CASE STUDY

IN THE FIELD OF

COMPUTERS, COGNITION AND COMMUNICATION IN CONTROL (CO4) IN THE FRAMEWORK

OF THE ERASMUS+ PROGRAM

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1. INTRODUCTION

This case study is an attempt to provide insights into the management journey of an Erasmus+ Key Action (KA) 203 Strategic Partnerships for Higher Education. First, after giving a general description and objectives of the project "Co4AIR - Computers, Cognition and Communication in Control: A strategIc paRtnership", the paper presents the main challenges and difficulties encountered in the management of a technical project with partners and faculty members coming from different scientific fields and countries. This section provides a reflection of both the positive and negative experiences. Secondly, it proposes potential solutions to obstacles the project has faced. Recommending precise and evidence-based findings is believed to be a useful tool for current and future Higher Education Institution (HEI) KA203 managerial teams, for them to make decisions in relation to their performance or risk assessment. Our conclusion reiterates that traditional causes for project success/failure are at stake. This case study may help identify them quicker by demonstrating mistakes to avoid and remedies to address.

2. Co4AIR PROJECT

The project "Co4AIR - Computers, Cognition and Communication in Control: A strategIc paRtnership" is funded through the Erasmus+ Key Action 203 Strategic Partnerships for Higher Education. Co4AIR comprises seven universities from France, Germany, Spain, Portugal, Romania and Slovenia, as well as a European network.

Our initial objectives were:

- to investigate the theory-practice gaps in the teaching of Computers, Cognition, and Communication (Co3) in Control;
- to develop and test new course content integrating multi-sectorial material;
- to design and develop a pedagogical multimedia product and a student contest, both of these to be validated during two summer schools organized by the consortium.

The concrete outputs of the project to meet these objectives are:

- a Skills Matrix: a tool used to compare the required competencies for a student and to design course content,
- a Serious Game: a pedagogical multimedia tool implementing learning-by-mistake methods

- a student contest: an event which challenges student teams to design, build, and test efficient solutions for real-life in the field of Co3 in control problems.

The project ran from September 1st 2018 to August 31st 2021, with a provisional budget of 350 K€. Due to the Covid-19 crisis, summer schools could not take place as planned in the application and some project activities had to be redesigned.

SKILLS MATRIX

The skills matrix was meant as a framework to highlight the competencies required in the field of Co3 in control in order to be used by academics (to map students' competencies, to design course content…) or industrials (to define a job description, to evaluate the skills of employees…).

Beyond the fact that there is currently no educational program at the European level fully dealing with Co3 in control, one of our objectives was to investigate the theory-practice gap in the teaching of Co3 in control. The diagnosis was that this gap is twofold. One concerns the transfer from Research to Industry, the second from Research to Education. Of course, these gaps are strongly linked, as whenever education will lower this gap, the future engineers and master students will lower the time from research to enter the industry areas.

We intend here Research in the sense of academic partners that are used to the issues in engineering practice and want to disseminate the latest successful developments in modern control theory. The goal is to help the future engineers and the practitioners to gain a perspective of the potential impact of system and control theory to practice. Students dealing with the topics linked to Co3 in control are quickly confronted with practical situations, which they need to solve in their workplace. However, as the theoretical part of the study program is both fundamental for understanding and particularly time-consuming, the practical aspects tend to put them in the background. Real case studies in their training programs are rare when not missing for solving such issues.

The project Co4AIR was thus focusing on identifying a) key skills to have to overcome the plurality within the field Co3 in control, b) key skills to acquire as students, taking into account the diversity of their backgrounds, c) key course content to appear in educational program, and d) the industry needs in the field Co3 in control.

Those key inputs from practice were planned to be translated into a Skills Matrix, our first intellectual output, and introduced into other outputs.

Generally speaking, at the stage of the application, our initial plan could be summarized as follows:

- Benchmark on key competences
- Get inspired by other Skills Matrices in other fields
- Incorporate our data into a pre-selected template
- Share it with the industry professionals for them to suggest improvements.

