

# ICT Education and Requirements for ICT Graduates in the Czech Republic<sup>1</sup>

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## Abstract

This paper provides an analysis of university graduates at ICT specialist market in the Czech Republic. It focuses on universities effective in the ICT education area and compares their study programs (203 programs) with requirements of businesses (1002 businesses). It describes typical “product” of Czech education process in the area of ICT skills. General conclusions show that majority of graduate bachelors (at about 85%) in the Czech Republic do not have knowledge profile to enter business as qualified employees without expensive additional training. At master level the same applies for at about 40% of graduates.

**Keywords:** ICT Education, ICT Skills, ICT Curricula, Roles in ICT, Knowledge profiles.

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## Introduction

The current situation of the existing information technology world characterizes the increasing demand for different roles of Information and Communication Technology (ICT) specialists in different countries and regions. “Fundamental” ICT skills (e.g. programming, development and testing) are more required in countries with emerging economies as opposed to stable and developed countries where the demand is not so massive. In some regions, for example in Australia the rate of unemployment in these professions is permanently increasing according to some sources (Voříšek & Feuerlicht, 2006b). In contradiction is Hagan (2004). On the contrary, there is an increasing demand for “new” ICT skills (e.g. sourcing, business analysis) (Helfert & Doucek, 2007). We cannot forecast mechanically the demand for ICT specialists – each country and region has its own features and specific character.

The ICT sector was expected to grow worldwide at six percent in 2006, with growth more balanced in OECD area than in the years 2004 and 2005. With improved macroeconomic performance, aggregate investment is now increasing across the OECD area and ICT present the significant and growing share of this investment. Some ICT segments are very dynamic (Internet related investment, portable and consumer applications, ERP products etc.), with the major share of

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venture capital flow. Merge and acquisition activity is also very high. The overall prospects for continuous balanced and sustained growth at a relative high rate are good, but return to the unsustainable annual growth rates of 20–30% of the late 1990s is not expected (The ICT Professional Outlook, 2005; Information and Communication Technology, 2006).

Another dimension of this economic growth is characterized by changes in the area of human resources management. ICT like other new areas of human activity depends on one hand on new technologies development and improvement and on the other hand, it is deeply connected with the quality of employees in the sector – on human resources with specific skills (ICT Skills Monitoring Group, 2002), knowledge, abilities and competitiveness (Frinking, Ligtoet, Lundin, & Oortwijn, 2005).

Permanent development in the area of ICT implies demand for changes in workforce requirements (Frinking et al., 2005). Up to 5 % of total number of employees globally is working in ICT specialist occupations and around 20 % in ICT-user occupations. ICT specialist job definitions are continuously evolving, nowadays requiring combination of ICT specialist skills with other “non ICT” skills – marketing, business etc. (ICT Skills Monitoring Group, 2002). Basic ICT skills are increasingly filled “naturally” through diffusion of ICTs and use of ICTs in schools and in workplace (Frinking et al., 2005). Efforts are being made to improve the access of older workers to ICT skills through training programs. Because needs for ICT specialist skills are likely to change as rapidly as technology changes (at least once in two to three year frame), the formal education system may offer less flexibility for adapting curricula than private sector subjects usually set up as multi-stakeholders partnership (Information and Communication Technology, 2006).

As a reaction to the low flexibility of the Czech Republic formal education system in the area ICT skills the Faculty of Informatics and Statistics decided to initiate a research project in order to map:

- ICT education offered in the Czech Republic.
- Demand for ICT skills in the Czech Republic.

University education (tertiary education) forms an important component of the education system in each country in the world and this level should be one of the most effective and required in the area of ICT.

The aim of this project was to motivate universities and formulate recommendations for further development of the Czech university education in the area of ICT. To set up and formally pass the accreditation process of a new study program takes in minimum one year (only under conditions that relevant school or university has enough experts in required knowledge areas).

The main goal of the project was firstly to:

- Identify at all universities and technical specialist schools, which are involved in ICT education, topics of their education process, number of credits devoted to different IT subjects.
- Identify the actual number of students, expected number of graduates in an actual school year and actual number of new students in the first year.

The second goal was to do a survey of the ICT graduates skill requirements in the Czech market (ICT Skills Monitoring Group, 2002). The investigation started in September 2006 and in April 2007 we have got the first preliminary results.

General aim of this project is to repeat this survey (every second year) and based on the results prepare suggestions for new study programs and courses and provide evaluation for existing ones.

No gender analysis (Valenduc & Vendramin, 2005) was included in this survey. It represents one of the open issues for next period of survey.

## Methodology

All the project phases and methodology decisions were discussed and agreed by the team consisting from members of three leading Czech IT associations (CSSI, SPIS, CACIO), experts from five Czech universities and selected ten employers of ICT university graduates in the Czech Republic.

