to identify the current state of the system and its elements, individual types of support and interaction of subsystems (stress resistance tests, as well as regular, certification, post-test and other tests);

* means of ensuring staff work in the IP environment,

* facilities for maintenance of technical elements (instructions and manuals, as well as troubleshooting manuals and settings).

The task of the information manager is to ensure by the beginning of this stage the completion of the necessary staff training, its certification and staffing. At the same time, the use of modern large information systems is characterized by the use of outsourcing (the enterprise transfers part of its work to be performed by another company) and subscription service to the system by the development personnel or special service companies.

**Stage "Application" -** operation and maintenance. At this stage, the development of IP takes place first, during which the implementation of typical activities is practiced. Errors in the program are identified and corrected, reports on deviations, shortcomings and failures of the system are compiled, the system is adapted to the environment. As a result, IP reaches the level of declared operational characteristics, and its staff and users acquire the necessary knowledge, skills and abilities in a changing technological environment.

In the course of further operation of the information system, the monitoring of the functioning characteristics is carried out, identification and classification of problems or deficiencies, informing the relevant organizations and persons (users, developers, manufacturers or service bodies) about the need for corrective actions. Decisions are made on the maintenance, minor (temporary) or significant (permanent) modifications.

The system, in this way, is developing and improving, its new configurations and versions appear. Additional opportunities for improving information system are identified and analyzed, which can extend the life of the system.

At the same time, information system is maintained, i.e., it supports the functioning and use of the system of its components and the services it provides through maintenance, minor repairs, logistics, determining current risks and actions to minimize them.

As a result of the support, organizational interfaces are established with technical and industrial organizations that provide guaranteed solutions to problems and conduct corrective actions, and ensures the continuous operation of information system and the sustainable provision of services that support its application.

The escort service also solves the problems of further adapting the system to the characteristics of the enterprise by eliminating identified shortcomings in the operation, efficiently filling the information resource and progressive development of IP, as well as advising users of the system and contributing to increased user friendliness of the interface. In accordance with changes in the activities of the enterprise, its information system is being modernized.

Thus, at the stage of operation and maintenance of information system, the functions and control parameters of the system are adjusted, as well as operational maintenance and administration.

**Stage “Termination of Application" -** the seizure, retirement, liquidation of IP and related operational and support services.

This stage is applied when the deadline for fulfilling the functions of information system ends. The end of this period may occur due to replacement by

a new system, unrecoverable depreciation, and catastrophic failure, loss of interest on the part of the user or in the case when continued application and support of the system in question is economically inefficient.

In addition, the **reengineering of the information system** can so profoundly change the existing information system that it will legitimately speak of its actual liquidation and the creation of a new information system. In such cases, at the end of this stage, the transition to the first stage of the information system life cycle is carried out - the design stage.

Reengineering is understood as a fundamental restructuring of the system in connection with radically changed conditions for its functioning, such as:

* a significant change in internal conditions: deep modernization of the enterprise’s business processes, its reprofiling (change of industry, type of activity, etc.), its reorganization (merger, merger, crushing, etc.);

* a significant change in the external conditions of functioning, the characteristics of the external environment: (new requirements of the legislation and supervisory bodies, the transformation of general economic and political economic conditions - for example, monetary or legal reform, militarization of the economy, etc.);

* the final moral and physical obsolescence of the means of ensuring the activity of information system and the system itself for natural reasons.

From the point of view of the information manager, it is important to understand that the processes of both reengineering and liquidation (utilization) of the information system require the enterprise to plan certain, sometimes quite significant, cash costs. At the same time, the enterprise should have the infrastructure to support the process of removing and writing off IP, including tools, instruments, equipment and personnel trained in the relevant actions and procedures, as well as means for processing, removing or preserving IP elements.

As a result of the processes of this stage of the life cycle:

* the use of information system is terminated, including its removal from the environment of use, updating or processing in accordance with legislation in the field of health, safety, protection, secrecy and environmental protection;; * archiving of information system elements is provided;

* plans and procedures for the transfer of functions of the new information system are being formed;

* waste is removed;

* the environment returns to its original or other agreed state; * transfer, transfer or dismissal of relevant personnel.

