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TRAINING OF IT-SPECIALISTS IN RUSSIAN AND EUROPEAN HIGHER EDUCATION: A COMPARATIVE STUDY

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Abstract

Modern society is characterized by a new stage of its social and economic development, namely “digital economy”, and this paper studies the current issues in the development of modern IT specialists training in the context of the global digitalization of economy. Since Russian universities apply new Federal State Educational Standard of Higher Education (FSES 3++) that has a framework nature and is based on the occupational standards, it becomes reasonable to implement foreign experience into Russian training of IT specialists with due regard to Computing Curricula 2005 (CC2005) (2005) and the particular nature of a given university. The paper shows the results of a comparative study of bachelor’s degree programs in IT of Russian and EU regional universities: Nizhnevartovsk State University (Russia) and Liepaja University (Latvia). The analysis carried out by experts from academia and the professional community (regional IT employers) reveals how disciplines from the degree programs’ curricula of these universities correlate with the main levels of CC2005 models: organizational issues and information systems, application technologies, software methods and technologies, systems infrastructure, and computer hardware and architecture. To illustrate how the degree programs correspond to the characteristic features of CC2005 models, their graphical views were created. The study proves the proposed research hypothesis that both universities use Software Engineering model (CC2005) in their IT training. Moreover, the results of the study provide some guidelines for degree programs in IT and their improvement.

Keywords: Information technology, IT education, educational standard, occupational standard, international standards, degree program.

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1. Introduction

As modern society is characterized by a new stage of its social and economic development, namely "digital economy", today every aspect of human activity becomes information-based and digital. Globally, targeted transition to digital economy occurred in Cancún (Mexico), June 2016 when Ministerial Declaration on the Digital Economy was adopted (Ministerial…, 2016). This document outlined the main goals of digital economy development as well as stressed the necessity to establish international technical standards able to provide compatibility and security of technologies and strongly supporting free and open access to the Internet.

In 2016, Russia also adopted its digital economy development program when Russian President Vladimir Putin in his annual message to the Federal Assembly suggested "to launch a large-scale comprehensive program to develop economy of a new technological generation, namely the digital economy" (Presidential Address to the Federal Assembly, 2016). In this new phase, Russian education system should also work towards the goals of digitalization of all aspects of human activities to train human resources for various spheres of digital economy.

Digitalization of the society increases the demand for IT graduates in economic and social sectors. Every year sees growth in number of IT specialists procured by the government, and "the number of state-funded places in Russian universities for IT students will increase fivefold by 2024 and amount to 120,000 students a year." (News of digital …, 2019). Thus, universities attach much significance to the degree programs in Computer Science and Computer Engineering, Software Engineering, Cyber Security, and other programs related to automated systems, mathematics, computing disciplines, electronics, and radio-technical systems; IT jobs are ranked among the highest paying ones, and the development and use of information technology is consedered to be one of the most stable career paths in Russia.

The development of high-quality IT programs for various economic sectors is a top-priority not only for Russia (Truică & Barnoschi, 2015). Of special importance is software design and maintenance (Stepanova, 2019). Researchers say that having professional competencies only is not enough for an IT graduate. For instance, employers believe that young professionals should also develop communicative skills (Titthasiri, 2017). More than that, internationalization of higher education has become a global trend and IT education is no exception. Many countries have certain degree programs where not only national language but also English is used as a medium of instruction whereas insufficient English proficiency has a negative impact on the quality of education (Bradford & Brown, 2018).

2. Problem Statement

The problem of development of high-quality IT degree programs in higher education is connected both to the rapidly changing and dynamic nature of information technology field and to the wide and vague range of the needs of employers. The evolution of computer science as a field of knowledge and discipline in the postmodern condition (Lyotard, 1979) is described by Karakozov (2005) in his dissertation. The development of degree programs that meet the requirements of employers are studied by Karakozov, Petrov, and Khudzhina (2017) and other researchers.