### ***Roles in ICT – General Concept***

Our project prefers classification of specific roles in ICT (rather than particular professions which are in this context too detailed) underlining the competitive ability of graduates based on their knowledge potential (Valenduc & Vendramin, 2005). ICT specialist in this context is educated and qualified to use his/her knowledge potential mainly in the design, implementation and operation of ICT and their application (Beise, Thomas, & Fred, 1991; Clear, 2000; Fernandez & Tedford, 2006; Haywood & Madden, 2000; Round & Lovegrove, 2004). For the purpose of this project we have described his/her competencies as follows:

- Designs and develops ICT.
- Implements, customizes and integrates ICT applications within an enterprise or another economic subject, thus changes and modifies working procedures and effectiveness of staff.
- Implements and manages ICT operation including user application support.
- Manages ICT projects.
- Manages information services and knowledge provision.
- Provides and purchases ICT services and products – using professional skills regarding detailed knowledge and effective methods of their use.

End users of ICT are not (for the purpose of this project) considered as ICT specialists, even though most of the current university graduates (doctors of medicine, financial experts, architects) (Round & Lovegrove, 2004) are by definition active in data processing and computer aided operations. We decided to exclude this category from our research because it does not require specific ICT education. For example, user of SAP application software is not, according to our classification, an ICT specialist, but a methodology designer responsible for the overall SAP architecture is covered by our role definitions (Round & Lovegrove, 2004).

Due to fast developments and relatively high specialization in the area of ICT we have decided to define specialists at two levels of detail – the first level consists of core ICT roles. This level is relevant for our research because it focuses on the core competencies and procedures rather than detailed technical knowledge which universities could not provide in up to date manner. The Second level lists ICT professions included in the core roles as shown in Table 1.

Furthermore we have (together with above listed institutions and employers) identified obligatory skills that are required for all ICT roles in the Czech Republic:

- High level of creativity.
- Team work ability.
- Communication competence.
- Fluent spoken and written English.

**Table 1: List of ICT Professions** (Voříšek, & Feuerlicht, 2006b)

Basic ICT roles and ICT professions	Knowledge / Activity of basic ICT role
<p><b>Business Process Analyst/Designer</b></p> <p><b>Profession:</b> analyst, knowledge engineer, business consultant, standard SW implementer, information broker, competitive intelligence specialist.</p>	<p><b>Key knowledge:</b></p> <ul style="list-style-type: none"> <li>• Modeling of enterprise processes change to make them rapid, more effective and less costly in order to produce quality products/services.</li> <li>• Optimum use of knowledge and competence of employees and business partners.</li> <li>• Which ICT services/applications are advantageous to use for business processes support.</li> </ul> <p><b>Key activities:</b></p> <ul style="list-style-type: none"> <li>• Analysis, design, standardization and optimization of enterprise processes and organizational structures (financing, trade, production etc.).</li> <li>• Analysis and planning of business effects resulting from IS/ICT.</li> <li>• Analysis and design of knowledge management at organization.</li> <li>• IS/ICT risk analysis, business continuity.</li> <li>• Proposal of ICT services supporting enterprise processes.</li> <li>• Implementation and customization of standard software.</li> <li>• Proposal, design and search of information content (information services, portal, web) needed for management support.</li> </ul> <p>Note: Knowledge of global best practices, local conditions and enterprise culture is required (offshore outsourcing is not expected).</p>
<p><b>IS/ICT development and operation manager (ICT Manager)</b></p> <p><b>Profession:</b> CIO, project manager, operation manager, security manager.</p>	<p><b>Key knowledge:</b></p> <ul style="list-style-type: none"> <li>• Business/ICT relations management – the role of ICT in supporting business goals.</li> <li>• ICT services, processes and resources organization and management.</li> <li>• Management and coordination of ICT projects.</li> </ul> <p><b>Key activities:</b></p> <ul style="list-style-type: none"> <li>• ICT project management.</li> <li>• Information strategy working-out.</li> <li>• Sourcing strategy working-out.</li> <li>• ICT services delivery management.</li> <li>• IS/ICT enterprise operation management.</li> <li>• Problem and change management.</li> <li>• Risk management.</li> <li>• Security management.</li> <li>• IS/ICT economics management.</li> <li>• Quality control and IS audit.</li> </ul> <p>Note: This profession is not recommended for outsourcing.</p>

<p><b>Businessman in ICT products and services</b> (ICT Salesman, ICT Relationship Manager)</p> <p><b>Professions:</b> salesman in ICT products and services, supplies manager of external products and services, account manager, relationship manager.</p>	<p><b>Key knowledge:</b></p> <ul style="list-style-type: none"> <li>• Knowledge of global and local ICT markets.</li> <li>• Knowledge of existing/potential partners/customers.</li> <li>• Legal aspects of ICT trading.</li> <li>• Negotiation strategy and tactics.</li> </ul> <p><b>Key activities:</b></p> <ul style="list-style-type: none"> <li>• Marketing of ICT products and services.</li> <li>• ICT products and services sales.</li> <li>• ICT products and services purchase.</li> <li>• Preparation of agreements on supply of ICT products and services (SLA).</li> <li>• Management of relationship between supplier and customer (sourcing strategy principles).</li> <li>• Negotiation with partners (respecting different national and cultural environment).</li> </ul> <p>Note: This profession is not suitable for outsourcing.</p>
<p><b>Developer / IS Architect</b></p> <p><b>Professions:</b> developer, programmer, tester, system integrator, ICT architect, systems development manager.</p>	<p><b>Key knowledge:</b></p> <ul style="list-style-type: none"> <li>• Technologies and procedures needed for design, integration and operation of applications.</li> <li>• Design and development of user-friendly applications with simplified operational requirements.</li> <li>• Design of suitable technological and application architecture of IS/ICT organization.</li> <li>• Management of the team of designers and developers.</li> </ul> <p><b>Key activities:</b></p> <ul style="list-style-type: none"> <li>• Analysis and design of ICT applications (on-line services, BI, effectiveness of business processes, personal/tailored application. entertainment).</li> <li>• Database design.</li> <li>• Data mining.</li> <li>• Programming of client, server, database and web applications.</li> <li>• Grid programming.</li> <li>• Application testing.</li> <li>• Application documentation (design, program, operational, users).</li> <li>• Maintenance and administration of application versions</li> <li>• Integration of applications.</li> <li>• Design of hardware, software and data architectures.</li> </ul> <p>Note: Thanks to easy outsourcing these professions might be transferred to countries with low labor costs – except analysts and designers of applications.</p>

