Abstract: - Competence description remains a desideratum even in our days. The paper proposes some practical arguments that make possible some improvements. In education, Blooms taxonomy of educational objectives is still the reference regarding detailed competencies that can be achieved through learning. This taxonomy allows to define the desired learning level of a target audience. In addition, this taxonomy is useful to build assessment instruments. In order to improve the role of curricula for the undergraduate and graduate level (by point of view of Bologna process) a different approach is proposed. Starting from classical description of engineering (a specific standard from Australia [1]), we find some good results obtained from European programs. A new approach will be obtained, very useful for competence description.

Key-Words: - Competence standardization, Competence assessment, Practice competencies

1 Qualifications and competences
The three-cycle system proposed by Bologna process is not well understood yet, because, in author’s opinion, the engineer is considered in a classic way [2]: “the engineers offer an extensive wealth of knowledge in order to apply science, technology, mathematics and practical experiences. An engineer can be described as a problem solver and designer. The application of the design process results in the production and operation of useful products processes and services. Engineering involves a broad spectrum of specialized subdisciplines that focus on issues associated with developing a specific kind of product, process or service, or using a specific type of technology. Engineers design everything from rocking chairs to artificial organs and prostheses. Becoming a successful engineer requires more than a love for math and science.” The Bologna objectives, respectively the employability, look to the engineer in a different manner. The main difference consist in the complexity of the real jobs:

a) Simple, repetitive, complete defined, assisted by senior engineers
b) Complex, continuous variable, incomplete defined, working independent
c) Creative, innovative, research orientated

These three levels are the fundament for the three-cycle system, and the corresponding competences are connected. Thus, the development of the Frame for Qualification in the Field of Superior Education (CNCIS) [3] provides answers for a European need of access and progress in a university career, but regarding also the mobility of students and graduates. At the same time, it expresses a new perspective, more concentrated on the students, in agreement with the present international context. In order to become a reliable mechanism of internal and external regulation in the field of superior education, this complex system, the CNCIS, should be intelligible for all the interested groups. To the external arguments, stated on an European level, one can also add those which can be identified on a national level, like: the absence of a coherent structure of organizing and classifying the qualifications, a system of university formation that is rather narrow-minded as reported to the financial and social environment, as well as a weak balance between the demand and offer of education and formation.

All the stated arguments show the necessity of developing of the CNCIS and of assuming of responsibilities by the institutions involved in making decisions in the field of Educational Policy, these institutions being directly interested by the principles and mechanisms of development and implementation of CNCIS, and also by the effects that the CNCIS generates on a national and European level. A common point of view on the initial approach and further development of the CNCIS is essential. One of the expected results of the process of realization of the CNCIS is the use of qualifications, expressed in terms of results of studying. Two fundamental elements for the attaining of this objective are the active participation of all the relevant and interested categories, as well
as their desire to take active part in the subsequent process of the curricular reformation. The qualifications description is realized by the competences, because these are the main criteria for the employer. If the competences are not well described, a huge deadlock will compromise the entire process. Here we will find the contribution of this paper.

2 The classical model for competence
Like a tradition, competence in engineering was described by the ineffable: something between enabling and practice. Towards our surprise, we find a dedicated standard build on this conception [1]. Engineers Australia (the Institution of Engineers Australia) started the standardization process in 1992/1994, with a second improvement in 2002/2003. On short, the Australian Engineering Competency Standards imposes two levels [1]:
- Stages 1 - Graduate
- Stages 2 - Experienced Practitioner, with three subcategories:
  a) Professional Engineers (four-year Bachelor of Engineering degree);
  b) Engineering Technologists (three-year Bachelor of Engineering);
  c) Engineering Associates (two-year Advanced Diploma of Engineering or Associate Degree in Engineering).
Stage 1 is the level of competency achieved on completion of an educational qualification accredited, for entry to the profession. Stage 1 is primarily concerned with the enabling competencies. The accreditation criteria for an engineering qualification also require some exposure to engineering practice and an appreciation of its demands, and the development of attributes necessary for the assumption of responsibility as an engineering professional. In employment, they will typically work initially on tasks of limited scope and complexity, under the guidance of a more experienced person, while they develop practice competencies and experience (2).
Stage 2 competency embodies both the enabling and the practice competencies relevant to a field of engineering and an occupational category. Persons who are Stage 2 competent are practice-experienced and are capable of working autonomously under general direction in normal operating environments. Particularly complex, critical or innovative work might call for limited guidance while experience develops further.

