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CONCEPTION OF A NEW ENGINEERING CURRICULUM IN “SMART BUILDINGS”

Anne-Marie Jolly¹, Christophe Léger², Guy Lamarque³

Abstract — *The disaffection of students for electrical engineering led us to define new curricula based on concepts of electronics, electrical networks and sensors that could attract students whose interest lies in civil engineering or sustainable development.*

The idea of a course leading to jobs such as integrator of solutions for energetic efficiency of buildings, or designer of systems for smart homes revealed to be fitted as well with the needs of companies as with the interest of young people.

The point of view of the design of the curriculum is for 2/3 the point of view of the IEEE engineer and for 1/3 the point of view of the building engineer.

To go through such a transverse project, methodology of brainstorming and team efficiency is necessary. The result is a curriculum considered by major companies of the domain as useful and necessary, and by the team of researchers-teachers of the engineering school as a project allowing a better knowledge of the fields of each other.

The paper presents the methodology of development of the project in front of the needs in energetic efficiency of buildings and home caring of elderly. The course obtained and how companies and research organisms follow and help the approach is developed too.

A comparison with other approaches of new curricula in this field, based on civil engineering concepts is also presented.

Index Terms — *electronics, energetic efficiency, engineering education, home automation.*

INTRODUCTION

The number of problems related to energy management is getting bigger and bigger. Engineers, who are the actors of many technical solutions, should be able to propose solutions to them. Energy in building is one of the concerned fields because it is at the cross of two fields very distinct during engineering courses: civil engineering and electronics [1], [2].

In the same time, there is a real need to make students undergo studies in electronic engineering, while civil engineering meets a huge interest among men and women.

Companies are complaining because they do not find engineers able to manage a project intended to find global solutions for less consuming and comfortable buildings.

In the same time, great projects are emerging, involving academics and companies. There is not enough knowledge concerning thermal behavior of building depending on meteorological solicitations, new sources of energy or new algorithms of regulation. For that reason, research and development platforms aimed at those studies are in under elaboration.

To satisfy all these needs that will be the needs of tomorrow, it was necessary to imagine a specific course developing the skills necessary for jobs linked either to energy, comfort or easiness of life in buildings.

THE TWO OBJECTIVES

When speaking about smart buildings, two main directions appear [3], [4]:

- The first one concerns the energetic efficiency: in the house or in office building you have a great number of heat sources that can be controlled through electronic means: geothermic science, solar cells, fossil energy consuming boilers...
- The second one is related to the comfort and easiness of life for people living or working in the building: home automation, monitoring or care for elderly.

The curriculum aims to give skills in both fields, concerning the teachings in electronics, networks...the needs are the same because techniques for data transmission and data fusion are the same.

THE METHOD TO BUILD THE CURRICULUM

It is not in the use of teacher to build courses that are transverse to two fields of knowledge: civil engineering and electronic engineering, so a brainstorming methodology was used to come from skills expected in the jobs.

In our engineering school Polytech Orléans, we have the opportunity to have on the same campus 3 different categories of engineering courses: electronic engineering, civil engineering, energetic and mechanic engineering.

The first step was to mix teachers and researchers in electronics, renewable energy, materials and mechanics, heat

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energy, networks, automation.... They discussed about the skills necessary for jobs related to those fields:

- Technical management of buildings
- Design of electric or electronic devices for building
- Management of energy inside buildings
- Eco-design of buildings

These discussions were very fruitful for all of them because they discovered each other's fields that are complementary

All French engineers have basic knowledge in mathematics, computer science and management of project, but in this particular course, 3 great areas have been considered as the heart of the teaching:

- Management of energetic needs
- Management of people and assets
- Habitat and environment

The first item includes energetic optimization, ecodesign, renewable energy, management and optimization of energetic needs, home automation and electric devices for home comfort.

The second one is related to sensors, communication networks, interoperability, multimedia, video surveillance, safety, caring people at home

The third one concerns waste and water treatment, environmental norms about buildings, Electromagnetic compatibility.

Those points are then declined according basic teaching areas: electronics, automation, computer science, mechanics and materials, energetic, heat energy.