<p><b>Administrator of applications and of ICT infrastructure (ICT Administrator)</b></p> <p><b>Professions:</b> application administrator, database administrator, network administrator.</p>	<p><b>Key knowledge:</b></p> <ul style="list-style-type: none"> <li>• How to acquire, maintain, operate and terminate ICT infrastructure components.</li> <li>• How to scale up and down the ICT infrastructure.</li> <li>• How to support users of IS/ICT.</li> </ul> <p><b>Key activities:</b></p> <ul style="list-style-type: none"> <li>• Application administration, training and support of users.</li> <li>• Database administration.</li> <li>• Administration of data content.</li> <li>• Administration of computer network and of basic SW.</li> <li>• Administration of configurations.</li> <li>• Web administration.</li> </ul> <p>Note: Suitable for outsourcing – these professions might be transferred to countries with low labor costs.</p>
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## **Skill Categories**

During the research methodology design we have been concentrating on the 18 skill categories (based, but not limited to the respected IT curricula – Strawman curricula) (Strawman, 2004) and their importance in the university graduate or employee profile. Final list resulted from the discussion of the project team and was reviewed by above listed institutions and employers.

We have identified the following skills categories:

Process modeling (MS01), Application functionality (MS02), ICT service definition and operation (MS03), Architecture analysis and design (MS04), Software engineering (MS05), Data engineering (MS06), ICT infrastructure (MS07), Operational Excellence (MS08), Communication and presentation skills (MS09), Team leadership skills (MS10), ICT market knowledge (MS11), Organizational management methods (MS12), Enterprise finance and economics (MS13), Sales and marketing (MS14), Statistics (MS15), Law (MS16), Business sectors (MS17) and Other (MS18).

Note: Category MS18 Other was provided in the questionnaires for informative and crosscheck reasons (in order to get the total number of credits for study program) and was not used in the further analysis, clustering and distance measurement.

## **Knowledge Levels**

In order to compare the “amount” of knowledge devoted to each skill category by university program or by business requirements we have defined non-linear scale as follows:

- Level 0 - No knowledge.
- Level 1 - Overview (relevant to 1-3 credits or intensive training days).
- Level 2 - Basic orientation and terminology (relevant to 4-8 credits or intensive training days).
- Level 3 - Good orientation and basic practical skills (relevant to 9-32 credits or intensive training days).

- Level 4 - Good orientation and good practical skills (relevant to 33-64 credits or intensive training days).
- Level 5 - Highest knowledge quality and advanced practical skills (relevant to 65 and more credits or intensive training days).

One credit is in the Czech Republic understood as 90 minutes direct (in university) and 45 minutes of indirect (home) education in each of 13 weeks of one semester. In total it is equivalent of 1170 minutes of direct and 585 minutes of indirect education.

We have decided to use non-linear scale in order to conform to industry requirements (different non-linear expectations from each knowledge level) expressed to us by the employers.

We have decided to compare (and express) one credit of university study program to one intensive training day, because not all the businesses we had planned to include in our surveys were familiar with the university credit scheme.

Above listed scale was initially developed by the project team and approved after analysis of the pilot surveys (see below).

### ***Knowledge Profiles and Their Distances***

A set of knowledge levels for each of the skill categories is in our research defined as “knowledge profile” and is used for comparison of the business requirements with the supply of universities.

In our research we have used for the above listed comparison the measure “Distance between the knowledge profiles”. The distance between university knowledge profile A and business knowledge profile B is expressed by the number of additional intensive training days required for the university graduate with the knowledge profile A in order to fulfill the minimum requirements of profile B required by business. The smaller the distance, the “cheaper” it is for the business to employ this university graduate.

## **General Scheme of the Investigation**

The Bologna process, which started with the well known declaration in 1999 (“Joint Declaration of the European Ministers”, 1999), currently, has major impact on university and higher education curricula all over Europe. EU improves higher/tertiary/college education model based on schema of three-year bachelor study (undergraduate - bachelor studies), two-year master study (graduate – master studies) (3+2 model) and the PhD level study for the majority of universities in EU member states. Czech education system has accepted the Bologna declaration and almost all Czech universities and HEIs have implemented this model. We have decided to concentrate on only undergraduate and graduate studies, which are producing the vast majority of ICT graduates in our survey.