So, throughout the life cycle of the information system at various phases and stages, various and complex processes of a technical, economic and social orientation are implemented, requiring mandatory interconnection among themselves, coherence and consistency.

**The life cycle process** is a set of interrelated or interacting activities that transform some input into output. Each process contains a specific set of actions,

and each action, in turn, consists of a range of tasks. Each task has its own set of methods and procedures.

**The objectives of the life process** are requirements (―should‖), recommendations (―should‖) or acceptable actions (―may‖) designed to support the achievement of outputs (results) of the process..

**Basic principles** for determining the processes of life cycle:

* connectedness principle - all life cycle processes are connected and connected in an optimal way, considered practical and feasible;

* principle of responsibility - the process is transferred to the responsibility of any organization or party throughout the life cycle.

The processes of information systems life cycle are aggregated into four groups, namely: agreement (contracting) processes, enterprise processes, project processes and technical processes (Fig. 11.2). Moreover, the last three groups of processes are nested one into the other: enterprise processes are generally organizationally supporting information system life cycle; within this group are the design processes responsible for the implementation of the project as a whole, within which the technical processes that carry out the work, rather than organizing it, function.

In the given process structure of the information system life cycle, the **project** is understood as an attempt to act with specific start and end dates, undertaken to create a product or service in accordance with available resources, specified requirements and other conditions.

A project can be considered as a unique process, including coordinated and managed activities, and it can be a combination of activities from project processes and technical processes.

**Verification -** a set of actions in comparison with the actually obtained result (product) with design characteristics. Verification is a confirmation based on the provision of objective evidence that the product is made as intended.

**Validation -** a set of actions to analyze the conditions of use of the product and assess the characteristics of the product for compliance with these conditions. The result of the validation process is the conclusion about the possibility of using the product in the existing specific conditions. Validation is a confirmation based on the provision of objective evidence that in these specific conditions of use and application, the system is able to fulfill its purpose, current and future goals.

In the life cycle of an information system at the same stage of a life cycle, any process can be performed **iteratively**, i.e., repeatedly, with an increase in detail at each pass (iteration). In addition, processes can be performed **recursively** when the same process is applied to successive levels of the hierarchical structure of the system. Finally, the application of processes can occur in **parallel** if two or more processes are carried out simultaneously within the same project.

Life cycle of information system

Agreement process

Organization process

Object process

Technical process

Obtaining

Delivery

|  |  |
| --- | --- |
|  |  |
| Managing the enterprise environment (infrastructure) | |
| Investment management (projects) | |
| Process management (model) of the | |
| Resource management (human resources) | |
| Quality management | |

|  |  |
| --- | --- |
|  |  |
| Planning project | |
| Project evaluation | |
| Project control | |
| Decision making (decision management) | |
| Risk management | |
| Configuration management | |
| Information management | |
| Measurements | |

|  |  |
| --- | --- |
|  |  |
| The definition of customer requirements (stakeholders) | |
| Requirements  analysis | |
| Architecture design of IS | |
| Preparation of IS | |
| Integration (complexities) | |
| Verification | |
| Transfer IS to  partner | |
| Validation | |
| Functioning | |
| Maintenance | |
| Withdrawal and write-off | |

Fig. 11.2 life cycle processes of an information system

Thus, the application of the process during the information system life cycle is an action that varies rapidly over time and responds to many external influences on the system. Therefore, the use of selected processes constantly requires checking for their consistency, compatibility and synchronization.

In each specific project, in accordance with the goals and planned results, at the information system design stage, the necessary and suitable processes and actions of the information system life cycle are selected, which are included in certain stages of the life cycle. These stages, forming a logically verified and clear sequence, can overlap and / or be repeated cyclically in accordance with the scope of their application, size, complexity, need for changes and possibilities. Therefore,

at the design stage, a specific model of the life cycle of the information system is formed, which then finds its practical implementation at all subsequent stages of the information system life cycle.

