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# APPLIED INFORMATIONAL TECHNOLOGIES INTEGRATION PRINCIPLES IN SYSTEMS WITH DUAL PROCESSES

It is shown in this work that the topical question should be the implementation of innovative technologies in education activity management, namely in the process of knowledge, skills and experience acquisition in educational systems, and their realization in industry with the use of informational, communication and network technologies. Thus, there appears necessity for the development of the applied informational technologies integration principles, in systems with dual processes. The purpose of the creation of educational and industrial processes formalization technology is the development of formal representation instrumental means that can guarantee a united approach at building the special mathematical provision for informational and technological solutions in systems with dual processes. Processes and phenomena that occur in educational and industrial systems, can be represented in bases of knowledge on the grounds of the methodical base, and the integration processes and phenomena between them can be represented in the form of different algebraic systems. These systems consist of some ensemble and a set of operations, i. e. an algebraic signature. The methodical base of formal representation of knowledge consists of heuristic, logical, ontological and topological methods of modelling, and at the base of the object domain kernel isolation lie methods and formalisms of the set theory. An example of adjacent manifolds kernel building in topological space on the grounds of the algebra of sets is shown. The proposed logical methods of the representation of knowledge allow to proceed to the heuristic representation of knowledge, i. e. with production rules, semantic networks, frame systems, and the ontological constructions as well.

**Keywords:** integration; applied informational technologies; education; industry; systems with dual processes.

## Introduction

At present, the priority of reforms that are carried out in higher education field, is given to the improving of educational services rendering with application of the modern informational systems and technologies [1]. At the same time, the complicated problem is to build a united system of educational processes management, taking into account the industrial requirements to modern specialists.

There appears necessity to increase the professional knowledge and skills by the implementation of new forms of education.

One of the ways to resolve the problem in question is the implementation of the dual system of education and teaching aimed at the improving of the personnel's vocational training quality.

This dual system is the new and more flexible form of the vocational training organization, which stipulates for the coordinated interaction between the educational and the industrial branches for training of qualified personnel of the certain profile in the context of the organizationally different forms of training [2-5].

In this connection, the topical question is the application of innovative technologies in the educational activity management, i. e. the management of knowledge, skills and experience acquisition process, in educational systems, and their realization in industry with the use of informational, communication and network technologies. Thus, there appears necessity for the development of the applied informational technologies integration principles, in systems with dual processes.

The purpose of the creation of educational and industrial processes formalization technology is the development of formal representation instrumental means that can guarantee a united approach at building the special mathematical provision for informational and technological solutions in systems with dual processes.

## 1. Generalized Outline of the Topological Manifold Formalization Technology

Let us designate processes and phenomena that occur between educational systems of 1st-2nd and 3rd-4th levels of accreditation with $\wp^{\left(1,2 \xleftrightarrow{f} 3,4\right)}$ symbol, and processes and phenomena between educational systems of 3rd-4th levels of accreditation and industrial systems with $\wp^{\left(3,4 \xleftrightarrow{f} p\right)}$ manifolds, respectively. Then, the semantics of processes and phenomena of these manifolds will consist in reflections between the systems in question, e. g. students of different schools make their acquaintance with the resources of higher education institutions and with professions they can acquire in these institutions. Here, the students can be interpreted as the elements of some space, with the knowledge and abilities that reflect on the space of information presented to the students and concerning some set of professions.

In the fig. 1, the principal formalisms, their hierarchy and their-based methods of knowledge representation are shown, where with the $O^{1,2}$, $O^{3,4}$ and $O^{p}$ symbols the manifolds of processes and phenomena that occur in educational systems of 1st-2nd, 3rd-4th levels of accreditation and in industrial systems, respectively, are designated.