This example is specific to a separate world (Australia) which is confronted with a highly intense process immigration of the specialists from overseas. Curiously, in Europe we have the same problems, but the vision of Bologna process about competence is totally different.

3 The Romanian competence description, between up-to-date or deadlock
The National Agency for the Qualifications in the Field of Superior Education and Partnership with the Financial and Social Environment (ACPART) organizes the frame of qualifications in partnership with the educational institutions and with the financial and social partners [3], by:
- the elaboration, implementation, updating and monitoring of the CNCIS, which will permit a broader acknowledgement of the results of the study, expressed in terms of knowledge, abilities and competences;
- the guarantee of the transparency of the CNCIS on a national and international level;
A problem occurs if we want to describe the competence. In [3, pag. 11] we can find the mechanism for competence setting up (fig. 1).

![Fig 1. Learning outcomes, after [3, pg. 11].](image)

First of all, the transversal (key) competences will not be discussed here (not figured). Second, a new category is introduced: the level descriptors for competence. As we can observe in figure 1, these are:
- Knowledge and understanding
- Explanation and interpretation
- Applying and problem solving
- Critical reflection
- Innovation and creativity
At page 13 [3] we can find that “level descriptors describes the qualification and, at the same time,
gives the criteria for competence assessment”. The second affirmation is correct and will be underline, but the first one is totally wrong. A special affirmation was found very close: “a level descriptor can be reach only if the predecessors are satisfied”. In essence, is correct, but in practice it was used to plan the different teaching disciplines in a wrong order: from beginning (knowledge and understanding) to the finalization of the learning cycle (innovation and creativity). The result? The senior teacher imposed, using persuasion and paternalism, their point of view. By author’s opinion, the obtained curricula were exactly the same like in the past, and no elements of reform were observed. On demonstrate this on www.ACPART page http://docis.acpart.ro/index.php?page=exemplificari-gri where we can find ACCEPTED GRIDS. These grids [3, pg.33] realize the connection between the Level descriptors for competence (column 2) and Disciplines (Column 4). The result is a classical arrangement (starting with Mathematics, Physics that are associated with the first level of competence: Knowledge and understanding. Here we have a huge mistake, because every Science must be study to attend all levels (until Innovation and creativity) as on demonstrate in the next paragraph. For this paper, it is useful to demonstrate the real meaning of level descriptors.

4 THE BLOOM’S TAXONOMY VERSUS LEVEL DESCRIPTORS OF COMPETENCE

The learning outcomes (figure 1) have a logical contradiction: understanding is different from knowledge (mechanical recall) and, more important, understanding = explanation and interpretation. In defense of this affirmation, we use Bloom’s taxonomy for the Cognitive Domain [4]. This taxonomy is very old, but still accepted, although different taxonomy was developed (for the military science, for example). We don’t need complicate demonstration, it is sufficient a direct comparing between level descriptors and Bloom’s taxonomy (Table 1), helped by useful verbs:

<table>
<thead>
<tr>
<th>No</th>
<th>Level descriptors (ACPART)</th>
<th>Bloom’s taxonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge and understanding</td>
<td>Knowledge</td>
</tr>
<tr>
<td>2</td>
<td>Explanation and interpretation</td>
<td>Comprehension</td>
</tr>
<tr>
<td>3</td>
<td>Applying and problem</td>
<td>Application</td>
</tr>
</tbody>
</table>

Table 1 - Comparison between level descriptors and Bloom’s taxonomy

In order to understand the significance of Bloom’s taxonomy, useful verbs are in general indicated:

<table>
<thead>
<tr>
<th>N o</th>
<th>Bloom’s taxonomy</th>
<th>Useful verbs (for Bloom’s taxonomy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>Tell, list, describe, relate, locate, write, find, state, name</td>
</tr>
<tr>
<td>2</td>
<td>Comprehension</td>
<td>Explain, interpret, outline, discuss, distinguish, predict, restate, translate, compare, describe</td>
</tr>
<tr>
<td>3</td>
<td>Application</td>
<td>Solve, show, use, illustrate, construct, complete, examine, classify</td>
</tr>
<tr>
<td>4</td>
<td>Analysis</td>
<td>Analyze, distinguish, examine, compare, contrast, investigate, categorize, identify, explain, separate, advertise</td>
</tr>
<tr>
<td>5</td>
<td>Synthesis</td>
<td>Create, invent, compose, predict, plan, construct design, imagine, propose, devise, formulate</td>
</tr>
<tr>
<td>6</td>
<td>Evaluation</td>
<td>Judge, select, choose, decide, justify, debate, verify, argue, recommend, assess, discuss, rate, prioritize, determine</td>
</tr>
</tbody>
</table>