**Life cycle model –** the structural basis of processes and actions associated with life cycle and organized in the stage. At present, three types of information system life cycle models are distinguished in systems engineering: cascade, iterative, and spiral.

The American scientist Winston Royce first proposed the cascade model of the LC in 1970. In the future, this model of the information system life cycle received other names: ―waterfall‖, ―sequential‖, ―single pass‖, ―classical‖. The essence of this model (strategy) is a linear sequence of going through the stages of creating an information system: the transition to the next stage of the life cycle is carried out only after the work has been completed at the previous stage. In modern versions of this model, a return (rollback) from the current stage to the previous one is allowed to eliminate identified shortcomings and other adjustments.

Cascade model is used in the development of small information systems, for which at the stages of design and development it is possible to accurately and fully formulate all the requirements and conditions. In addition, the customer must have the entire amount of funds necessary to finance the project as a whole. The advantages of the model include the fact that at each stage a complete set of project documentation is formed that meets the criteria of completeness and consistency, and the stages carried out in a clear sequence allow you to confidently plan the timing of the work and the corresponding resources (financial, material and human).

However, the real processes of developing information systems, especially large and complex, as well as atypical ones, almost never fully correspond in such a rigid scheme. In addition, there is a risk of getting bogged down in endless improvements, and inaccuracies in the initial requirements and forced returns to previous stages can significantly shift the project's planned timelines and lead to its cost increase until the project is stopped and the project is abandoned in its original form.

The main drawback of the cascading strategy is that the results of information system development become available to the customer only at the end of the project, and in the case of initially inaccurate statement of requirements or their changes during the period of information system creation, there is a high risk of delivering a product that does not completely satisfy the needs of the customer.

**The iterative LC model,** being an alternative to the cascade model, consists in the fact that the project life cycle is divided into a sequence of iterations (approximations), each of which contains all stages of the development and operation of the IC and is the next version of the system with increasing functionality (Fig. 11.3).



Idea

*Version 1*



Liquidation

|  |  |  |  |
| --- | --- | --- | --- |
| Develop | Production | Intergration | Application |

*Version 2*

### …

*Version N*

**…**

|  |  |  |  |
| --- | --- | --- | --- |
| Develop | Production | Intergration | Application |

|  |  |  |  |
| --- | --- | --- | --- |
| Develop | Production | Intergration | Application |

Fig. 11.3. Iterative model of LC IS



The result of each iteration is to obtain a complete and workable version of the information system with functionality that integrates the contents of the current and all previous iterations. With the completion of the next iteration, the product receives an increment in its capabilities - increment (increment - increment, increase). Thus, step-by-step product improvements are planned in advance, at the very first stage of the LC IS, and the result of the final iteration contains all the required functionality of the system.

The iterative model is used in the creation and operation of complex and complex systems, for which, however, there is a clear understanding by both the customer and the developer of what the final product should be. An iterative strategy has several advantages:

* it is beneficial for the customer to stage-by-stage (according to versions) financing an expensive project, as well as suspend it at any of the iterations or even refuse further implementation;

* it is beneficial for the developer to stage-by-stage (planned) attract various resources for the implementation of a complex project;

* it is convenient for the customer and the developer to gradually implement the complex product, as well as accompany it; users are comfortable in stages (gradually) mastering a new information technology and the information system as a whole.

One of the shortcomings of the iterative model is the high moral hazard: the integrity of the developer’s performers may turn out to be low due to the fact that

―all the same, everything can be redone and improved later on‖. For this reason, most of the work carried out in previous iterations may turn out to be ―in the trash‖, and a holistic practical understanding of the project’s capabilities and limitations will not take quite a while.

The iterative model is also referred to as "iterative", "step-by-step", "incremental", "incremental", "IID" (iterative and incremental development). In the

70s, Tom Gilb called this model ―evolutionary,‖ but later this name was assigned to another model - spiral.