Initially, we developed the survey questionnaires for universities and for the businesses (legal entities) in the Czech Republic. We tested these questionnaires at the pilot survey in small number of universities (5) and businesses (15). Then we updated them based on the comments received and distributed them among all universities and other HEI (Higher Education Institutions) in the Czech Republic.

### ***Survey among Universities and HEI***

#### **The surveyed population**

All faculties and HEI providing IT related study programs based on evidence of the Czech Ministry of Education. There were 54 faculties and 19 HEI identified in that evidence on 2006/03/01.

Questionnaire was sent out to all these subjects. They were asked to fill this questionnaire for each IT related study program they provide. Response rate was 81% for faculties and 42% for HEI. We have collected the data about 203 IT related study programs.

### Method of sampling from the population

Therefore we have surveyed the whole population no sampling method had to be used. Missing quantitative data (number of enrolled, number of students, number of graduates) from non response we have reconstructed from the official resources of the Czech Ministry of Education. Missing qualitative data (number of credits devoted to each skill category) were not reconstructed and these faculties and HEI institutions were included into final results as "not classified" segment.

### Variables

- a) Number of students, number of enrolled (new entrants to the study program each year) number of graduates in the school years 2000 to 2006 and expected numbers for some following years.
- b) Number of credits devoted to each of 18 skill categories defined.
- c) Classification variable: level of study program – HEI, bachelor, master (2 year), master (5 year; these are the "pre Bologna" programs ending in 2006 or 2007 school years)

## Survey among Businesses

### The surveyed population

The survey covered all active economic subjects in the Czech Republic on 2005/12/31 (the survey was held in 2006). According to data of the Czech Statistical Office, there were 1 266 336 subjects of various size and main economic activity (Table 2).

*Size of entity:* According to the number of employees, 6 categories were used: 0, 1 – 9, 10 – 49, 50 – 249, 250 – 999, 1000 and more.

*Sector of main economic activity:* There are 17 main sectors in Industrial Classification of Economic Activities of the Czech Statistical Office. According to the requirements on information technologies, these sectors were coded into 3 categories: sectors with the lowest requirements (MIT), sectors with the middle requirements (SIT) and sectors with the highest requirements (VIT).

**Table 2: All active economic entities in the Czech Republic on 2005/12/31**

	0	1 - 9	10 – 49	50 – 249	250 – 999	1000 +	Total
<b>MIT</b>	263 289	49 914	14 270	4 317	369	87	<b>332 246</b>
<b>SIT</b>	697 380	138 555	28 014	6 217	1 164	182	<b>871 512</b>
<b>VIT</b>	49 851	9 590	2 216	710	170	41	<b>62 578</b>
<b>Total</b>	<b>1010 520</b>	<b>198 059</b>	<b>44 500</b>	<b>11 244</b>	<b>1 703</b>	<b>310</b>	<b>1266 336</b>

### Method of sampling from the population:

According to the size of subject and to the category of its economic activity, the population was grouped into 18 subpopulations. Then, stratified sampling was applied. Proportionate allocation when the sampling fraction in each of the strata is proportional to that of the total population was not useful here. There are no homogenous subgroups in the population. As we can see in Table 1,

their size is very varied. Because of number of employees the variation of number of IT workers in subject certainly is very heterogeneous, too. Optimum allocation requires knowledge of this variability (it was un-known). So, we took this heterogeneity into account at least in the following way: the sampling fraction was higher in strata with more employees and in sectors with the higher requirements on information technologies.

The interviewing methods used were CAWI and CATI. Realized sample size was 1002 (Table 3).

**Table 3: Structure of the observed sample**

	0	1 – 9	10 – 49	50 – 249	250 - 999	1000+	Total
MIT	56	28	28	28	37	16	193
SIT	56	56	56	56	71	36	331
VIT	56	110	160	122	26	4	478
<b>Total</b>	<b>168</b>	<b>194</b>	<b>244</b>	<b>206</b>	<b>134</b>	<b>56</b>	<b>1 002</b>

## Variables

- Number of IT employees in 2006 in the following structure: business analyst, IT manager, IT salesman, architect of information networks, administrator, advanced user. Expected number of IT workers for some following years.
- Knowledge requirements on particular professional positions: there were 18 skill categories defined (thus, 18 ordinal variables with values 0 – “no knowledge (0 training days)” ... 5 – “highest knowledge (more than 65 training days)”.
- Classification variables: number of employees, sector of main economic activity, requirements of the sector on information technologies, IT supplier or customer, national or exterior owner.

## Number of IT employees:

Sample distributions in the particular strata are highly right skewed (duly incidentally) and they include outliers (the box plots were used to make the explanatory data analysis). Therefore, to characterize their location and variation, and for estimates of total number of IT employees in Czech economy, medians and median absolute deviations were used. In the stratum “entities without employees”, the proportion of “IT entities” in that stratum in population was estimated.

## Knowledge requirements:

With respect to nature of variables, medians were used again. To compare different professional positions and different skill categories, box plots (for sampling distributions) and scatter plots (for medians) were used.