Our difficulties

For this output, we suffered from a common lack of experience and expertise in designing such a tool.

First, national constraints usually bind teachers developing educational programs. In Co4AIR, they had to combine their respective experiences for building a common Skills Matrix in a multidisciplinary and multi-practice context.

Some treated the exercise as a simple spreadsheet-filling task, others as a real scientific work. We found our way in the middle with months of discussions on it without any inspiration or method from which to get a framework that convinces and suits all partners.

Indeed, considering the multi-sectoral perspective for Co3 in control and overcoming the fragmentation of the research community was our main goal. One will be naive thinking that our common work on Co4AIR Skills Matrix might come easily to an agreement for an integrated approach. Co3 in control cuts across many branches beyond embedded and cyber-physical systems, telecommunication-based automation systems, intelligent control, e.g. decision and uncertainty management, autonomous agents, reinforcement learning, diagnosis, fault detection, etc.

Brainstorming on a common template catching their diversity of perspectives on their field of research was also very challenging. The consortium was overtaken by delays in delivering a framework able to cope with all our objectives and suitable for all the partners.

The lack of expertise in benchmarking skills was also a barrier : looking for templates can give participants inspiration but don't replace the know-how.

Moreover, as output interdependencies were strong, participants had in mind the learning activities and the related target groups while building the Skills Matrix. However, debating the level of study was a deadlock as students were indirect beneficiaries, not the target group.

Concerning the evaluation, our consortium was constrained to prefer informal connections for creating the industrial board.

At the initial stage, participants were convinced that Universities are involved in industrial networks and/or associations, and none of those potential links were questioned. However, industry is wrongly defined as an homogeneous entity - *a catchy name with a great brand*, a *sum of individual contacts.* This doesn't make an institutional network anyone can reach for their projects while seeking for external evaluators. Industrial-university links might be stronger based on contractual partnerships.

LESSONS LEARNED

At different stages in a project, discussions are intense on finding a common understanding/definition on how participants perceive the outputs they would like to produce as a consortium. This is in a sense in project lifetime a kind of *allegory of the Cave*: Outputs have been described and refer to a certain reality. However, each participant might perceive the output in their own way. Their perception might not fit the description, its features and the required expertise.

Relevant expertise within institutional partners on indirect but related topics mentioned in the project might have been beneficial. The 'innovative' imperative was not well understood : partners were not aware that an innovative project must not build all from scratch.

On the contrary, partners are often willing to assemble what exists in their university and consider it as a tool. Although this step is essential, it might only give a repository without any transferability potential. Participants should remember to focus first on common diagnosis and framework.

Regarding the involvement of the industrial sector, a better engagement strategy would have been to (1) summarise the project into a pitch understandable for the industry, (2) identify incentives for them to participate, (3) define a correct quality plan for qualitative results and (4) anticipate the barriers from HR or Communication/Marketing departments being hesitant to get involved.

While building the project team, participants might have focused only on the project field, here Co3 in control. They neglect other crucial competencies such as good level of English, pedagogical engineering, IT knowledge, interest in quality management etc. It leads to self-replication and burdens project with isolation. Therefore, project teams should be composed of complementary profiles.

SERIOUS GAME

The main objective of the Serious Game (SG) is to dispose of an innovative pedagogical support for teaching in the Co3 field in Control. The SG is devoted to English speaking students coming from various trainings (Automatic, Embedded Systems, etc.).

The idea is to apply the concepts seen during their studies, both on aspects of real-time programming and on system control, in a realistic application. In addition to the playful side, the serious game must allow the student to project himself in practical use cases.

To realize the conception of the serious game we were accompanied by a company specialized in the conception of software and serious games.

The division of tasks between the company and the project consortium was as follows: members of the consortium had to develop the scenario, and define all the elements of the mechanics and the company was in charge of the implementation of our proposals within a 3D video environment. In the end, it was a co-construction with regular interactions between the members of the consortium and those of the company.

From the consortium side, the SG was designed and developed:

- with respect to the Skills Matrix relying on some of the topics described inside
- with drone flying constraints in mind, which has recently become popular in various areas of industry and allows for real challenges from a control point of view, with different levels of complexity achievable for the students
- taking into account pedagogical aspects offering several options in its use:
    - in parallel of a lecture as an illustration example for the teacher
    - during lab session or for problem based learning teaching
    - in a face to face mode or in a distant way
- with the opportunity to develop your own control algorithms via the Matlab/Simulink® software which offers unlimited control possibilities

- with a view to being improved by modifying/adapting the quizzes according to the teaching needs and by adding levels and additional missions

Our difficulties

Participants faced difficulties in finding a common ground and matching supplier expectations. While working with a company, common vocabulary should be found as well as working methods. Consortiums and companies don't face the same constraints. Academics are used to Research projects work on the basis 'test and fail, retest". However, when working with a company which replies to a call, expectations might be different.With Co4AIR partners' limited experience in designing such a tool, difficulties on crafting and consolidating product requirements occurred as universities are not used to a product-design approach.

Participants were experts in their research field and excellent teachers, yet they had insufficient pedagogical knowledge in an IT environment and expertise in transferring their pedagogy into interactive elements. Especially, in the case of a SG, the critical aspect was how to convert a pedagogical objective into a task to achieve in a game scenario.

In IT companies, roles are defined such as information system managers, network architect, database administrator. In the Co4AIR project, participants were divided into task forces with a leader. However, for the SG design and development, some specific positions were missing. Defining such roles in KA203 projects might be too ambitious. However, defining working areas among third parties and academics would have been beneficial for the SG development.

LESSONS LEARNED

Expertise issues are at the core of such projects. Owing, or at least being able to identify, significant knowledge on a topic should be the priority. Participants need to speak the same language in a specific field and agree on notions in order to work together and collaborate with external stakeholders. This aspect was underestimated in Co4AIR project.

It could have been useful for a consortium to work with an external consultant before starting their work. This is particularly true when working with other stakeholders (companies). As a consortium, it was particularly hard to know what was behind the scene for building such a tool.

At a preliminary step, experts - outside the consortium - could have helped participants in defining product requirements. In a second step, they could have been intermediary between consortium and supplier’s needs.

Once the supplier was chosen, they could have supported this new collaboration in defining their common vocabulary and designing what they perceive as their common working space. Every project has its own specifications teams need to define.

At the institutional level, it is important to notice that academics are rarely engaged in lifelong learning, whereas it is often the case in the industrial sectors. Some activities such as teaching or managing such educational projects – are not valued nor recognised in their academic careers, as compared to their research. Therefore, it is important to identify the incentives for the participants to learn, be challenged and maintain involvement until the end of a project (cf. recommendations Incentives).

Moreover, resource allocations based on working days are not enough for defining who leads an output and how much work participants should give to activities. KA203 applications are limited to task definition and output features. Insufficient time is spent on concrete required expertises for performed activities. It puts resource management at risk: *who can do what and at what cost?*

Contest

Still with the objective of proposing innovative teaching methods, the third intellectual output of the Co4AIR project concerned the implementation of a competition for students on the dedicated field of the project. The idea was to stimulate students' motivation to implement or deepen methodologies seen in class and/or to learn new ones in a competitive mode against other students at the consortium level.

In the context of our project, the overall goal was to design and implement a challenge called “Co4-marathon”, which requires student teams to design, build, and test efficient solutions for a current and practical control problem.

In order to maintain a link between the deliverables of the project, the contest focused on a problem involving a quadrotor drone.

The core task, of course, was to be fun and involved an interesting problem that motivates students to participate and to invest significant effort into finding a solution.