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Today, Russian universities are applying new Federal State Educational Standard of Higher Education (FSES 3++) and all degree programs that have already had their standards approved have to meet them from 2019-2020 academic year. For this reason, universities face an immediate task to update their degree programs in accordance with the new requirements, with the selection of and due regard to occupational standards that correspond to the field of study being at the forefront. These updated FSES 3++ standards have a framework nature. The content of a program is now formulated in a sample main degree program. Simirlarly, there is a change in competencies name, structure, and description. Every degree program must now have its competency indicators part where specific student actions assessed in the educational process are identified.

Yet, there exist several challenges in the development of updated degree programs associated with the absence or imperfection of approved occupational standards and the difficulty to predict the sphere of the professional activity of a graduate and thus to choose certain occupational standard, especially in addressing interdisciplinary tasks. One of the possible ways to develop a degree program was articulated by A. Shokhin who suggested to use a bottom-up approach (from certain professional competencies) as a key component in defining both educational and occupational standards (Professors Forum …, 2019) that is at the heart of the establishment of Russian Centers of Professional Competencies.

Undergraduate professional training in IT is based on FSES standard, occupational standards, the needs of employers, and international requirements for IT degrees, with the latter stemming from the Russian membership in the Bologna Process that makes it necessary to establish quality criteria for degree programs comparable to those established in foreign universities. Given the above, it is reasonable to study and implement foreign experience into Russian training of IT specialists. International requirements for IT degree programs are illustrated in a number of documents while Computing Curricula CC2005, (2005) that summarizes the elements that are common to all computing degree programs (CC2005) enables the researchers to develop the curricula on the basis of a general methodology. It is worth mentioning that the existing documents provide curriculum guidelines and are designed to summarize and unify the requirements for membership in the profession.

Computer Curricula international project first came into being in 1968. Modern international standards for bachelor's and master's degree programs in IT and their use in developing curricula are analyzed by several researchers (Sukhomlin, 2012; Sukhomlin & Zubareva, 2015) who suggest to use standard curricula versions to develop computing curriculum guidelines. Computing may be defined as any goal-oriented technical activity requiring, benefiting from, or creating computers (CC2005) and thus includes designing and building hardware and software systems, information management, computer intellectualization, etc. (Sukhomlin, 2012). Computing is also defined as an integral discipline covering a wide range of specific applied disciplines: computer science, artificial intelligence, computer networks, computational mathematics, database technologies, etc. (Sukhomlin, 2012).

Ultimately, it is necessary to find a mechanism that is able to standardize IT curricula on the basis of the curriculum approach irrespective of the country.

3. Research Questions

Computing Curricula (2005) singles out five major computing degree programs (CC2005):

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1) computer engineering;

2) computer science;

3) information systems;

4) information technology;

5) software engineering.

Its main levels include:

1) organizational issues and information systems (information systems design and development);

2) application technologies;

3) software methods and technologies;

4) systems infrastructure;

5) computer hardware and architecture.

The portion of levels in a certain degree program determines its nature and quality while levels themselves are connected to the area of knowledge, corresponding disciplines and the curriculum of a degree program. Since every program has its own portion of the levels, the prevalance of this or that level found in the curriculum makes it possible to draw a conclusion on the focus of an IT degree program.

This research addresses the following questions:

1) which of the five major computing degree programs singled out by CC2005 does a degree program correspond to (a case study of a Russian and a European university);

2) to what extent does the degree program in IT defined by these universities meet the requirements of CC2005;

3) is it possible to provide a mechanism that is able to standardize IT curricula on the basis of the curriculum approach.

It also suggests to formulate a mechanism for making a university degree program in IT meet the international standards in order to find some strengths and weaknesses of the curricula and to develop some guidelines for their improvement.

4. Purpose of the Study

The overall goal of this study is to develop a mechanism that is able to standardize bachelor degree programs in IT on the basis of the curriculum approach and a comparative study of training of IT specialists in Russian and European regional universities, with a degree program in a Russian university under study corresponding to the requirements of FSES standard for this degree, occupational standards, and needs of local employers.

5. Research Methods

The study uses qualitative (the analysis of educational, occupational, and international standards, degree program curricula as well as the views of experts from academia and professional community) and quantitave (statistical analysis) methods.

The preliminary analysis of the compared degree programs in IT reveals that the study should use Software Engineering model (see Figure 01) illustrated in Computing Curricula (2005) in its research.

