

ENHANCEMENT OF COLLABORATION IN THE EARLY STAGE OF AN INTERDISCIPLINARY ENGINEERING AND DESIGN PROJECT: MAPPING GROUP DYNAMICS

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ABSTRACT

Health care systems are moving towards interdisciplinary patient-centred solutions. Team members can agree on high-level aspirations, but it does not imply that they will have conformity in specific objectives. Collaboration is a strong requirement for facilitating the research activities and fulfils the general expectations. It is believed that a common goal enhances collaboration and unifies the group in a shared direction. Under this premise, this study presented a qualitative procedure: Mapping Group Dynamics (MGD) that represents the interaction of the objectives of the project members and assists in identifying possible conflicts in the inner structure of the project. This method was applied in a specific research project: Patient Centric Engineering in Rehabilitation (PACER). The results and benefits of the method are discussed.

Keywords: Engineering and design, interdisciplinary practice, collaboration, doctoral education

1 INTRODUCTION

In patient centred services, technological solutions will continue to have gradually more impact in health care systems [1]. The complexity of this development requires effective collaboration between professions from all levels in health care. The success of new technological challenges is also dependent on good leadership and management of projects. Professionals who are experts in a specific field, while simultaneously mastering a cross-disciplinary understanding may only perform these functions. Therefore, it is of high importance to educate doctorates in interdisciplinary environments in which collaboration is integrated into the early stage of research projects.

This transition from individual to interdisciplinary research is not a recent event. Nowadays, there are several interdisciplinary doctoral programmes where the goal is to solve relevant problems by overcoming the limitations of isolated disciplines [2]. The individual research has become more or less extinct due to the increasing cost and complexity of the problems, which demands more facilities, and expertise. Hagstrom [3] stated this as the cost of research while Bennett and Gadlin [4] expressed this as the shift of the problems. Traditionally, problems that are heterogeneous in nature have been studied from separated and condensed point of views; it is reasonable that holistic approaches have emerged that aims to put them together and these kind of problems were concerned design community in context often mentioned by Rittel and Webber [5] and Ackoff, et al. [6]. The developed approaches to investigate the dynamics of the group usually contains complicated concepts such as nonlinear complex adaptive systems which requires much effort from the project manager [7-9]. Therefore, a less complicated approach would be more applicable to apply to an academic project with limited human resources. Moreover, despite the trend, there are not enough theoretical foundations that can be used as a framework for such activity [10]. In this document, an intuitive method will be presented in for a specific research case.

The investigated question in the current article includes how to explore the conflict and concordance of personal and team goals and their perceived influence on the team collaboration.

1.1 Case study

Oslo Metropolitan University has recently started the Patient Centred Engineering in Rehabilitation (PACER) project. This research project aims to facilitate an optimised and personalised rehabilitation environment for individuals with lower limb amputation. Four doctorate students from different disciplines are involved in the study to approach the topic from different perspectives. They will not only work in their own field during the 3-year lasting PhD trajectory, but they also will be challenged to collaborate towards the common goal of PACER. Effective collaboration depends on many factors, and it is necessary to reflect on the process before and during the project. Current strategies for collaboration include having the same office, weekly meetings and collaborative lab practices.

Each doctorate candidate is developing an individual project within a specific scientific field. The first PhD project (#PhD1) is within the discipline of human movement sciences and uses a mixed method design. Quantitative and qualitative data will be combined to get a more complete understanding of mobility of prosthetic limb users.

The following PhD project (#PhD2) applies a quantitative approach in the field of electrical engineering with a focus in developing a facilitated experiment to measure bio signals through the development of an optical-electrical device (functional near-infrared spectroscopy).

The third PhD project (#PhD3) aims to provide an understanding of mobility from an artificial intelligence perspective using machine learning and statistics state-of-art techniques.

The perspective of the fourth PhD (#PhD4) will be in human-centred design under a qualitative methodology. This doctoral project has the goal to integrate and improve users' perspective when developing the new technology.

