

Study Committee B3
Substations and Electrical Installations
Paper 10139_2022

**NEW ELECTRICAL AUTOMATION ENGINEER
PROFILE AND CURRICULUM**

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Motivation

- Challenging of **graduating the future engineers** to work in **modern electrical automation systems**;
- The electrical automation systems have evolved a lot in recent years... the associated engineering graduation* education should evolve as well.

*Note: "graduation" is a five years post-secondary education program for a student pursuing a bachelor's degree (Brazilian educational system).



Method / Approach

- Identifying the necessary **technical skills***;
- After that, those skills are associated to subject-matters to be included in the engineering curriculum.

*Note: here the word "skill" includes knowledge, ability and behavior.

Objects of Investigation

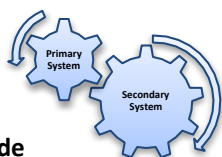
- The new engineers need to have **specific technical knowledge and practicing**, relating to the current electrical automation technologies and applications.

Technical Skills

- Modern automation systems have **many technologies and ideas**, which change quickly;
- New technical skills are necessary.

Basic Idea

- The engineers need "to understand both **primary** and **secondary** systems (the modern ones) and how they interact with each other".



Professional Attitude

- Working in **multidisciplinary teams**;
- Assuming a posture of **permanent learning**.

Discussion

- The electrical automation devices have changed, from *electromechanical relays* to *Intelligent Electronic Devices (IEDs)*...
- ... besides, there are new devices for *communication networking, data processing and interfacing*;
- In addition to the new devices, there are new standards and philosophies for automation*;
- A key point is to understand the concepts, basic functionality, philosophy and applications;
- Some of the required engineering skills to use those devices are not often included in the traditional electrical engineering programs.

*Note: The main causes of the cited evolution is the digital technology associated to information technology applied in the automation systems.



Conclusion

- The new electrical engineering programs should combine **classical theoretical subjects** and **new technological subjects** in a **motivational way**;
- Traditionally, the electrical engineer graduation programs emphasize the hardware; however, the **computing skills** are every day more relevant;
- According to the **category**, the required skills and experience can be somehow differentiated;
- Technically, the differences according to the **side** (or affiliation) are subtle;
- The **areas** are what make more difference in necessary technical skills, and then, in the curriculum;
- Multidisciplinary groups (with specialists in each area and generalists) are necessary to realize the tasks;
- Curriculum matrices including all issues in a proper time (usually five years in Brazil) is a challenge;
- The graduation programs should prepare the engineers for **new studies and specializations**. It is necessary teach the new engineers "how to learn".

Continued education is a must !

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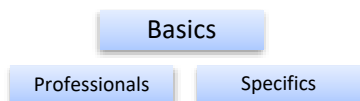
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The Engineer

- The engineer, classically, is seen as a technical expert in **solution of specific problems** limited to certain fields of interest. Nowadays, they need to be seen as **polyvalent professionals** able to contribute to the solution of a wide range of human problems.

Knowledge Types



Subjects

- Electromechanical equipment, analog and digital electronic devices, sensors, actuators, automation, control, data acquisition, data processing, data communications, computing, design, and, naturally, electrical engineer;
- Other areas skills:* management, administration, economics, communications, social, etc.

Experimental Teaching

- Reducing the total time spent in lectures and to realize multidisciplinary activities and projects:

Laboratory Lessons

- Development of the teamwork spirit;
- Contact with commercial PLCs, IEDs, RTUs, etc.;
- Normally the students are highly favorable to;
- Change some classes from traditional *hardware-based* laboratories to *software-based* laboratories.

Internships

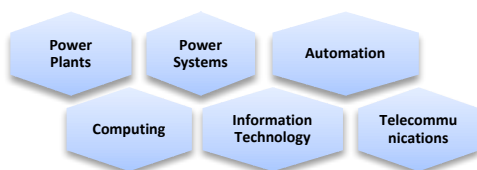
- Unique opportunities to know the equipment, devices and tools used in real world systems...
- ... and the professionals' aspects.

Trainings

- General** topics (educational institutes trainings);
- Specific** topics (manufacturer's trainings).

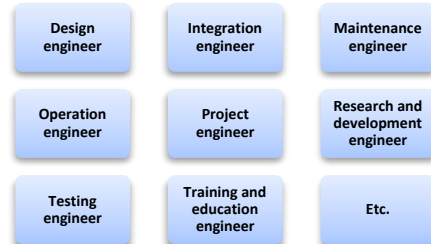


Areas

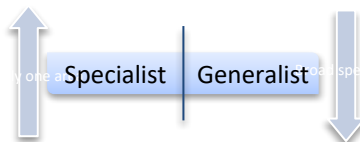


Categories

- The categories are associated to the functions developed by the engineers or to the position they occupy in the companies as:



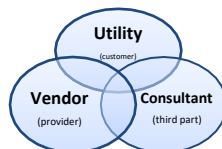
Species



- The **graduation** degrees provide core knowledge; thus, roughly speaking it results in **generalists**;
- The **post-graduation** certifications (and other educational and practicing activities) provide in deep knowledge for **specialists**.

Sides / Affiliation

- Basically, the engineer can act in three distinct sides:



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Continued Education

- **It is necessary additional intensive training to acquire the needed skills to work in protection, control and automation of power systems** (SC B5 WG 40);
- Complementary courses can be offered by universities, manufacturers, third parts, experts, etc.;
- Short course can be focused on specific practical activities and experiments;
- The knowledge of the existing staff is a strategic asset, and it can be transferred to the new engineers. That knowledge must be captured and documented;
- The cost of continued education must be seen as investments and not as expenses.

Standards

- **A new set of skills are required in order to deal with the complexity of the IEC 61850** "Communication networks and systems for power utility automation" standard and other standards, for example:
 - IEC 61588 (Precision Clock Protocol);
 - IEC 61499 (Function Blocks);
 - IEC 62443 (Security for Industrial systems).

Integration with Industry

- **The university education should be closely coordinated with industry** (SC B5 WG 40);
- There must be a balance between what the university teaches and what the labor market demands.

Engineering Subjects

- **Basics:** foundational courses in mathematics, physics.
- **Professional:**
 - Electrical and Electronic Circuits;
 - Reliability and Safety Engineering;
 - Data Acquisition and Signal Conditioning;
 - Sensors and Actuators;
 - Basics of Computing;
 - Control Systems Theory;
 - Basics of Automation.

Candidates Motivation

- Other areas of the electrical engineering have attracted more professionals;
- The power systems may look to not be so attractive to young people;
- There are a lot of new graduation programs that look to be more attractive and relatively easier;
- **Motivation to get new engineer candidates (and keep them in the program) should be considered.**

Challenging Generation

- The currently new engineers are mostly "millennials", also known as "Generation Y" (typically being defined as people born from 1981 to 1996);
- They have different expectation of their jobs;
- Noted tendency to not commit to long-term careers;
- By other side: complex tasks require a considerable preparation period for education and practicing;
- The companies must think in offering opportunities to learn, to grow, for career progression and additional motivations to retain those engineers;
- **The challenge starts at graduation. The universities need to think about ways to motivate and keep the millennials, avoiding graduation dropouts.**

Modern Systems Integration

- Many hardware and software components;
- The integrator engineers are very important;
- **The integration extends over the system lifetime.**

Specific Subjects

- Power Systems;
- Power Plants;
- Substations;
- Communication Networks;
- Specifics of Computing;
- Data Modelling;
- Databases;
- Electrical Automation;
- Standards.