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This model represents a graphical view of the software engineering discipline as proposed by CC2005 where the shaded area covers a wide range with respect to the systematic development of software (the third level) while the first and the fifth levels are mostly excluded. At the bottom, it covers the range from theory and principles to the practical application.

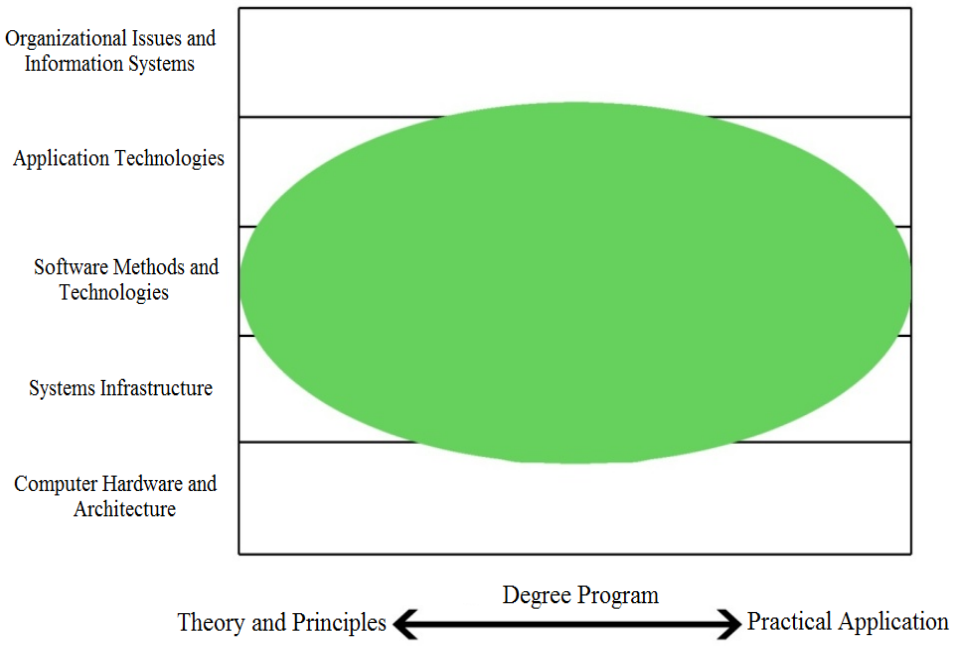

Figure 01. Software Engineering model

To show how each level is represented in the context of theory and practical application aspect, a table is generated on the basis of the graphical view of a Software Engineering model (see Table 01).

Table 01. Characteristic features of a Software Engineering model

Software Engineering Model	
Organizational Issues and Information Systems	
Theory	Application
Low	Low
Application Technologies	
Theory	Application
Medium	Medium
Software Methods and Technologies	
Theory	Application
High	High
Systems Infrastructure	
Theory	Application
Medium	Medium
Computer Hardware and Architecture	
Theory	Application
Low	Low

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The research studies degree programs in IT in Nizhnevartovsk State University (Russia) and Liepaja University (Latvia) where both universities are similar in the number of their degree programs and students.

The study is based on the hypothesis that the universities considered here use a Software Engineering model (one out of the five of major computing models). This study supports the hypothesis and compares degree programs in IT in Russian and Latvian regional universities.

Liepaja University (LU) has a degree program in Information Technology while Nizhnevartovsk State University (NSU) has bachelor's degree programs in Computer Science and Computer Engineering (The Software of Computers and Automated systems in particular) and Information Systems and Technology (namely, Information Systems and Technology in Business).

The study focuses on the comparison of two programs:

1) the degree program in Information Technology (LU, 4 years of study, English-taught curricula);

2) the degree program in The Software of Computers and Automated systems (NSU, 4 years of study, Russian-taught curricula).

To summarize the characteristics of degree programs in NSU and LU universities and to find out how they correspond to CC2005 levels, we ask competent experts who have been developing degree programs in IT for more than 10 years to express their view. These experts include the leading professionals in Russian and Latvian academia (Moscow State University of Education, Chechen State Pedagogical University, Nizhnevartovsk State University, and Liepaja University) and large IT companies (OOO Internet Company SIBINTEK). Table 02 demonstrates their concerted view and shows the total number of credits for every discipline in the curricula of these programs across CC2005 levels. The Table does not include credits for practical and workplace training and bachelor thesis. In addition, credit value in Russian and Latvian universities differs: 1 Latvian credit is equal to 1.5 Russian credits that explains some differences in numbers in LU and NSU universities.

Table 02. Number of credits across the levels of IT training in Liepaja University and Nizhnevartovsk State University

IT Training in Liepaja University		**IT Training in Nizhnevartovsk State University**	
Theory	Application	Theory	Application
Organizational Issues and Information Systems			
6 (9)	8 (12)	12	11
Application Technologies			
9 (14)	8 (12)	20	17
Software Methods and Technologies			
17 (25)	13 (20)	39	43
Systems Infrastructure			
16 (24)	11 (16)	16	10
Computer Hardware and Architecture			
4 (6)	4 (6)	14	13

The number in brackets indicates the number of credits brought in line with Russian standards.

Figure 02 shows how some disciplines in degree programs of both universities (names of the academic sublects may slightly differ) correlate with CC2005 levels, although it is worth mentioning that

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many disciplines could not be clearly linked to one level only. In such cases, experts jointly agree how to distribute the numerical values across the levels.

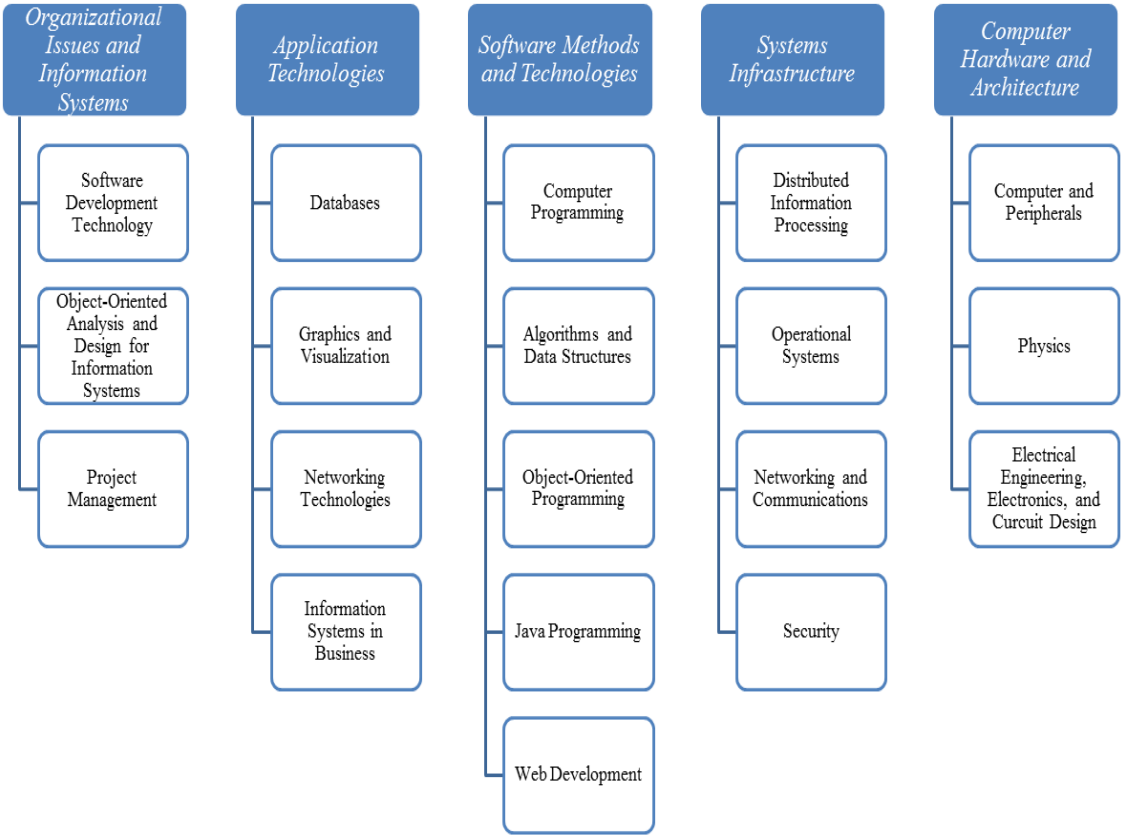

Figure 02. Disciplines in IT curricula in LU and NSU across CC2005 levels

Figures 03 and 04 show a graphical views of the results given in Table 02.