## Further Data Analysis – Clustering and Distances

In order to identify study programs with common patterns (from the perspective of the knowledge provided to their graduates) we have used cluster analysis (with the expectation-maximization algorithms). IT programs were classified into eight segments (four for bachelor and HEI and four for master programs). To express the location of particular obtained knowledge in each segment, medians were used again. The star charts (“spider” charts) were used to compare obtained and required knowledge in particular skill categories for each professional position.

In order to get detailed information about how relevant study program or segment of study programs knowledge profile differs from the requirements of practice we used concept of distance

described in previous chapter. Note: We have used "1 credit = 1 intensive training day" comparison ratio.

In the end we compared the supply and demand for each of the defined ICT roles from the quantitative (number of graduates and number of needed employees) and from the qualitative (knowledge profiles comparison) perspective.

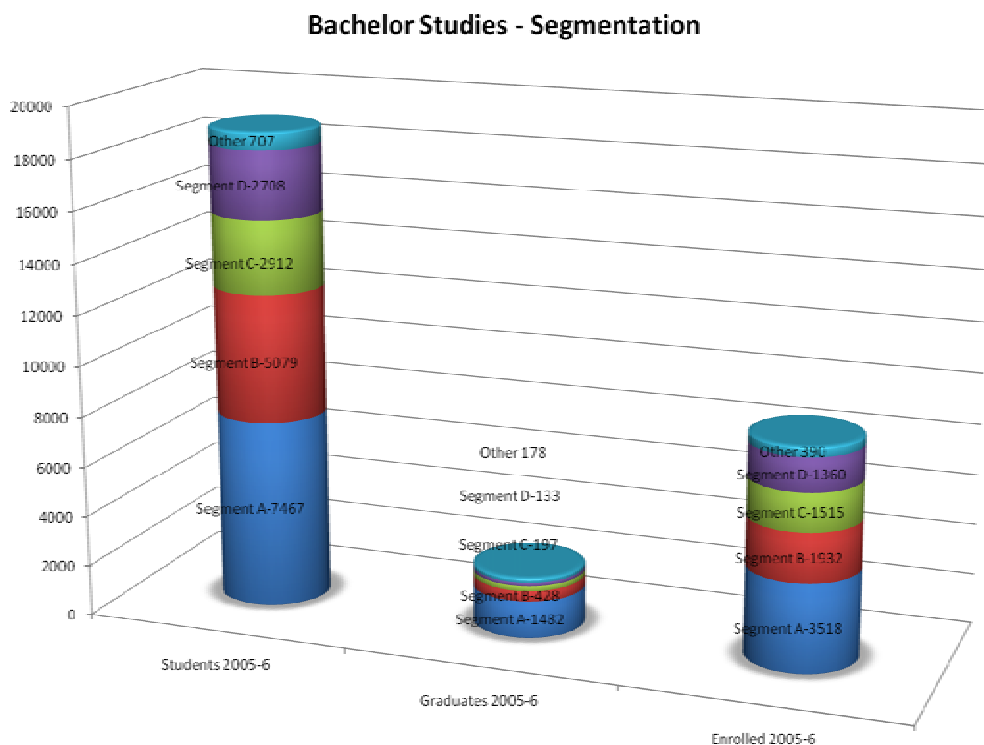
## Results Overview

Due to the limited scope of this paper, we are presenting here only the results of the first part of the project – analysis of the Czech ICT education market. The most important part of this research is based on the characteristics of study program segments (clusters), which brought very interesting results. (For more information see Novotný & Doucek, 2007 and Voříšek, Doucek, & Novotný, 2007).

Note: Some of the study programs on Bachelor and on Master levels were excluded from clustering because their questionnaires in the area of the knowledge profile were not filled in properly – they are listed as “Not classified” or "Other" in the following tables).

### Bachelor Level Education

Size of the Czech Republic bachelor level IT education sector (bachelor and HEI IT related programs) in the school year 2005/6 and its split among sectors with similar knowledge profiles defined in the project (see "Further data analysis – clustering and distances" chapter) is depicted in Figure 1.



**Figure 1: Bachelor Studies in the Czech Republic (in Number of Students, Graduates and Enrolled for each defined Segment)**

