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Adaptation of Bachelor and Master Degree Programs to Meet Modern Standards (Information Systems and Technologies)

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The paper considers different approaches to the use of models, which are applied in the sphere of information technologies and specified in modern standards and guidelines, for the development of Bachelor and Master degree programs, the specialty of Information Systems and Technologies. The authors give examples of educational process management based on Unified Modeling Language (UML).

Key words: education program, object-oriented approach, product life cycle, business model, the object of professional activity, information resource.

Providing Bachelor's and Master's degree courses in Information systems and technologies, one faces the following specific challenges:

1. Constant extension of IT application scope. Instead of studying different spheres of IT application, it is necessary to master IT analysis applicable in any sphere of activities.
2. Steady and intensive development and improvement of IT. Growing variety of IT models, methods and tools to design information systems (IS). It is necessary to use higher level of abstraction while describing both existing and newly designed methods of IS design in a uniform way.
3. Considerable diversity of classes of information resources. It is necessary to determine an appropriate level of abstraction while studying classes of information resources, which would prevent duplication and simplify study via inheritance mechanism.
4. Considerable gap between a problem domain and solution domain. It is necessary to use technologies of IS design focused on high-level domain-specific languages that allow reducing the gap between problem and solution domain.

All these challenges are quite well formalized by means of unified modeling language (UML), and CASE tools allow using modern informational technology to full extent.

The specific feature of the professional activity trained in the course is that the main part of information processed at the stages of analysis and design is presented as metadata, where classes of objects, processes, events, as well as various associations, relations and limits between them are formally described [1, pp.10-20]. Fig. 1 shows a diagram describing a gap between the income data for information system development and implementation. This gap can be overcome by obtaining intermediate data called a metamodel for problem frames and metamodel design patterns. One of the main aims of the course is to provide students with skills and knowledge that would allow them to identify and decompose a problem to obtain a metamodel of the analysis followed by a metamodel of a design solution and then system implementation. A variety of methods and tools can be applied at each stage of the system development and implementation [1, pp. 88-98].

There are goals of adaptation as follows:

1. To adjust the content of the education

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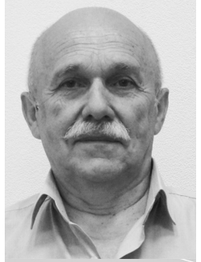

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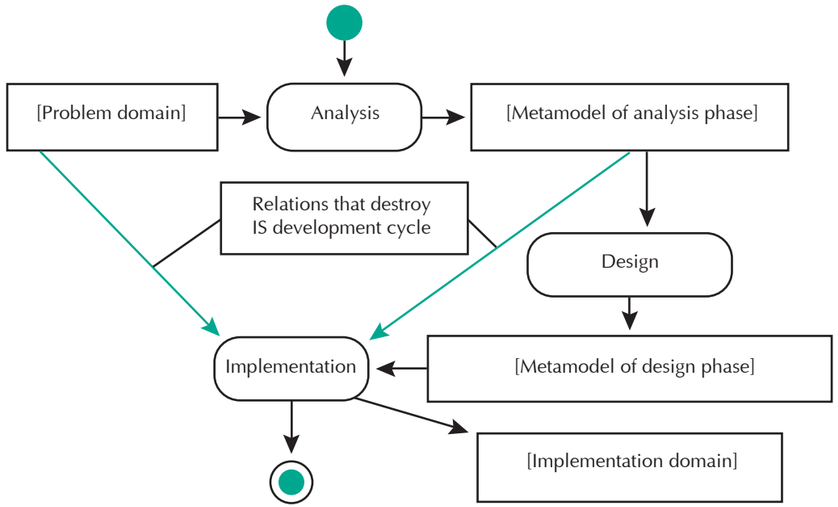
Fig. 1. Gap between the problem domain and implementation domain



programs and student learning outcomes to the modern level of IT development and employers' requirements.

2. To comply the content of the education programs with IT models required by modern standards and recommendations.

3. To enlarge the spectrum of used models, methods, and tools of IT design.

To achieve the goals, the following tasks should be performed:

1. To analyze the existing standards and recommendations to identify the elements that should be introduced into the curriculum and programs of the subjects.

2. To enlarge the range of the studied models and methods for management problem-solving, to develop a unified approach to their description and study.

3. To enlarge the spectrum of the design and implementation tools to be studied.

4. To ensure a detail study of the basic classes of informational resources.

5. To develop laboratory classes, practical tasks, and course projects basing on project approach.

While adapting the education programs of the courses, the following concepts, recommendations and standards should be taken into consideration:

1. The Federal State Education Standard (FSES) provides a framework and extension points to develop concrete education programs.

2. Conceive Design Implement Operate (CDIO) concept. The aim of the initiative is to bring the content of engineering education program and students' learning outcomes to the level of modern technological development and employers' expectations [2].