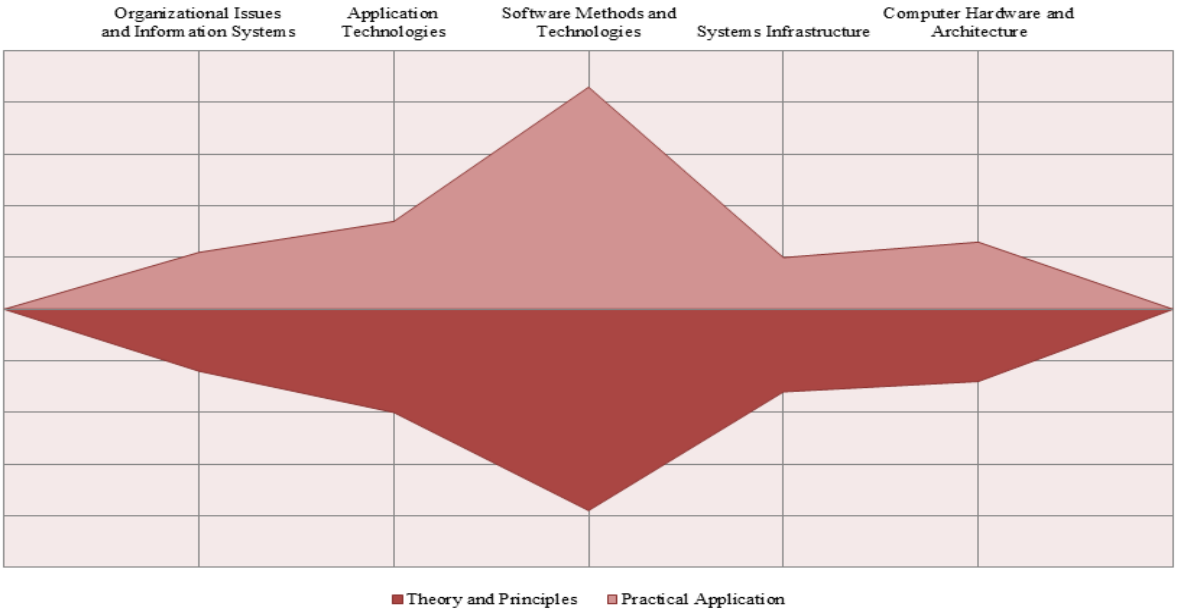

Figure 03. Graphical view of IT training in Nizhnevartovsk State University

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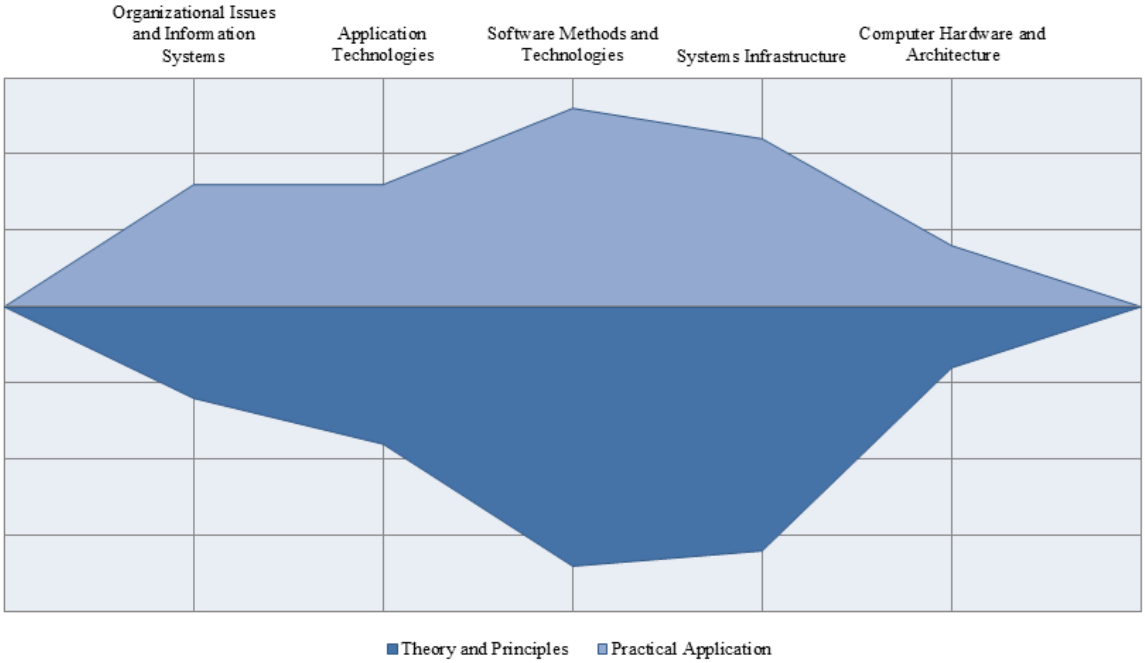

Figure 04. Graphical view of IT training in Liepaja University

As seen from the Figures, the geometric object in Figure 04 is more elliptical in shape than the one in Figure 03. Thus, it can be concluded that IT training in Liepaja University corresponds to CC2005 Software Engineering model more than the one in Nizhnevartovsk State University. At the same time, both IT degree programs under study correlate with Software Engineering model. Moreover, credits for practical training and bachelor thesis were not included while the numerical values for them may be assigned to application technologies level. Consequently, the left part of both Figures 03 and 04 may be considered "smooth" while systems infrastructure and computer hardware & architecture levels on the right are rather low in both cases.

6. Findings

The analysis of IT degree programs in Liepaja University and Nizhnevartovsk State University proves our hypothesis that both universities use Software Engineering model.

Further, it is necessary to present the results of a comparative analysis of the content of the degree programs in LU and NSU in some key aspects that are crucial to developing high-quality IT programs.

First, it is important to mention that both universities provide their undergraduates with practical training while they are the 3rd and the 4th year students. Yet, credit value of the training provided differs. Liepaja University has 12 (18) credits for training of the 3-year students and 14 (21) credits for the 4-year students. Nizhnevartovsk State University gives a total of 12 credits for training its 3-year and 4-year students (6 credits each). It also provides in-school practical training for the 2-year students (3 