Table 2 – Useful verbs for Bloom’s taxonomy

Level descriptors are still useful, they describe the learning process, but, based on Bloom, must be applied at every learning objective, at every step. Reciprocally, even the most complex engineering subdomain or science must cross all stages, together with the learner. Like an immediate conclusion, the assessment will find the efficiency of the learning process. But what we discover? If the level descriptors can’t organize the curricula, what can we do? The answer consists in the difference of qualification corresponding to the three cycles. For example, a competence will be established in two step: first using simplified methods (tables, using software, nomograms) for simple tasks, repetitive, complete defined, assisted by senior engineers (license qualification). Second step (master) will complete the gained competence with general methods (fully mathematics, developing software, simulation etc) for complex tasks, in continuous changing, incomplete defined and working
4 The Matrix of Competence

The idea to use a matrix to describe Electronics / Electrical Engineering competences was find also in [5], an European program VQTS II – Vocational Qualification Transfer System Leonardo da Vinci – LLP-LdV-TOI-2007-AT-0017. The matrix has two dimensions. On have eight rows, each row for a Competence Areas (corresponding to the core work tasks). Each row has three or for columns, corresponding of competence development. The columns significance is very close to Romanian qualification frame (License, Master and Doctoral), describing the complexity of the task: starting from simple to complex. This is why we must underline the Competence Area, because for the first time we have a very practical description about what electrical engineering must be, in a language understandable also by the employers, the students and maybe even the teachers. In order to offer a immediate image about this matrix of competences, we ask permission to quote from [5] some “elements”, followed by our comments:

Competence Area 1 (CA1): Preparing, planning, mounting and installing electrical and/or electronic systems for buildings and industrial applications.

   CA1. Step 1
   He / She can prepare and carry out simple electrical and electronic installations (e.g. cables, electrical outlets, connection and distribution systems, modular electronic components, computer components) as well as carry out and check the necessary wirings and mountings.

   CA1. Step 2
   He/She can plan, prepare and connect electrical and modular electronic installations. (e.g. energy supply in private and business premises, including lighting; alternating and three-phase current; electronic systems as units, wireless LAN, multimedia systems). He/She can advice the costumer and select the best implementation according to customer specifications.

   CA1. Step 3
   He/She can plan complex electrical and/or electronically networked installations (e.g. systems of energy distribution, building management systems / KNX, regulation and monitoring systems, building access systems, RFID-systems etc.) and fully wire them. He/She can configure, service and diagnose the functionality of the installation according to customer requirements and for this purpose can use computer-assisted tools.

Competence Area 2 (CA2): inspecting, maintaining and servicing electrical and/or electronic systems and machinery.

   CA2. Step 1
   He/She can carry out basic and scheduled maintenance tasks, inspections and checks at electrical and/or electronic equipment according to maintenance schedules and predefined instructions (e.g. checking voltage tolerances, changing wearing parts in industrial plants, switching and control systems, electrical machinery, computer systems). He/She can use the measuring and testing tools necessary for it.

   CA2. Step 2
   He/She can carry out and document preventative maintenance and alignment tasks at electrical and/or electronic industrial appliances and systems according to established methods of the quality assurance (e.g.continuous monitoring).

   CA2. Step 3
   He/She can analyse and determine availability and condition of electrical and/or electronic systems. He/She can analyse influencing factors on reliability and performance of electrical/electronic systems and find causes of malfunctions (e.g. leakage current analysis, power factor correction, EMC analysis).

   CA2. Step 4
   He/She can develop and document maintenance and inspection methods for electrical/electronic systems based on production and service process analysis as well as on quality management and customer requirements. He/She is able to develop related maintenance, inspection and quality assurance plans (e.g. optimizing MTBF of a production line, planning reserve power supply).

Competence Area 3 (CA3): setting up, putting into operation and adjusting electrical and/or electronic systems.

   CA3. Step 1
   He/She can set up, adjust and put into operation electrical and/or electronic systems (e.g. allocating frequency channels for a TV set, basic
settings of a frequency converter or a thermo relay for a motor) following customer requirements and instructions from the technical documentation.