The design of the Co4-marathon followed the following steps:

- Brainstorming on CO4-marathon
- Designing guidelines for building CO4-marathon
- Drafting rules for the contest
- Disseminating to all partners
- Collecting feedbacks from partners and adapting rules,
- Sharing final rules' contest to partners and future participants
- Preparing the Team enrollment
- Organizing the online event
- Evaluating via feedback from a group of students/teachers

Our difficulties

Despite the Covid-19 crisis, the Co4-Marathon was the less challenging output in Co4AIR project. The consortium was able to adapt the guidelines to the new context and to go online.

This intellectual output is an example of efficient coordination based on expertise, as one of the partners had experience in such learning activities and led the taskforce.

However, difficulties were mainly linked to the nature of this output as an event open to students. This Co4-Marathon gave students the opportunity to compete with each other. However, the number of participants was low compared to the total number of students among the consortium.

It seems that academics have day-to-day contacts with students but when it comes to reaching them on a larger scale, they fail to define a concrete strategy. The consortium has successfully focused on the output delivery plan but underestimated its communication strategy.

However, it should have been fully integrated into the output planning so our audience could be clearly identified and reached.

Promoting such events at university levels should have been a priority.

Another challenging aspect is to catch what might be sustainable after an event took place. Some students shared their interest in sharing feedback with each other. As the event was done online, defining a shared space for students to discuss was not prioritized.

Finally, students are often perceived as a homogenous target group while building the application, available at any time. However, when it comes to event planning, difficulties on academic periods, student schedules, student levels, etc. were not anticipated.

LESSONS LEARNED

Based on Co4-Marathon successful experience, we noticed the strength of having a participant with experience involved in coordinating the tasks. It made this output easily adapted and delivered on time.

However, it was noticed that difficulties came with communicating about the event. Students were satisfied with the event but expected to make it last after it took place. We underestimated the importance of building a common space for discussions/networking among students.

As project communication is not always part of an institution’s Communication department's responsibility, the ‘burden of communication and dissemination’ might easily fall on the participants' responsibilities. However, communication is not something one can improvise. Output delivery plan will go with procedures and protocol but event delivery should go with a communication plan.

A common challenge was to maintain the involvement of participants. We observed two levels of engagement in Co4AIR, and believed this can be generalised on other KA203 projects. On the one hand, partner institutions commit their responsibility and justify participation in the project, partly through their legal representative. On the other hand, individuals commit their area of academic expertise in a certain field. In the process of application (Section Background and Experience of KA203 application form), key persons involved need to be described as well as the activities and experience of the partner organisation. Generalizing partner expertise and “dropping names” is too easily done, in comparison to ensuring both organisational and individual involvement in the activities once the project is granted.

Projects are made among partner institutions and agreements are signed on the behalf of institutions with duties and obligations. Yet, it is individuals who are involved in the day-to-day work, based on timesheets declarations. At the same time, the institutional responsibilities concentrate mainly on budget distribution and reporting. As a consortium, it is hard to know how the project is known and implemented at the local level and how important is the project for the institution.

Turnover and changes in participant workload are some examples of common changes that occurred during the project and this needs to be prevented. Legitimacy for participants to work on projects needs to be clarified and even formalised. Projects cannot depend on individuals but on activities to be performed and related workload. So, if a participant leaves the institution but his work still needs to be done, he will be replaced.

3. RECOMMENDATIONS

This section provides recommendations for response to challenges raised in the above sections. They are intended to establish a level of consistency and to warn of early signs of problems in similar projects.

- **Don't presume participants reread and fully understand the application**
  Ask partners to present their plans with the project and assess aims and crucial information. Repeat this if necessary. Do not hesitate to make the project as understandable as possible with easy project documents, write guidelines and instructions. Make your participants own the Project.

- **Agree on the scope and (re)define activities before starting**
  Project applications are not Project execution plans. Once the diagnosis is (re)confirmed, it is important to (re)think about the scope and objectives of our project by looking for relevant adaptations.