The projects and research methods as described above lead to different perspectives, which is a common challenge in interdisciplinary projects [11]. This does not need to be a disadvantage. If real world problems are considered as a system of underlying problems, each PhD student has its personal way of understanding and simplifying the bigger problem in relation to their discipline (see figure 1). However, to increase the impact of the problem outside academia, working in a team could bring the individual approach together to a broader perspective on the problem. This creates a more creative environment that could benefit the individual PhD as well as the project in itself. To get a better understanding of the dynamics between each team member, we designed a method intended to create a discussion about the implicit structures in the project. The current study was done after the first six months of the project. Insights from this method will be presented and can be valuable in other interdisciplinary PhD projects.

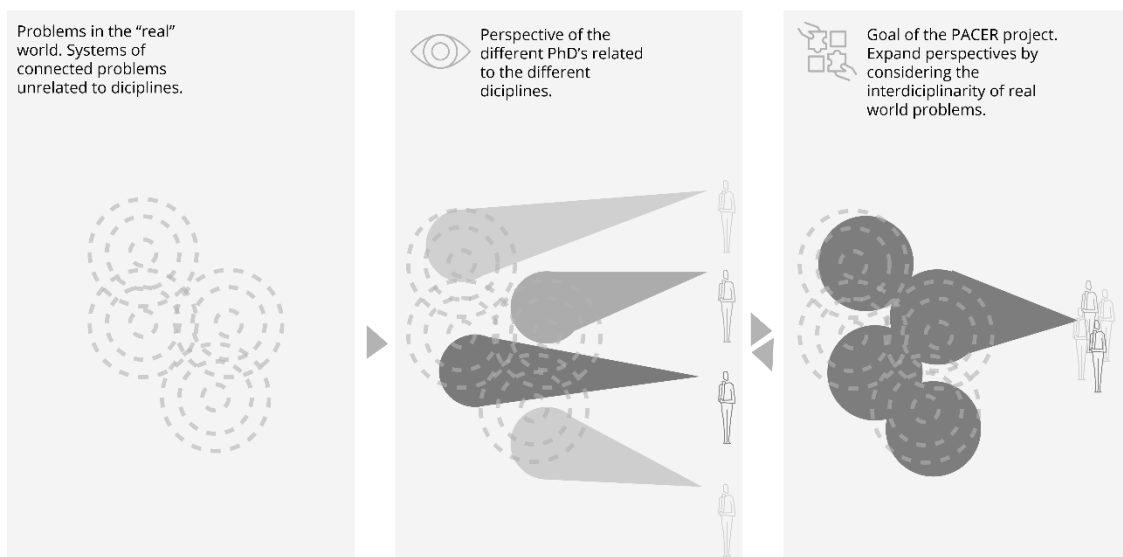


Figure 1. Conceptualisation of the project from "the blind men and the elephant" metaphor [12]: each member of the team has a different point of view in relation to their discipline which can lead to a broader perspective

This paper aims to describe the process of collaboration between the four PhD students in the early stage of the mentioned project. A method to investigate agreement and differences among goals and expectations of the project members will be described. It will also be discussed what the main goal of the project is and whether there is consistency in this between students and mentors. Lastly, expected challenges in the interdisciplinary collaboration and possible tools to improve effective teamwork will be described.

2 METHOD

A qualitative procedure is applied based on a thematic analysis method as it was defined by Braun and Clarke [13]. The thematic approach provides the required research tools to investigate the underlying relationship between team members. In the proposed procedure, the interaction and the perspectives of each researcher are determined and analysed uniformly; and the group interaction is visualised in a Venn diagram. This novel process was called Mapping Group Dynamics (MGD).