**The spiral model of the LC** was proposed in 1985 by Barry Boem and is a further development of the iterative strategy. The principle of this model: the sequence of development cycles (iterations) is determined by the degree of risk, and the iterations themselves should contain clearly defined measures for assessing and minimizing risks. B. Bohem named the 10 most frequently occurring risks and ranked them in descending order of priority:

* lack of specialists;

* unrealistic deadlines and budget;

* implementation of inappropriate functionality; * wrong user interface design;

* perfectionism, unnecessary optimization and refinement of details; * a continuous stream of changes;

* lack of information on external components that determine the environment of the system or are involved in integration;

* deficiencies in the work performed by external (in relation to the project) resources;

* insufficient performance of the resulting system;

* the gap in the qualifications of specialists in various fields.

The spiral model of the life cycle is especially well suited for the development of non-standard systems, when the customer and the developer do not have a clear understanding of what exactly the final product should be:

* system requirements cannot be clearly defined and formalized; * project completion risks are very high.

This model is characterized by iterative development of the system in parts, with the possibility of a significant change in requirements as the project develops, up to the rejection of further evolution of the system.

The advantages of the spiral model include the following:

* the model allows you to quickly enough provide users of the system with a workable product, thereby activating the process of clarifying and supplementing requirements;

* it is allowed to change the requirements during the development of an information system, which is typical for most developments, including standard ones;

* provides great flexibility in project management;

* the model allows you to get a more reliable and stable system. As the system develops, errors and weaknesses are detected and corrected at each iteration;

* the model allows to improve the development process in each iteration, thanks to the analysis stage;

* the risks of the customer are reduced to get bogged down in an expensive and endless project, thanks to the ability to quickly complete the development of the project.

* The disadvantages of the model:

* the developer is permanently in a state of uncertainty about the prospects for the development of the project;

* operations of temporary and resource planning of the whole project as a whole are complicated. To solve this problem, it is necessary to introduce time limits for each of the stages of life cycle. The transition to the next stage is carried out in accordance with the plan, even if not all the planned work is completed. The plan is compiled on the basis of statistical data obtained in previous projects, and the personal experience of developers.

#### The impact of the information system on the enterprise.

The choice of an adequate model of information system life cycle and the maintenance of the above-mentioned necessary processes throughout the life cycle of the information system is an important factor in the activities of a modern enterprise. Today, information system is becoming one of the most powerful sources of strategic change in a company. Thanks to the introduction of information system, after a certain time, the need for reengineering of this enterprise itself begins to form in the enterprise.

Information systems are able to automatically transform the enterprise, because the functioning of information system:

* reorganizes the management process (standards, hierarchy and decision- making competencies change);

* improves business processes (their structure, scope, means of communication, labor management mechanisms, product production and service delivery are being transformed);

* reduces the cost of acquiring information by increasing the company's own information resource and the widespread use of information technology in operational activities.

For example, in the event of a change in the organization of information technology (software), changes occur in almost all other components of the life of information system and the company as a whole, which may entail personnel shifts, changes in working methods, transformation of the organization structure, transformation of its costs and revenues. Currently, there is an increase in the interplay between business strategy, rules and procedures, on the one hand, and information software systems, equipment, databases and data transfer - on the other.

Thus, information system is able to give additional marketing flexibility to market participants and increase the profitability of the enterprise, which has led to the emergence of a huge variety of information systems to date, despite the relative youth of such an area of activity as systems engineering.

#### Classifications of Information Systems

Many diverse information systems (IS) can be classified on various grounds, for example:

#### The industry functioning of the economic object:

IS industry; Agricultural IS; IS transport; Communication IS; Educational IS; IS public services; technical IS; humanitarian IS; economic IS, etc.

In turn, economic IS in the field of activity are divided into: statistical IS; financial IS; accounting IS; tax IS; customs IS; stock IS; insurance IS; banking IS; industrial IS; Oil and Gas IS, etc.

In banking, trading and other retail businesses, ISs differ in relation to the external environment of the enterprise:

* IS front-office (front-office) - automation of operations with clients; * IS back-office (back-office) - automation of internal operations of the enterprise.

There are special classifications of IS, for example:

**According to the class of ongoing technological operations,** IS working: * with a text editor;

* with a table processor;

* with database management systems; * with graphic objects;

* with multimedia objects; * with hypertext objects;

* with a range of technologies (universal IS).

Different ISs use different data presentation systems**: *** word processor files;

* specialized data storage formats used in the ―pre-relational‖ period (x- Base, Paradox);

* xml-based structured markup languages; * relational model;

* object, object-relational models;

* document-oriented storage (IBM Lotus / Domino). **According to the type of user interface, there are:** packet IS; interactive IS; network ISs.

In packet ISs, data is first accumulated, then a data packet is formed from them, and then a number of programs sequentially processes this package. The disadvantage of batch mode is the low efficiency of decision-making and the isolation of the user from the system. Economic problems solved in this mode are characterized by the following properties:

* the algorithm for solving problems is formalized, the process of solving it does not require human intervention;

* there is a large amount of input and output data, a significant part of which is stored on magnetic media;

* the calculation is performed for most entries in the input files; * longer time for solving the problem due to the large amount of data; * regularity, i.e., tasks are solved with a given frequency.

Dialogue ISs operate in the mode of exchanging messages between users and the system (for example, an interactive information system for the sale of airline

tickets). This mode is used when the user is required to provide a choice of one or more promising options for solving the problem from all offered by the system.

If the use of batch mode allows you to reduce user intervention in the process of solving the problem, then the interactive mode of operation of the IS assumes the absence of a rigidly fixed sequence of data processing operations.

Network ISs are classified by the method of building a network: local; multi- level; distributed.

ISs are also classified by the nature of the use of information: * information retrieval systems;

* information management systems;

#### By activities followed by management processes:

* IS organizational management - provide automation of management activities in the non-productive sphere;

* IS for managing technological processes;

* IS management of organizational and technological processes - multilevel management systems in the manufacturing sector;

* IS of research and development; etc.;

#### By the degree of coverage of management tasks:

* electronic data processing;

* automation of management functions; * decision support;

* electronic office; * expert support;

**Automated control systems (ACS) -** a comprehensive, common name for automated information systems (AIS), which may include one or more IS of various functional orientations in the field of management in the broadest sense.

**Decision Support Systems (DSS)** are a fairly new class of AIS, the theory of creation of which is currently being intensively developed. DSS are designed to automate the activities of specific officials in the performance of their official (functional) duties in the process of managing personnel and (or) technical means.

**Problem-based simulation systems (PSS)** are designed to automate the development of simulation models in some subject area. For example, if we take the development of the automotive industry as a subject area, then any model created in this subject area may include standard blocks that simulate the activities of enterprises that supply components; in fact, assembly plants; sales, service and car repairs; advertising and others. These building blocks can be built with different details of the simulated processes and different speed of calculations. The user, working with the PSS, tells her which model he needs (that is, what needs to be taken into account when modeling and with what degree of accuracy), and the system automatically generates a simulation model that the user needs.

**Automated information and computing systems (AICS)** are designed to solve mathematically complex problems requiring large volumes of a wide variety of information. Thus, the type of activity automated in these AIS is various (complex and ―voluminous‖) calculations. These systems are used to support

research and development, as well as subsystems of ACS and DSS in cases where the development of managerial decisions must be based on complex calculations..

**Design Automation Systems (DAS)** is a class of AIS designed to automate the activities of units of a design organization or a team of specialists in the process of developing product designs based on the use of a single information base, mathematical and graphical models, automated design and construction procedures, special information output devices, etc. DAS is one of the systems of integrated automation of production, ensuring the implementation of an automated production cycle I have a new product from pre-design research to serial production. In the field of economics, DAS can be used in the design of economic information systems and their elements.

**Automated training systems (ATS)**are designed to automate the training of specialists with or without the participation of a teacher and providing training, training courses, management of the learning process and evaluation of its results. The main types of ATSs are automated systems of program training, business games support systems, simulators and training complexes, etc.

**Automated information and reference systems (AIRS)** are automated information systems designed to collect, store, search and issue various types of background information in the form required by the consumer. Accounting, economic, legal, statistical and other systems are distinguished.