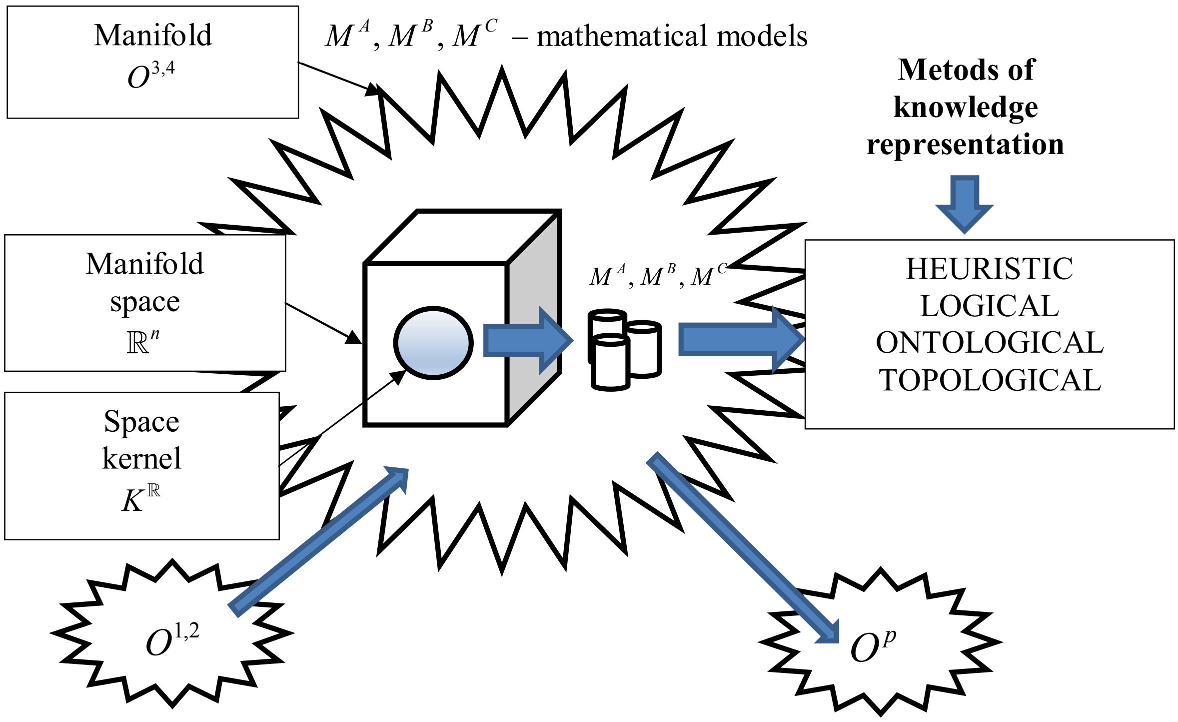


**Fig. 1.** Illustration of $O^{3,4}$ manifold formalisms hierarchy

It is necessary to mention that the abstraction degree hierarchy shown in the Fig. 1, concerns only one, $O^{3,4}$ manifold.

Analogically, it is possible to uncover the essence of formalisms hierarchy for $O^{1,2}$ and $O^p$ manifolds.

As a matter of fact, the worked out scheme allows to assign temporal relations in the process of formalization, e. g. to describe manifold $O^{1,2}$ $\to$ to assign space $\mathbb{R}^n \to$ to select the significant elements of the topological space, i. e. to form the space kernel $K^{\mathbb{R}} \to$ to develop space kernel significant elements models $\{M^A, M^B, M^C\}$.

The arrows are used here to designate temporal relations of the formalization procedures. Let us amplify the temporal relations with the inclusion relations $(\subset)$, in order to assign analytically the hierarchy relations of the formalization procedures. Finally, we can formally write it down:

$$\begin{cases} O^{1,2} \to \mathbb{R}^n \to K^{\mathbb{R}} \to \{M^A, M^B, M^C\}; \\ O^{1,2} \supset \left(\mathbb{R}^n \supset \left(K^{\mathbb{R}} \supset \{M^A, M^B, M^C\}\right)\right). \end{cases} \quad (1)$$

It follows from the interpretation above, that the processes and phenomena that occur in educational and industrial systems, can be represented in bases of knowledge on the grounds of methods shown in the Fig. 1, and the processes and phenomena of the integration between are representable in the form of different algebraic systems. They are composed of some set, in this case, set of models, and of operations with them, i. e. of an algebraic signature.

In this work, the methodical base of formal representation of knowledge consists of heuristic, logical, ontological and topological methods of modelling, and in the basis of the object domain kernel isolation lie methods and formalisms of the set theory.

An example of adjacent manifold kernel building in a topological space, on the grounds of the set algebra, will be shown in the next subdivision of this work.

## 2. Adjacent Topological Spaces Kernel Models Synthesis Procedure

In the previous subdivision, the general scheme of some formalization technology for processes and phenomena that occur in educational and industrial spheres, has been developed. Let us lower the degree of community of the developed scheme, using decomposition and abstracting methods (Fig. 2). To simplify the formal procedures notation we shall suppose that from the every $K_{1,2}^{\mathbb{R}}$, $K_{3,4}^{\mathbb{R}}$, and $K_p^{\mathbb{R}}$ kernel, groups of three significant objects (topological space elements [6, 7]) are isolated, which have between each other some connection or relations assigned in the form of functors or cones of morphisms $\vec{F}, \overline{K}$.