3. Product Lifecycle Management (PLM) concept offers a standard structure of product lifecycle, recommendations on composition and structure of information about the product for all the stages of the lifecycle [1, pp. 33-45].

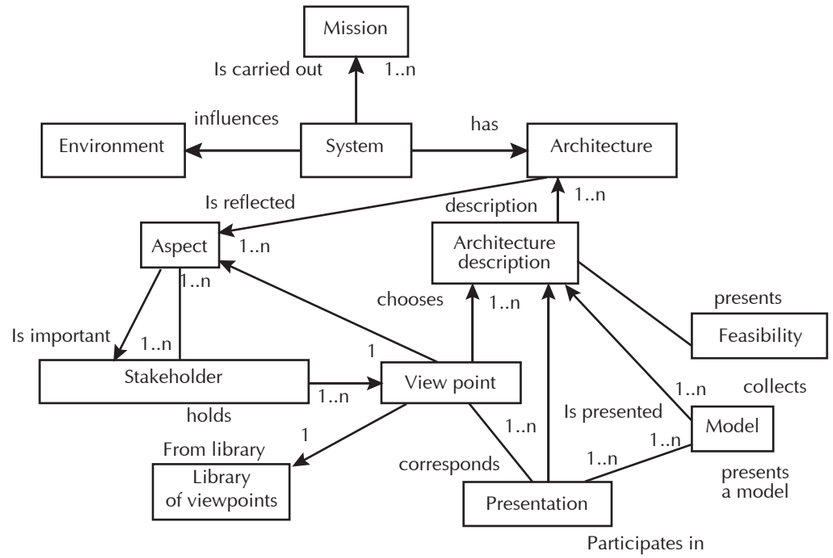
4. Document IEEE 1471 «Recommended Practice for Architectural Descriptions» contains a guideline to describe the architectures of information and program systems. It offers a template to describe architectures as object models [3].

5. The ITIL recommendations (Infrastructure Library) are a catalogue of best practices for the IT organizations [4].

Let us study particular features of some recommendations. Fig. 2 shows a class diagram that depicts the structure of IS architecture recommended by IEEE 1471. There are such notions as Stakeholder, Viewpoint, and View. They allow developing complex requirements to a designed IS. Besides, it is recommended to use a spectrum of model to present architecture solutions from different viewpoints. To master technologies of IS design according to the recommendations makes it necessary to use interdisciplinary relations.

Fig. 3 shows a class diagram with fragment of information recourse classification. The classification complies with ITIL recommendations. The use of ITIL practices in the education programs development allows structuring the study of different information resources, preventing duplication, and identifying views and used models.

Fig. 2. Class diagram presenting a structure of IS architecture



The aspects of the education programs to be adapted are as follows:

1. To make closer connections between theory and practice. CDIO recommendations are to be applied.

2. To agree on the content, views, and models of the studied information resource classes. ITIL, IEEE 1471 information resource management models are to be used.

3. To agree on the content, views, and models of the studied product classes. PLM models are to be used.

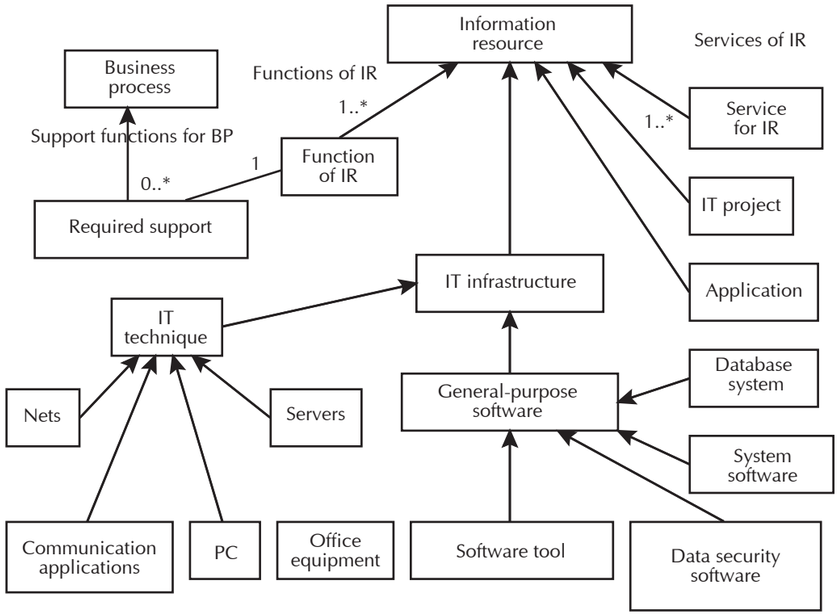
4. To agree on the studied models and methods of IS and IT analysis. IEEE 1471 models are to be used.