THE 3 YEAR COURSE

The courses begin two years after A Level, it lasts 3 years, and during this time the student receives 1800 hours of academic teaching. The time left can be used for a trainee in enterprise.

1 st Year Courses	Time with students(hours)
	Lecture, tutorial, practical work
Electronic and Control Engineering	
Digital and analogic electronic	100
Control Theory	50
Electrical communication	50
Sensors	50
Electric actuators	50
Project	
	300
Mathematics and Computer Science	

Mathematical analysis and algebra	25
Probability and statistic	25
Computer Science (imperative programming, parallel computing, client-server model)	50
Project	
	100
Materials science	
Fundamental properties and characteristics of materials	50
Thermal science of buildings	50
Project	
	100
Human, Economic, Management, Language Sciences	
Personal statement	6
Economics and management	18
English language	76
Project management-team project	
	100
Number of hours per student	600

During the first year (last year of Bachelor Degree), the student learns basics about electronics, materials, applied mathematics. These skills are necessary for a necessary adaptation to the job he will occupy all along his career. He is also initiated to the team work through projects.

2nd Year Courses	Time with students(hours)
	Lecture, tutorial, practical work
Applied mathematics	
Optimization and Operations Research	50
Information theory (channel, modulation, Fourier modes)	50
	100
Electrical integration and local area network	
Networks and protocols	50
Web services	50
Electricity generation and stocking	50
EMC : guided and radiated	50

modes, emission and hypersensitivity	
Project	
	200
Water and Energy	
Renewable and Alternative energy	50
Ecodesign of habitat	50
Thermoregulation	50
Water management	50
Project	
	200
Project management	
Team management tools	20
Safety engineering	20
Project management	30
	70
Human, Economic, Management, Language Sciences	
Carrier plan	6
Human resources	8
Labour law	6
Business law	6
Environmental management	10
Information technology law	12
English language	112
	160
Number of hours per student	730

The second year is devoted to the tools specifically used for designing smart devices. At this moment the students can realize projects that are more linked to the technique of smart buildings than previously.

3rd year courses	Time in front Of students
	Course
Process Control, man-machine cooperation	
Process control, Field bus, Human-computer interaction	50
Image and information analysis and processing	50
Standards : Advantages and aims illustrated by application	50
Project	

	150
Integration	
Arrangement of housing spaces. Architectural typology	50
Housing accessibility, interior architecture	50
Construction, urbanism and environment law	50
Sensorial Design applied to materials, Design and structure of habitat	50
Project	
	200
Human, Economic, Management, Language Sciences	
Career plan approval	6
Interview preparation	4
Human resources	8
Economics and management – strategy	16
Economics and management – marketing	12
Economics and management - business plan	8
English language	66
	120
Number of hours per student	470

During the third year, there are less leaching in front of student because half of the year is devoted to a synthesis project.

BENEFITS EXPECTED

The benefits are numerous:

- For companies: they are satisfied to have graduated students that can be the coordinators of activities in the fields of energetic efficiency and smart buildings.
- For students: they are much more interested by electronics whose interest is proved through every day life and for environmental purpose. Moreover, girls that are very few to study electronic engineering are more interested by transversal curricula (Project Helena [3]) especially if they are in link with sustainable development
- For teachers: for the teachers whose research is in touch with smart grids or energetic efficiency or technologies for home automation, it is very interesting to work with people mastering the complementary technologies

CONCLUSION

The course in itself will begin in September 2011 but we have already tested some of the teachings in a curriculum developed in Orléans, it showed the global interest of this project. The development of the course in Chateauroux, a city not far from a great company as Legrand is interesting to be able to show very quickly to the student the practical application of the courses.

The origin of the creation of this curriculum: a brainstorming of electronic teachers to decide how to make their course more attractive, makes the result obtained different of other curricula in smart buildings: for example in Université de Cergy-Pontoise [4] or in Polytech Nice(an engineering school of the same network as Polytech Orléans) they decided to make a civil engineering course become a smart building course. In those curricula the proportion of IEEE an civil engineering is opposite as ours. The two categories of engineers will have to work together in the future.

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