Before we proceed to describe the formal procedure of synthesis of models shown in the Fig. 2:

$$K_{1,2}^{\mathbb{R}} = \left\{ M_1^{K_{1,2}^{\mathbb{R}}}, M_2^{K_{1,2}^{\mathbb{R}}}, M_3^{K_{1,2}^{\mathbb{R}}} \right\},$$

$$K_{3,4}^{\mathbb{R}} = \left\{ M_1^{K_{3,4}^{\mathbb{R}}}, M_2^{K_{3,4}^{\mathbb{R}}}, M_3^{K_{3,4}^{\mathbb{R}}} \right\},$$

$$K_p^{\mathbb{R}} = \left\{ M_1^{K_p^{\mathbb{R}}}, M_2^{K_p^{\mathbb{R}}}, M_3^{K_p^{\mathbb{R}}} \right\}.$$

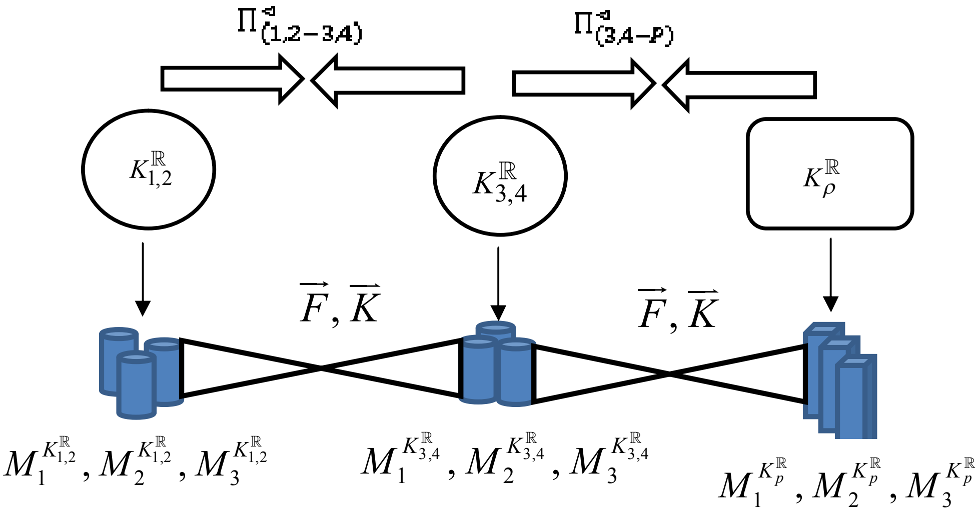


**Fig. 2.** Formal representation of integration processes at the level of topological spaces kernel elements

It is necessary to mention that between these models there also are some connections and relations, i. e. exist inner kernel morphisms. As a matter of fact, models

$$K^{\mathbb{R}}_{3,4} = \left\{ M_1^{K^{\mathbb{R}}_{3,4}}, M_2^{K^{\mathbb{R}}_{3,4}}, M_3^{K^{\mathbb{R}}_{3,4}} \right\}$$

are analogous to the models of kernel, for their originals are the elements of the educational system.

It is important to mention that the inner-kernel morphisms of $O^{1,2}$ and $O^{3,4}$ manifolds directly depend on methods, procedures and technologies that are used in corresponding educational systems, and the morphisms of $O^p$ manifold – on the industrial manuals, logistic schemes and other attributes of one or another industrial technology.

At the same time, in the work [8] the proposition is made to represent separate processes and phenomena as linguistic informational technologies, where are created models of dictionaries, reference-books, methodical working-outs and other linguistic objects. Then, the isolated in the fig. 2 can be represented with three models

$$M_1^{K^{\mathbb{R}}_{3,4}}, M_2^{K^{\mathbb{R}}_{3,4}}, M_3^{K^{\mathbb{R}}_{3,4}},$$

where their originals are ‘higher education institution’, ‘some educational technology’ (as a process), ‘higher school pedagogics’ (as an object of the research), respectively.

With the aim to isolate the inner-kernel morphisms, on the basis of terminological dictionary the $O^{3,4}$ manifold ontological model there was built.

Let us suppose that between the element 1 of the kernel, its model designated with, there exists some connection or relations with elements 1 and 2 of the kernel, models of these elements designated with

$$M_1^{K^{\mathbb{R}}_{3,4}}, M_2^{K^{\mathbb{R}}_{3,4}},$$

respectively, and the model is connected with models

$$M_1^{K^{\mathbb{R}}_{p}}, M_3^{K^{\mathbb{R}}_{p}}$$

of the kernel $K^{\mathbb{R}}_{p}$.

Let us write these procedure down in the analytical form using the methods of the set algebra.