5. To organize and structure the education programs according to FSES and basic IT standards.

6. To develop complex tasks that would simulate a real IT engineering activity.

Object modeling with UML is used to perform complicated professional tasks. It is proved in [5, pp. 89] that most of known methods of IS design can be

Fig. 3. The fragment of information resource classification



successfully modeled in UML. UML with some extensions allows providing formal representation of results of all design stages. These features of UML make it an ultimate tool to train theoretical and practical analysis, design, implementation, and maintenance of IS.

To control changes in the education programs it is suggested developing a specialized IS that would allow performing a complete set of tasks related to education program data management by analogy with PDM systems. The example of such system is shown in [5, pp. 110-141]. Fig. 4 demonstrates a fragment of metamodel for an education program.

Let us consider some results of education program adaptation according to the requirements mentioned above. To manage laboratory works (LW) and practical classes (PC), the following approaches are offered:

1. Each LW is aimed at training a fragment of real professional task and includes the analysis of a domain fragment, development of design solutions, their implementation and test execution. All the stages are registered by corresponding CASE-tools.

2. A set of tasks is focused on the repeated use of the fragments developed beforehand. Each successive LW implies using the fragments developed beforehand.

3. Practical classes (PC) are focused on developing skills related to analysis, design and implementation of the IS fragments to be implemented in LWs.

4. The amount of LW is quite big (at least 12 academic hours). Some subjects have a united cycle of LWs. Each subject studies different aspects of the project solutions.

5. Internet sources are used to obtain income data. A basic set of tools is available

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Fig. 4. Fragment of an object model for an education program

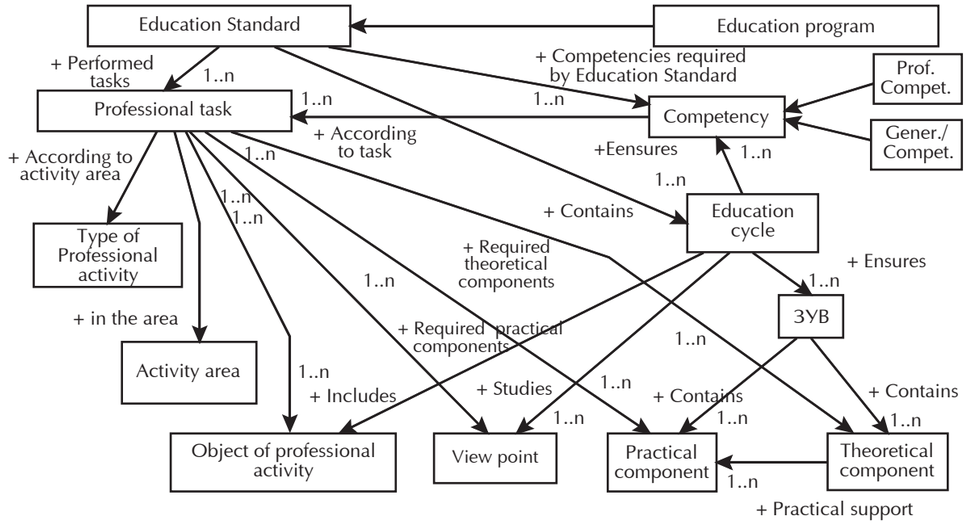

Table 1. Academic hour (credits) distribution to fulfill a set of tasks on design technology

Subject	Corporate IMS	Methods and tools for IS design	IS object and process models	Modern methods of IS design
Year	4	4	1	2
Term	8	8	1	3
Credits	2	3	5	5
Lectures	22	22	18	36
Practical Cl.	11	11	–	36
Lab. work	22	22	54	36
Class form. training	55	55	72	108
Independent work	13	47	108	72
Total	**68**	**102**	**180**	**180**

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for each student. It is allowed using other tools at student's discretion.

Tab. 1 presents an example of academic hours (credits) distribution with the emphasis of practical experience. Tab. 2 contains an example of report on task performance.

Thus, it can be concluded that:

- Introduction of fragments of real engineering activity in educational process is a challenging task.
- The education programs should be adapted to this practical approach by incorporating the requirements and standards applied in engineering and science of a particular area.
- The use of object technology allows increasing significantly the level of abstraction in project solutions.
- There is a need in diversity of successive tasks for students.

Table 2. Model report on task performance

№	Stage	Result
1.	Input data analysis	Informal description of income data. Domain class model.
2.	Development of functional requirements to the designed sub-system	Use-case diagrams. Description of the diagram components.
3.	Development of a class model for dedicated processes	Class diagrams with attributes and operations.
4.	Development of a storage model to keep product data in database	ER diagrams. Metadata scripts with comments.
5.	Development of basic SQL procedures to work with the reference	SQL procedure scripts with comments.
6.	Procedure testing	Test description. Scripts of income data to be tested. Screenshots of test results.

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