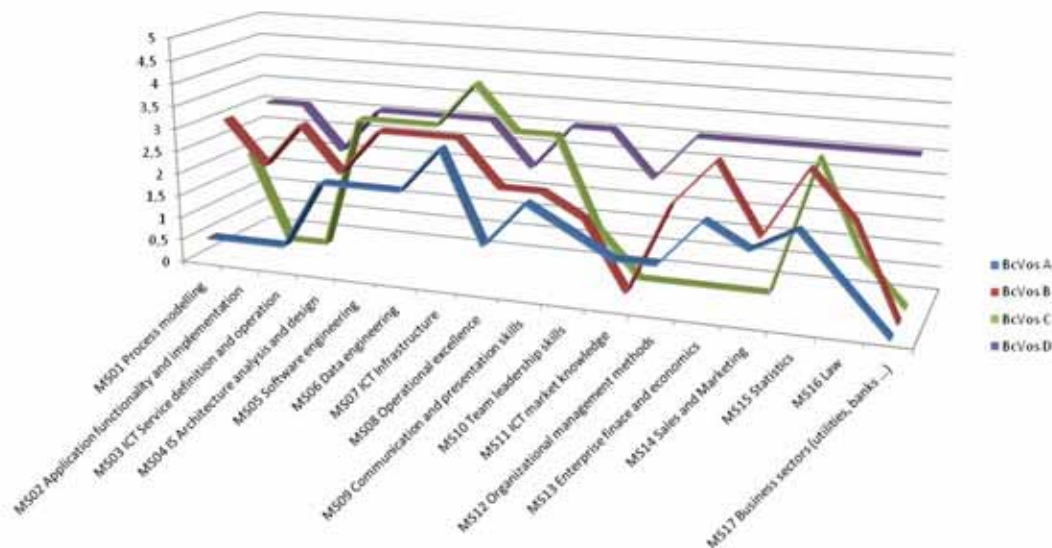
**Segment BcVosA** – students of this segment get only basic knowledge in investigated skill categories. We distinguish two main topic areas for this segment – informatics represented by following classical skill categories: Architecture analysis and design (MS04), Software engineering (MS05) and Data engineering (MS06) with additional emphasis on the category Communication and presentation skills (MS09). The second area of topics lies in economics education. This part is mainly represented by following categories: Enterprise finance and economics (MS13), Sales and marketing (MS14) and Statistics (MS15).

The whole donation of credits offers only very low ICT education. The level is under the average of the whole ICT education level through all investigated segments. Knowledge and skills represent here only a briefly overview of the completely problematic and have more character of general information about informatics.

It could be essential problem for those institutions that declare to prepare ICT employees and experts. On the other hand is this level acceptable for additional informatics education for example for teachers.

**Segment BcVosB** – knowledge profile of this segment offers very similar structure of education as BcVos A, but with important quantitative difference for credits. The number of taught credits is visible grater and it represents the better competitive advantage for graduates of this segment on ICT labor market. Main skill categories are following: Architecture analysis and design (MS04) Software engineering (MS05), Data engineering (MS06), Communication and presentation skills (MS09), Organizational management methods (MS12), Enterprise finance and economics (MS13), Sales and marketing (MS14), Statistics (MS15) and Law (MS16).

**Segment BcVosC** – knowledge profile provides common education in classic ICT. It does represent application analysis, design with additional knowledge of statistics. The most significant skill categories are: Process modeling (MS01), Architecture analysis and design (MS04), Software engineering (MS05), Data engineering (MS06), ICT infrastructure (MS07), Operational Excellence (MS08), Communication and presentation skills (MS09) and Statistics (MS15).



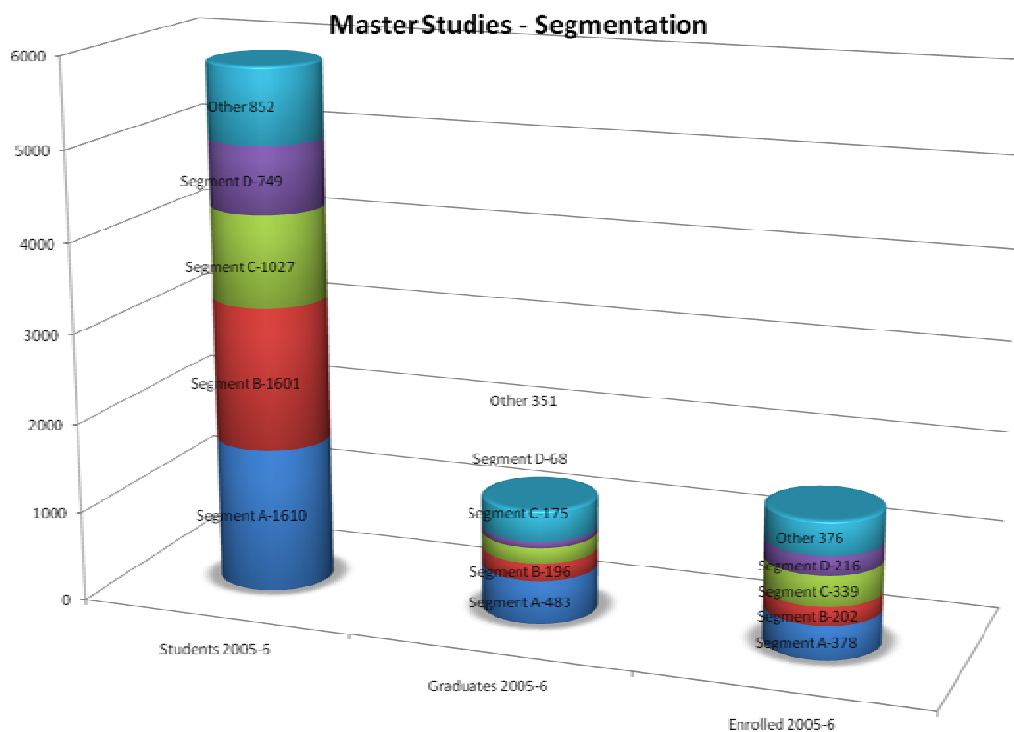
**Figure 2: Bachelor Studies Knowledge Profiles Comparison**

**Segment BcVosD** – knowledge profile provides the most complex set of knowledge with accent not only on ICT education. All skill categories are taught in harmonic relations and graduates have possibility either for further study or for starting their ICT jobs.