- **Don't presume participants know and understand Erasmus+ project rules**
  In order to secure successful and effective implementation of a KA203 project, involve university staff who understand the rules and ask them to explain them to all staff from the particular Higher Education Institutions. It helps participants to focus on intellectual outputs' activities. Measuring the level of knowledge on project management and Erasmus+ program Key Action before the start of the project, and involving Erasmus+ administrative coordinators, or people who know the Erasmus+ rules, from all partners, may be necessary.

- **Agree on the terms of the project**
  KA203 projects are not research projects. Highlight the importance of innovation, relatively short implementation period and the need for tangible and transferable outputs. Procurement is possible to a certain extent, but knowledge should be already in the partner institution (ex: IT tools, researcher, developer). Estimate and share the procurement process schedule before the project starts.

- **Establish a vocabulary**
  Ask and answer the following questions: What are the terminus technicus of the project? How do we define them? Does everybody

understand these expressions, abbreviations? Clarify and state your vocabulary as early as possible. Update this vocabulary during the lifetime of the project. English or your expertise cannot be your unique common language!

- **Define and adapt your working method**
    - **Organise technical meetings (biweekly, monthly)** where technical developments are being tracked and followed up. Intensify the frequency of these meetings if necessary before a launch or milestone.

    - **Have an architecture or blueprint of the project developments**: how the different deliverables will complement the main aim of the project? Which interdependencies exist?

- **Evaluate and/or discuss time to give to the project**
  Have a detailed Gantt chart, where tasks are allocated precisely. Track implementation. Evaluate your capacity and not your ambition! A consortium agreement is not enough for time management of your peers.

- **Come up with a gentlemen's agreement about consequences**
  When a partner does not show up, does not keep deadlines, or the quality of the work is questionable. Although no written terms and conditions are set in a contract, straight from the kickoff meeting, participants should agree on involvement standards and be aware, or reminded, of the time and efforts required.

- **Match stakeholders with your needs (educational engineering)**
  Too few university faculty members have experience and expertise in instructional design, pedagogical tools, and educational technology, and in the current European market this isn't a field one can improvise.

- **Find the suitable incentives for the participants involved in the project**
  This goes hand in hand with knowing the objectives and challenges of KA203 projects : innovation is a stepwise process, and no participants are at the same stage nor view ideas and products the same way. A three-year project is a long relay race to run. For keeping the dynamic and making the team finish together, you need to find what makes them run.

- **Don't hesitate to adapt your working team over the duration of the project**, meaning an efficient human resource management in each university. Especially for long term projects, as you cannot always expect a maximum involvement of the same persons all along the project, a turnover in the staff could be a solution to prevent or to limit the risks of failure.

- **Be careful with your partner's choices,** meaning a good partner for a research project is not necessarily an adequate one in a KA203 project. Make sure that your partners meet the recommendations given above concerning the local staff that should be involved. For example, only one person is not enough, you need at least a team of two people supported by an administrative coordinator.

4. CONCLUSION

As a more complete and accurate body of managerial experience is needed to understand the causes of KA203 management challenges more generally, we believe that this case study offers an opportunity to HEI management teams involved in similar projects to learn from our lessons (Section 2) and apply the solutions of our recommendations (Section 3). An analysis of the Co4Air's Intellectual outputs delivered globally, and of the stakeholder management particularly, show that the choice of the team, the involvement of participants, the management of the schedule, the monitoring of the activities and the definition of the requirements are critical to the success of such a project. These are among traditional causes of project failure. On the other hand, the project benefited from a responsive organization to solve the various problems encountered , which, taken as a whole, allowed the management to close the project in a satisfying way.

Once we have a clearer understanding of the performance of past Erasmus+ KA203 projects since the launch of the key action in 2014[1], HEI management teams could take steps to improve various aspects of their need assessment, result measuring and scope planning, among other crucial aspects in the preparation of a KA203 proposal writing. Project proposals would then be better institutional fit and be easier to execute.

1

We are aware of the website for the publication of statistics and data from the Erasmus + program, for actions implemented by the Erasmus + France. Consulted September 2021 https://www.staterasmus.fr/partenariats.php