We shall obtain:

$$K^{\mathbb{RS}}_{1,2-3.4} = M_1^{K^{\mathbb{R}}_{1,2}} \cup \left( M_1^{K^{\mathbb{R}}_{3.4}} \wedge M_2^{K^{\mathbb{R}}_{3.4}} \right), \qquad (2)$$

$$K^{\mathbb{RS}}_{3.4-p} = M_3^{K^{\mathbb{R}}_{3,4}} \cup \left( M_1^{K^{\mathbb{R}}_{p}} \wedge M_3^{K^{\mathbb{R}}_{p}} \right), \qquad (3)$$

The expressions 2 and 3 based on the developed generalized formalization technology scheme, can be transformed and and represented in the predicate form, i. e. on the basis of the algebra of logic.

$$\forall M_i^{K^{\mathbb{R}}_{1,2}} \; \exists \vec{F} \xrightarrow{f} M_j^{K^{\mathbb{R}}_{3.4}}, \qquad (4)$$

$$\forall M_\gamma^{K^{\mathbb{R}}_{3.4}} \; \exists \vec{K} \xrightarrow{f} M_\beta^{K^{\mathbb{R}}_{p}}. \qquad (5)$$

Such notation signifies that between all the models $M_i^{K^{\mathbb{R}}_{1,2}}$ of $\mathbb{R}^n$ topological space of the $\wp^{\left(1,2 \xleftrightarrow{f} 3,4\right)}$ manifold, there exists $\vec{F}$ functor, the morphisms of which are biuniquely reflected on the models $M_j^{K^{\mathbb{R}}_{3.4}}$.

## Conclusion

Thus, the generalized technological scheme of formalization of processes and phenomena in the educational and industrial fields on the grounds of highly abstract topological manifolds, has been developed.

The adjacent topological spaces kernel models synthesis procedure has been shown. The generalization of this procedure has been obtained in the predicate form. The technology of educational and industrial processes formalization has been created for the purpose of elaboration of instrumental means of formal representations, which can guarantee the united approach at the building of the special mathematical provision for informational and technological solutions in systems with dual processes.


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**Основи інтеграції прикладних інформаційних технологій в системах з дуальними процесами**

О. І. Морозова

В роботі показано, що актуальним є застосування інноваційних технологій в управлінні освітньою діяльністю, а саме процесом набуття знань, умінь і навичок в освітніх системах та реалізація їх на виробництві з використанням інформаційно-комунікаційних й мережних технологій. Таким чином, виникає необхідність в розробці основ інтеграції прикладних інформаційних технологій в системах з дуальними процесами. Метою створення технології формалізації освітніх та виробничих процесів є розробка інструментальних засобів формальних уявлень, що забезпечують єдиний підхід при побудові спеціального математичного забезпечення інформаційно-технологічних рішень в системах з дуальними процесами. Процеси й явища, які відбуваються в освітніх та виробничих системах, можуть бути представлені в базах знань на основі методичної бази, а процеси й явища інтеграції між ними представлені у вигляді різних алгебраїчних систем. Дані системи складаються з деякої множини й набора операцій над ними, тобто сигнатурою алгебри. Методичну базу формального представлення знань складають евристичні, логічні, онтологічні та топологічні методи моделювання, а в основі виділення ядер предметних областей лежать методи й формалізми теорії множин. Показано приклад побудови ядра суміжних різноманіть в топологічному просторі на основі алгебри множин. Запропоновані логічні методи представлення знань дозволяють перейти до евристичних уявлень знань, тобто продукційних правил, семантичних мереж, фреймових систем, а також онтологічних конструкцій.

**Ключові слова:** інтеграція; прикладні інформаційні технології; освіта; виробництво; системи з дуальними процесами.

**Основы интеграции прикладных информационных технологий в системах с дуальными процессами**

О. И. Морозова

В работе показано, что актуальным является применение инновационных технологий в управлении образовательной деятельностью, а именно процессом приобретения знаний, умений и навыков в образовательных системах и реализация их на производстве с использованием информационно-коммуникационных и сетевых технологий. Таким образом, возникает необходимость в разработке основ интеграции прикладных информационных технологий в системах с дуальными процессами. Целью создания технологии формализации образовательных и производственных процессов является разработка инструментальных средств формальных представлений, обеспечивающих единый подход при построении специального математического обеспечения информационно-технологических решений в системах с дуальными процессами. Процессы и явления, протекающие в образовательных и производственных системах, могут быть представлены в базах знаний на основе методической базы, а процессы и явления интеграции между ними представлены в виде различных алгебраических систем. Данные системы состоят из некоторого множества и набора операций над ними, т.е. сигнатурой алгебры. Методическую базу формального представления знаний составляют эвристические, логические, онтологические и топологические методы моделирования, а в основе выделения ядер предметных областей лежат методы и формализмы теории множеств. Показан пример построения ядра смежных многообразий в топологическом пространстве на основе алгебры множеств. Предложенные логические методы представления знаний позволяют перейти к эвристическим представлениям знаний, т.е. продукционным правилам, семантическим сетям, фреймовым системам, а также онтологическим конструкциям.

**Ключевые слова:** интеграция; прикладные информационные технологии; образование; производство; системы с дуальными процессами.