credits). To summarize, Liepaja University provides more credits of training (26 (39)) than Nizhnevartovsk State University (15 credits). Transition of Russian universities to an updated FSES 3++ standard implies that more credits will be given to practical training. Still, the increase will not be significant.

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Project activity is a key component in training a Software Engineering graduate. The curriculum of Liepaja University includes term projects from the first year of study while 4-year students write their bachelor thesis (see Table 03).

Table 03. Projects credit value in Liepaja University

Year	Curriculum Section	Credit Value (Latvian Credits)
1	Annual Project (Software Development)	2 (3)
2	Annual Project (Databases)	3 (5)
3	Annual Project (Information Systems)	2 (3)
4	Bachelor Thesis	12 (18)

The curriculum of Nizhnevartovsk State University includes only one project on the 3rd year of study (3 credits) and bachelor thesis (6 credits).

Thus, it can be concluded that the degree program in Liepaja University focuses more on practice and project activities that fully meets the international standard requirements for IT graduate (Sliva, 2016; CS 2013 - Computer Science Curricula, 2013).

7. Conclusion

The results of the study suggest some guidelines for degree programs in IT and their improvement while graphical representations identify a program's weaknesses. Given the above, methodology described in this research (graphical representation namely) provides a mechanism that is able to highlight a degree program's weaknesses as it is compared to one of the CC2005 models that meets the international standards in IT. Further, it is planned to extend the range of the universities and their curricula in IT to be studied to find out how they correspond to CC2005 models that were not considered here.

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