Comparison of the knowledge profiles of the bachelor studies segments is provided in Figure 2. Note: numbers 0-5 on Y axis represent knowledge level scale values.

### Master Level Education

Size of the Czech Republic master level IT education sector in the school year 2005/6 and its split among sectors with similar knowledge profiles defined in the project (see "Further data analysis – clustering and distances" chapter) is depicted in Figure 3.



**Figure 3: Master Studies Segmentation (With Number of Students, Graduates and Enrolled for each Segment)**

**Segment Mgr5A** – specializations posted in this segment provide basic knowledge overview in following selected categories: ICT infrastructure (MS07), Communication and presentation skills (MS09). Additional graduates get overview in categories: Process modeling (MS01), Architecture analysis and design (MS04), Software engineering (MS05), Data engineering (MS06) and Statistics (MS15).

Spectrum of taught information knowledge is not sufficient for enter into the ICT business. Character of this education is more similar to additional education in ICT. These graduates should have another job area than ICT, but the complementary orientation in ICT could be for them very useful and could represent for them competitive advantage on labor market outside of the ICT.

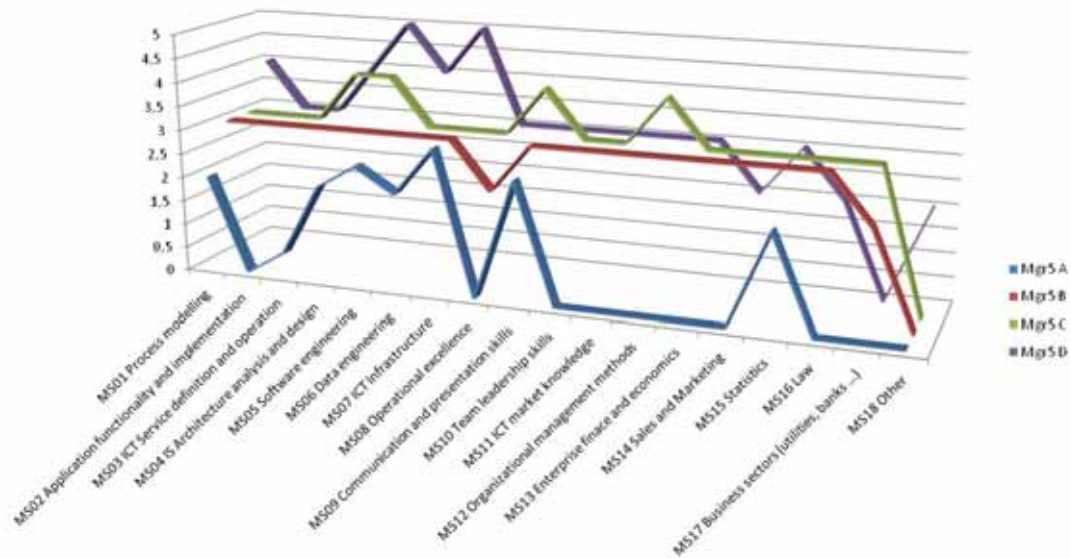
**Segment Mgr5B** – knowledge profile offers comprehensive basic education in ICT on level three in each category in fact without a specialization. Graduates enter the ICT jobs as universal labor force and their employer have opportunity and chance to create own profile of each of them according to their needs. They have basic knowledge for each ICT job.

**Segment Mgr5C** – prepares graduates on the same base as segment Mgr5B, but with more detail accent to following skill categories: Architecture analysis and design (MS04), Software engineering (MS05), Communication and presentation skills (MS09), Organizational management methods (MS12). Graduates are (after additional training and practice) ideal candidates for leading positions in ICT branch from project managers to the CIOs.

**Segment Mgr5D** – knowledge profile provides comprehensive informatics education on master level in all categories (except economics ones). Graduate get more detail knowledge in following categories: Process modeling (MS01), Architecture analysis and design (MS04), Software engineering (MS05), Data engineering (MS06) and ICT infrastructure (MS07).

Graduates have potential for ICT jobs with main accent on business process analysis, application analysis, design and development.

Comparison of the knowledge profiles of the master studies segments is in Figure 4. Note: numbers 0-5 on Y axis represent knowledge level scale values.