CA3. Step 2
He/She can obtain and set system test parameters for set up and operation of electrical and electronic systems and select and carry out test procedures for installation and adjustment (e.g. adjusting interfaces in multimedia system, sensitivity setting of alarm equipment, elevator control unit).

CA3. Step 3
He/She can select, set up and adjust electrical and/or electronic systems and their control including accompanying sensors and actuators according to requirement analysis (e.g. energy supply systems, drive systems, electrical machinery, radio relay systems).

Competence Area 4 (CA4): designing, modifying and adapting wirings and circuit boards for electrical and/or electronic systems including their interfaces.

CA4. Step 1
He/She can modify, plan and build up simple electrical/electronic circuits according to standards and guidelines (e.g. wiring for rooms, connection diagram of basic motor circuits, simple operational amplifier applications, small programmable control units).

CA4. Step 2
He/She can modify, plan and build up standard electrical/electronic appliances according to customer requirements and official regulations (e.g. fire-warning devices, layouts for electrical / electronic wirings with the help of CAD programmes, energy supply in private and business premises).

CA4. Step 3
He/She can design, build up and improve electrical/electronic applications and its interfaces together with experts working in interdisciplinary teams according to emc standards and confirming test (e.g. electronic control circuits and equipment, microcontroller applications, PLC and related software).

CA4. Step 4
He/She can design, build up and configure devices and facilities, units for process control systems including related programming and considering complex system requirements (e.g. controlled drive systems, process monitoring, automated production line, real time microcontroller applications for car control, GSM data transmission for monitoring and remote control).

Competence Area 5 (CA5): developing custom designed electrical and/or electronic projects

CA5. Step 1
He/She can develop and propose solutions for simple electrical/electronic system based on customer requirements (e.g. lighting installations, power supply unit, basic automation and control systems).

CA5. Step 2
He/She can design electrical/electronic systems (e.g. PLC program for industrial applications, microcontroller application, ensuring expansion capability) and provide the necessary documentation (operational, maintenance, safety instructions, function, integration and acceptance tests).

CA5. Step 3
He/She can develop technical solutions for electrical and/or electronic systems and applications (e.g. microcontroller board for heating and air condition, RFID access system, new production line...) and provide appropriate documentation and customer training

It is the moment to underline the clearance of description for designing competences: CA4 and CA5. For CA6 and CA7 we don’t indicate the steps, it can be found also in [5]:

Competence Area 6 (CA6): Supervising and supporting work and business processes including quality management.

Competence Area 7 (CA7): Installing, configuring modifying and testing of application software for setup and operation of electrical and/or electronic systems.

Competence Area 8 (CA8): diagnosing and repairing of electrical/electronic systems and equipment. The steps of competence are very well described, from simple to complex:

CA8. Step 1
He/She can carry out standardized test procedures and diagnostic methods using wiring diagrams and test tools and carry out simple repairs at electrical/electronic systems (e.g. power measurement, level measurement).

CA8. Step 2
He/She can use testing and diagnostic tools as well as expert systems for the fault diagnosis at electrical/electronic systems up to the component level and carry out the necessary repairs (e.g. software control test, spectrum analyzer).

CA8. Step 3
He/She can select and use diagnostic methods for complex electrical/electronic systems and carry out preventative measures for the avoidance of disturbances and malfunctions in arrangement with customers (e.g. detection of bit error rate, overvoltage protection analyze).
CA8. Step 4
He/She can carry out system analyses (FMEA, FTA etc.) of electrical/electronic systems, determine error types and develop suitable diagnosis and repair methods including preventative measures.

In author’s opinion, it we split those three-four steps in two (License and Master) we will obtain a perfect matrix of competence, very close to CNCIS, but more understandable for all students, teachers, employers.

1 Conclusion
CNCIS represents a huge step, developing an instrument for qualification and competences in engineering. Using level descriptors for competence (close to Bloom’s taxonomy), both educators and students will be able to evaluate their performance in a detailed way and to give answers to questions like: “Which is the degree of qualification of a specialist who wants to work in a certain field of activity, after graduating a university stage?”

Competence is something witch belongs to the experienced specialists? No, it must be fix this believes, even in some regions (Australia) on maintained it. Now, the professors but also the students must be able to measure the level of the competence after license or master study, for a specific occupation and role. First of all, we must improve the competence description, and this paper offers a valid model.

References: