Industry and Engineering Education Interacting in an Interregional Project – a Flanders' perspective

Knockaert, J.
Professor
Ghent University – Department Industrial System and Product Design
Kortrijk, Belgium

De Lepeleer, G., **Stevens,** T., **Saey,** P.
Professor
KU Leuven – Faculty of Engineering Technology – E&A (Energy & Automation)
Gent, Belgium

Conference Topic: Continuing Engineering Education and Lifelong learning

INTRODUCTION

The Interreg-IVa 2-Seas project i-MOCCA ("interregional MObility and Competence Centers in Automation") concentrates on two fast evolving topics in industrial automation: industrial data communication and embedded control [1]. Both require high-end training of practicing engineers in industry and demonstrators illustrating proof-of-principle of emerging technologies. The i-MOCCA project aims to develop competence centers in different universities in the coastal regions of the UK, France and Flanders, Belgium. The project started in July 2011 and ends in September 2014.

The outline of the paper is as follows. In the first part, the triple helix model is applied to the project. In the second part, the project's deliverables and the project management are discussed. Part three briefly explains the use of common basic equipment. Part four is the main part of this paper and discusses how the cooperation between the seven university partners was achieved and how the industry could be involved. Some facts and figures close the paper.

1 TRIPLE HELIX

The "triple helix model" incorporating universities & knowledge centers, government & professional organizations, and the private (industry) sector, is regarded by the EU as very important for the "knowledge based economy". From the beginning, the i-MOCCA project partners have established numerous contacts with the private sector via courses, MSc final year projects delivering use cases for industry and for relevant laboratory exercises, lectures, … Cooperation with government & professional organizations is established by funding, dissemination, broad communication, …

The triple helix has grown during the last years from useful to necessary. Useful means that the cooperation between the partners creates new opportunities. Nowadays it can be stated that the triple helix is not only useful, but also necessary. Without the collaboration of the three actors, universities will do work or research with no valorization potential (nowadays more essential in engineering disciplines), industry will become non-competitive and the government will face both a brain drain and unemployment due to the loss of industrial activities. The triple helix becomes in this way a rigid structure, nowadays reaching a point that the three actors not only benefit from each other, but really need each other to survive. Fig. 1 shows the implementation of the triple helix model in i-MOCCA.

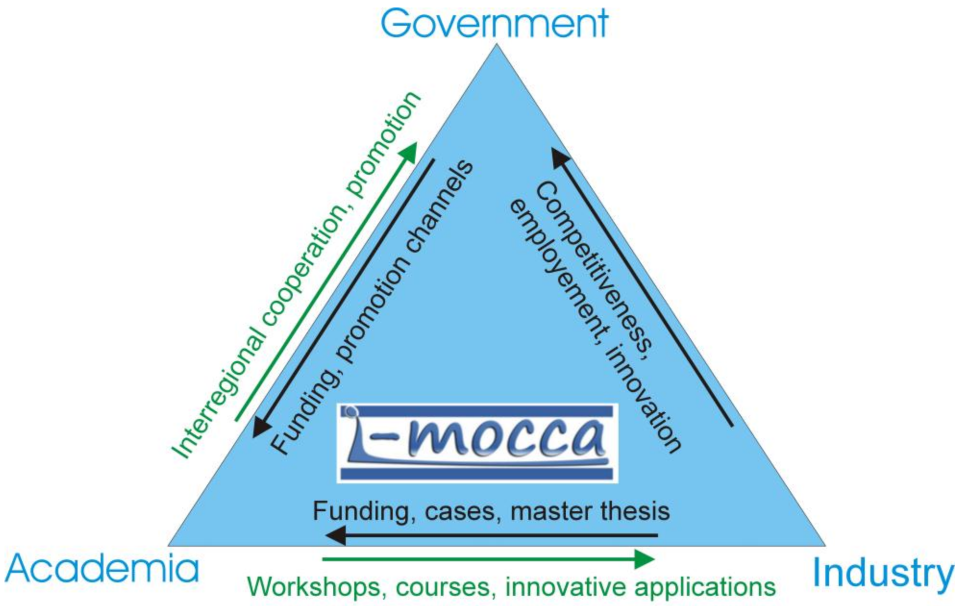

Fig. 1. Triple helix applied to i-MOCCA

In the i-MOCCA project, the **government** was involved as funding partner at two levels. The project was mainly funded by the European Union, more specific in the Interregional Cooperation program Interreg IVa 2 Seas [2]. Besides this, the regional government (provinces of East- and West-Flanders in Belgium) provided an additional funding, emphasizing the expected benefit for the local economy. The government also provided channels for promotion of the project results to a broader public, e.g. the annual 2 Seas event 2013 in Rotterdam.
The **industry** is involved as funding partner and as main user of the project results. The courses and hands-on workshops were developed for industrial partners and are at Master's level. The target industry of the project is mainly users of advanced automation. Examples of users are Volvo Cars Ghent and Arcelor Mittal Ghent, both private companies, employing about 5000 people each, of which a large number of engineers. SMEs offering high end services in automation to industry are another example. During the project more than 200 companies in Flanders alone, from SME to large companies, were reached. Also in France and the UK, tens of companies were reached. Industry was also involved as "source" of lectures and workshops, being hosted by the universities; often a combination of test rigs and measurement equipment from both industry and university were used.
The **academic partners** are the main developers in the project. Seven universities were involved in three countries. These partners developed new courses, lab set-ups and experiments, and taught the courses. The main purpose of the project was to cooperate cross-border in the 2 Seas region (France – UK – Belgium) in order to create courses and workshops for industry and students. The students were involved by choosing related Master thesis projects. Large groups of students benefit by renewed and updated courses, labs and workshops, a lasting result. The students also got acquainted with international lecturers, teaching them advanced topics. Short student exchanges, e.g. for a workshop, which are otherwise not funded by EU grants, were also incorporated in the project. Moreover, when students had obligatory traineeships abroad in their curriculum, project partners exchanged students and know-how.

2 PROJECT MANAGEMENT

The **project targets** are the development of courses, workshops and lectures on selected topics concerning industrial automation and industrial embedded control, and developing proof-of-principles and demonstrators for innovative and emerging technologies. A signicficant part of the project consisted of developing interesting striking examples and demonstrators. In this way, the students and practicing engineers can work on challenging, complex topics in order to experience the benefits of these complex systems. The final target was to establish in each country a center on industrial data

communication and a center on industrial embedded systems. In total, for data communication, one large ICC (Interregional Competence Center) was started in Flanders and two regional nodes, one in France and one in the UK. For embedded systems, one ICC was started in France and two regional nodes, one in Flanders and one in the UK.
The **project management** (Fig. 2) was established at several levels in order to reinforce the cooperation and reach the targets. The project partners had one representative for each institute in the PMC (Project Management Committee). A financial advisor and communication manager were added. The PMC had in theory meetings every six months, but the real number of meetings was higher. Besides this, many bilateral meetings were done. The PMC coordinates the total project and each member is responsible for the local implementation.
The PMC is assessed by the ETEC (External Transnational Evaluation Committee). This committee exists of three professors from three different countries, who are independent of the project partners.
The PMC is also advised by the national UG (User Group). The UG exists of representatives of several companies. These companies propose master thesis projects, discuss cases and help to direct the project in order to maximize the benefit.
Finally, the JTS (Joint Technical Secretariat), supervised the project from the viewpoint of the financing government, in se the European Union.

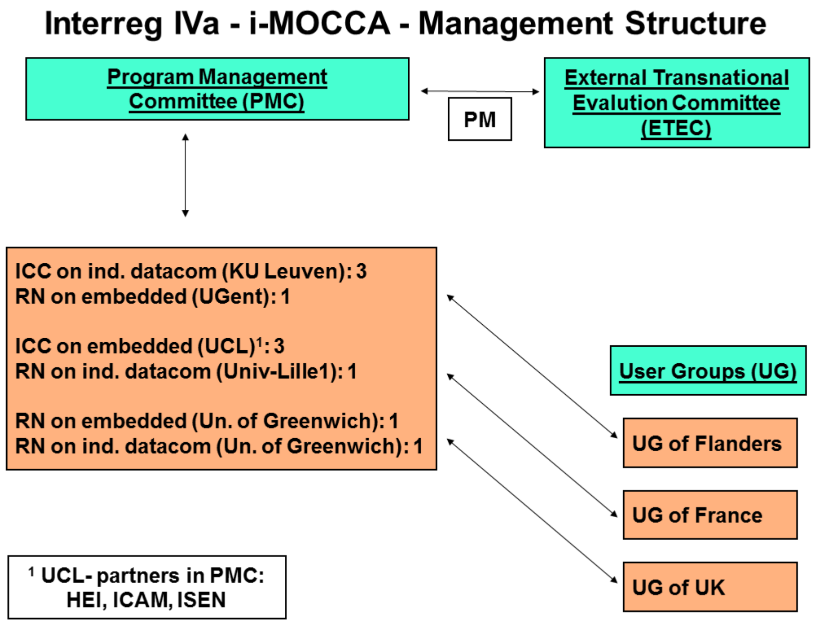

Fig. 2. Project Management

3 COMMON BASIC EQUIPMENT

Essential for interregional cooperation between the i-MOCCA partners is the use of “common basic equipment”, facilitating efficient cooperation and joint development. This enables staff mobility to avoid movement of lots of equipment. This supported the “move-the-trainer” concept, which was one of the fundaments of the project. Due to the combined order, the partners also benefit from a large discount. Examples of common basic equipment bought by most partners are, for industrial data communication high-end controllers and IO devices for Profibus and Profinet, and compact cases for Sinamics (Fig. 3) and Simotion. For embedded control, S7 mEC industrial embedded controllers, Speedgoat and xPC-target were used by several partners.

4 ACHIEVING INTERREGIONAL COOPERATION

4.1 Introduction

Cross-border cooperation between seven universities and reaching the project targets asked besides a good management also for enough possibilities to exchange information and ideas. In this section the methods to achieve inter-institute cooperation and industry-institute cooperation are discussed.

4.2 Internal conferences

Internal conferences can be seen as normal one-day conferences, but the participants were limited to the researchers, students and staff of the participating universities. The internal conferences were held every six months (typically June and January), each time at a different location. The emphasis alternated between industrial data communication and industrial embedded controllers. On the internal conferences, intermediate work packages and results were discussed and lectures were given on the reached targets. Examples of topics are the developed courses, the experiences with given courses, developed demonstrators and innovations.
Besides the lectures, the participants had the possibility to visit the guest institute’s laboratories and new set-ups. This promoted the generation of new ideas and new cooperations between the partners. In total, five internal conferences ran during the project.
At the beginning of the project a starting conference was given. At the end of the project, a closing conference for the broader public was held.

4.3 Technical days

The technical days are the more interactive and informal counterparts of the internal conferences. These days were also held every six months (typically March and October), each time in another university. The combination of the internal conferences and the technical days gave the project partners a challenge to reach new project targets every three months. The technical days have proven to be the best moments for cross border exchanges. Every partner informally showed one or more setups on industrial data communication or innovative applications of industrial hardware targets. The partners, including staff and researchers, followed several parallel sessions of about 15 minutes during the day. As the groups are small and the applications are directly available, the interactivity is high. Finished courses are exchanged and used on the same (common) equipment. Some interesting innovative ideas were reached and developed after these sessions.
The main emphasis in technical days was on the developed demonstrators (Figs. 3 - 4). One of the topics was data communication. In order to develop attractive workshops, e.g. a demonstrator was developed to generate different kinds of faults on a Profibus DP network. Besides this, a link between Profibus and an embedded controller was developed [3], using a newly developed interface-board (Fig. 4). The purpose of this is to give the participants of the course (including students) an in depth view on the Profibus DP operating principle. For embedded controllers, different advanced demonstrators were made [4], to give the participants of the courses real, complex problems to cope with. Examples here are a two axis ball and plate positioning system, tablet Android based HMI (Human Machine Interfaces), motion control demonstrator on torsion [5], … Fig. 3 shows a demonstrator for the levitation of a beach ball, combining industrial embedded control and data communication: algorithms designed in Simulink, generation of real-time code for an industrial hardware target (S7-mEC), and also the use of industrial networks (Profinet, IO-Link) connecting actuators (e.g. Sinamics S120 via Profinet) and sensors (e.g. laser distance sensor via IO-Link) all in one application.

4.4 Student and staff mobility

To emphasize the cooperation between universities, both students and the staff were exchanged. The main purpose of the project was to ‘move the teacher’. During the project all institutes welcomed visiting guest lecturers from the participating universities, to teach specialized topics to their students. The students benefit in three ways, they increase their knowledge, the specific topic is normally no part of the standard curriculum and they make acquaintance of an international lecturer, which can stimulate further international exchanges. Examples of discussed topics are Control of Fuel Cells, EMC in automation, Building Automation Systems, … The lectures were given mainly for master students, as this involved advanced topics. Some of the lectures became part of the curriculum extending and perpetuating the cooperation. Besides this, training days were organized, teaching an in-depth course to the other project partners. All project partners visited e.g. KU Leuven for a four day course on Profibus DP.

Fig. 3. Demonstrator beach ball levitation (developed by KU Leuven – Campus Ghent)

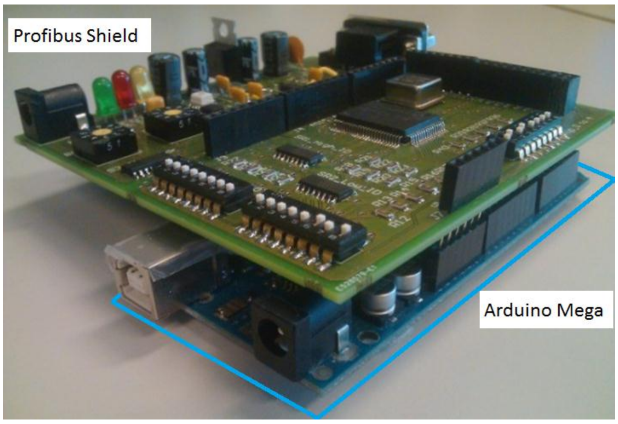

Fig. 4. Demonstrator Profibus Shield for external controllers as Arduino, dSpace or similar (developed by UGent – Campus Kortrijk)

Fig. 5. Engineers from Arcelor Mittal Gent and Volvo Cars Gent working on a troubleshooting exercise in Profibus DP (KU Leuven – Campus Ghent)

Fig. 6. Workshop on EMC for 60 engineers (UGent – Campus Kortrijk)

4.5 Workshops

To reach the industry, several types of workshops were developed. Starting with short 1 to 2 hour evening lectures, for teasing the audience, the participants quickly found their way to the half day workshops, full lecture days and intensive courses (up to 4 days) (Figs. 5 - 6). As most of the setups are mobile, the sessions were given both in the universities and (for larger companies) on location. The following list shows some of the developed courses during the project:

- Introduction to Matlab
- Introduction to Simulink
- Introduction to DSP
- Introductory Profibus
- Introductory Profinet
- Analog control design
- Analog signal processing using Matlab
- Digital signal processing using Matlab
- Digital embedded control
- Programming FPGA by Matlab
- Programming Arduino by Matlab
- DSP and Code Composer Studio for digital filters
- Image processing by Matlab
- xPC target
- Profibus DP
- Profinet
- Electromagnetic Interference and drives
- Shielding performance
- Installation guidelines according to the current EMC-directive
- …

4.6 Cases with industry

Mainly the Flemish project partners, apparently more used to close cooperation with industry from the beginning of the project, also received input from industry by master thesis projects and test and measurement cases in industry. Within the project, more than 15 master thesis projects were done, related to the mentioned topics. The industrial partners also provided use cases and hard-to-find real life industrial problems. In this way, complex systems were tested, analyzed and in return explained to practicing engineers [6]. Measurements on industrial equipment (e.g. EMC) and in situ (e.g. ArcelorMittal Gent, Volvo Cars Gent) also provided valuable input.

5 REACHED TARGETS IN FLANDERS

The interaction in the project was between the universities of the different countries and between the universities and the local industry. Although both Ghent and Kortrijk are located in the western region of Flanders, companies from all over Flanders were reached. Table 1 gives the reached targets for Flanders after 80% of the project done. A view from the French partners is presented in [7].

Table 1. Reached targets in Flanders (after 80% of the project)

Item	Number of items taught	Number of participants [1]
Intensive courses (> 1 day)	7	54
Workshops (1/2 day or 1 day)	22	685
Lectures (20 min – 1 hr)	33	631
Papers / posters	12	-- [2]
Articles for the general public	19	-- [2]
Non-technical lecture on the project	17	-- [2]
Courses taken	24	-- [3]
Master or bachelor thesis	21	25

Demonstrators	> 15	-- [3]

1 The number of participants do not include the members of the project partners institutes

2 The number of people reached is not determined

3 Not relevant

In the table, the intensive courses are typical four day advanced courses. Examples are Profibus, Profinet or Matlab & Simulink courses. Study days combines different topics, the starting conference and specific academia to business meetings are examples. The workshops are the main part of the project. These workshops focus on one specialised topic during 1 day or half a day. In this way by the end of the project more than 1000 engineers in Flanders will have followed at least one workshop or lecture. In total 12 papers and posters were presented on international conferences, 19 articles were written for the general public at national level, 17 lectures were given to present the project itself. Finally, 19 master thesis projects and 2 bachelor projects were done in the Flemish institutes in cooperation with the industry.
In total in Flanders, up till now 270 different companies delegated engineers and technicians to follow at least one lecture.

6 SUMMARY AND ACKNOWLEDGMENTS

The project i-MOCCA developed courses, lectures and demonstrators on industrial data communication and embedded control. Several lessons were learnt during the project. For reaching the targets, a strict follow up was necessary. In this way, the technical days and internal conferences were very useful to prevent a slowdown of the project. The half day and full day lectures were a success. It proved to be the optimum choice to gain a large public.
The students were positive about the guest lectures and the well-equipped laboratories with challenging demonstrators.

The project 07-022-BE-i-MOCCA was partially funded by the European Interreg IV-A 2 Seas program [1]. Additionally, for the Flemish partners, the project was co-funded by the provinces East-Flanders and West-Flanders. The project will also be part of the Cluster project i-MOSYDE [8]

REFERENCES

[1] www.imocca.eu

[2] www.**interreg**4a-2mers.eu

[3] Knockaert J., Vanseveren B., Cottegnie W., Saey P., Profibus DP Slave Shield for embedded controllers (2014), IEEE conference on Emerging Technologies and Factory Automation, ETFA 2014, Barcelona, Spain (submitted).

[4] Saey P., Hauspie W., De Landtsheer T., Knockaert J., Deconinck G., Using an industrial hardware target for Matlab generated real-time code to control a torsional drive system, European Power Electronics and Applications Conference (2013), EPE 2013, Lille, France.

[5] Saey P., Cauwe X., Deconinck G. (2011), Drive systems with torsional load: versatile low-cost educational laboratory set-up, EPE2011, Birmingham, UK.

[6] Saey P., Knockaert J., Derre H., De Landtsheer T., Hauspie W., Kokosy A., Evaluation of Timing Measurement Tools for Industrial Ethernet (2014), IEEE conference on Emerging Technologies and Factory Automation, ETFA 2014, Barcelona, Spain (submitted).

[7] Vannobel J.-M., Bekaert M.-H., Benhammou H., i-MOCCA: Cross border cooperation in traning for Engineers in Industrial Automation (2013), SEFI Conference 2013, Leuven, Belgium.

[8] www.imosyde.eu