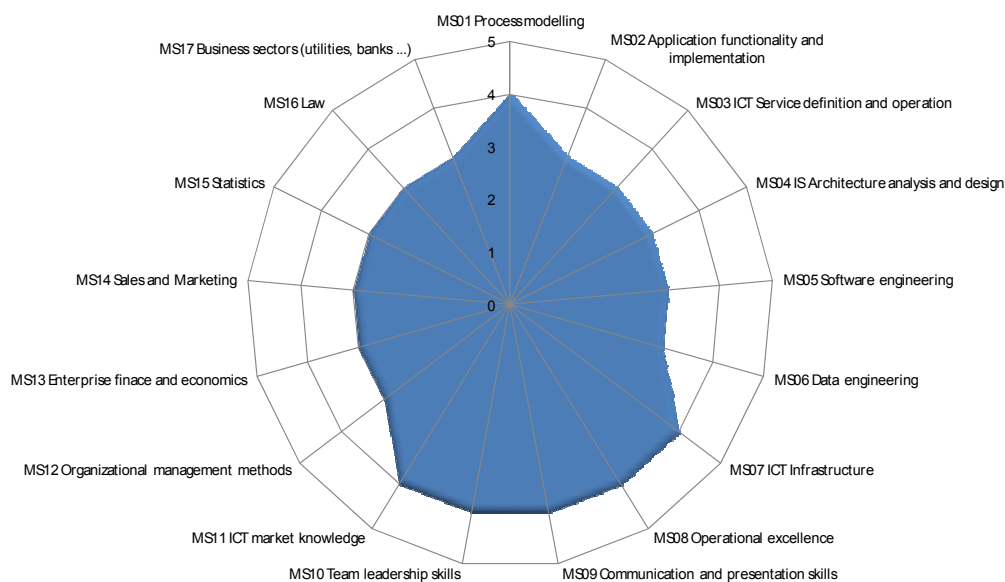


**Figure 4: Master Studies Knowledge Profiles Comparison**

### ***Distance between the University Programs and Business Requirements***

In previous chapters, we have described how we have been analyzing the distance between the knowledge profiles of university programs and business requirements for the particular business role. Let us discuss the example of such analysis for the Business Process Analyst/Designer ICT role. Requirements for this role are described at the Figure 5.

Note: numbers 0-5 on each axis represent knowledge level scale values. Interpretation is in this case that e.g. business requires knowledge level 4 (Good orientation and good practical skills) in MS01 Process modeling skill category for new employees in the Business Process Analyst/Designer ICT role.



**Figure 5: Knowledge Profile of the Business Requirements for the Business Process Analyst/Designer ICT Role**

Distance (expressed in the number of additionally required intensive training days) among between the bachelor level programs and business requirements for the Business Process Analyst/Designer ICT role is depicted in Table 4.

**Table 4: Distance Among the Bachelor Level Programs and Business Requirements for the Business Process Analyst/Designer ICT Role**

Bachelor level programs segment name	Distance (in number of required additional training days)	Number of Students in school year 2005/6	Number of Enrolled in school year 2005/6	Number of Graduates in school year 2005/6
BcVos A	146	5027	1861	714
BcVos B	109	2280	1121	188
BcVos C	114	2720	1178	343
BcVos D	68	3084	1526	237
BcVOS not classified		3848	2211	726
<b>Total</b>		<b>16959</b>	<b>7897</b>	<b>2208</b>

Distance (expressed in the number of additionally required intensive training days) among the master level programs and business requirements for the Business Process Analyst/Designer ICT role is depicted in the Table 5.

**Table 5: Distance Among the Master Level Programs and Business Requirements for the Business Process Analyst/Designer ICT Role**

Master level programs segment name	Distance (in number of required additional training days)	Number of Students in school year 2005/6	Number of Enrolled in school year 2005/6	Number of Graduates in school year 2005/6
Mgr5 A	155	1610	378	483
Mgr5 B	59	1601	202	196
Mgr5 C	40	1027	339	175
Mgr5 D	42	749	216	68
Mgr5 not classified		852	376	351
<b>Total</b>		<b>5839</b>	<b>1511</b>	<b>1273</b>

## Conclusions

After analyzing results in the way as presented in Table 4 and Table 5 for all ICT roles defined in this project, we came to the following interesting conclusions.

- ICT oriented study programs significantly differ in the level of knowledge provided in comparison with the business requirements. Even though all the surveyed study programs were defined and presented as IT related, there is a big difference among them. E.g. graduate of BcVos A segment study program requires 78 extra training days in comparison to graduate of BcVos D segment to start in Business Process Analyst/Designer ICT Role. In total graduate of BcVos A segment (32% of all graduates) requires 146 extra training days which makes him/her absolutely uncompetitive at the IT labor market.
- There is no direct relationship between the specific study program and specific ICT role. Some study programs form excellent background for any of the defined ITC roles, others are not useful for any of the defined roles.
- Graduate bachelors in the Czech Republic do not have in majority of cases (at about 85%) appropriate knowledge profile to enter business as qualified employees (especially in Business Process Analyst/Designer, Developer/IS Architect, IS/ICT development and operation manager) without additional training. They are too “expensive” in terms of further education in companies. Bachelor programs are nowadays in fact formulated not as standalone, but rather as prerequisites of the Master studies. Related conclusions we have found in South Africa conditions (Scott, Alger, Pequeno, & Sessions, 2002).
- Situation is better for graduates of Master studies where "only" at about 40% is not competitive and not able to enter the IT market without extensive training.

- It is time to start restructuring of higher education system especially in ICT education in the Czech Republic. It must be realized by opening of new study programs in ICT, which have to offer multi-, trans- and interdisciplinary presentation of knowledge.

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