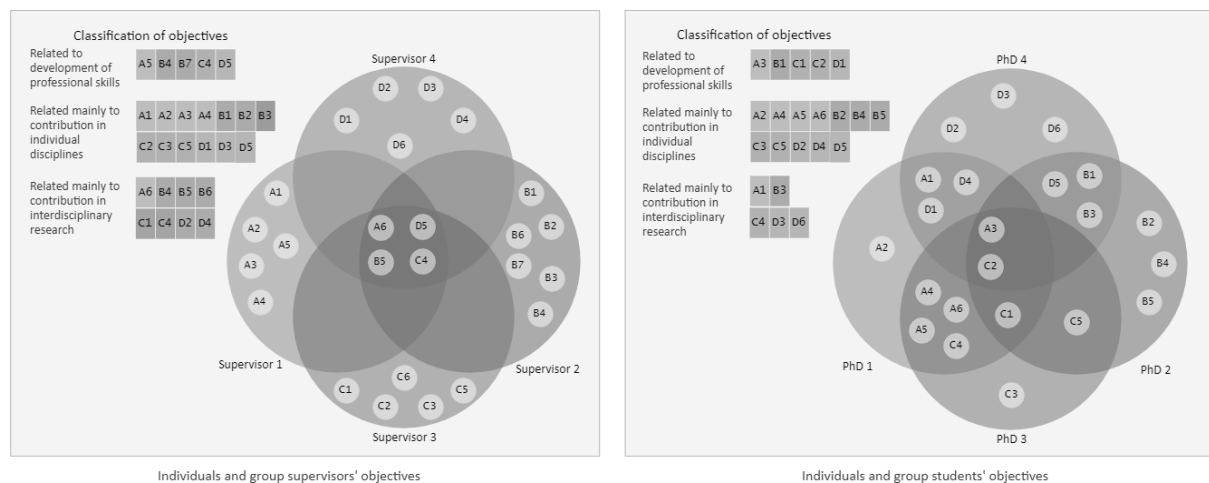


Figure 2. Venn diagram of mentors' and students' perspectives

Particularly, this document focused on research projects that are structured in academia where the following hierarchy is typical: administrative-organisational personnel, research mentors, and graduate students/researchers. It should be considered that under this structure, the main research task is performed by the students/researchers.

The core of the MGD method is the six key steps of analysing a cross-disciplinary project:

1. **Describe students' perspective** and list the individual aims and academic goals of each student as a member of the project team.
2. **Find the interaction paths among students** using the previous list of objectives, and the support of a Venn diagram, the relationships between the different objectives could provide additional information about the collaboration potentials.
3. **Describe mentors' perspective** through expressing the academic objectives of each mentor as a project member. In the case study, the data was collected through written correspondence.
4. **Find interaction paths among mentors** as explained in item 3.
5. **Describe possible conflicts and points of interaction.** It is likely that there will be differences between the perspectives of each researcher and mentor. Assuming that people with shared goals will collaborate more, the previous diagrams provide a visual tool to observe and recognise the degree of collaboration between each member.
6. **Solve or reformulate incompatible goals.** In the previous steps, conflict and dissonant goals are identified. In the early stage of the project execution, these contradictory intentions can be discussed and reformulated if it is necessary with the appropriate people involved to preserve the structure and successful implementation of the project.

The steps of MGD can provide a general panorama of a research project, while at the same time, can establish foundations for improving collaboration between members of the research team. The method was applied for the PACER project as an example of its applicability, and the diagrams (see figure 2) were obtained as the goals' diagram of students and mentors (steps 1 and 3, respectively).

3 RESULTS AND DISCUSSION

Like most interdisciplinary research projects, the PACER project has a broad objective: to have a patient centric approach in engineering for improving rehabilitation for individuals with lower limb amputation. Despite the predefined guidelines, specific and precise individual objectives were still lacking. Therefore, the PACER group members needed to set-up project directions and objectives with a collective agreement. However, it still is not clear how the individual goals can fulfil the expectations of the general aim. For this purpose, the method MGD is developed to assist in this process. The PhD students presented the results of the MGD in a team meeting with all the mentors. The purpose of this meeting was to investigate if a new direction of the project was necessary to ensure the individual and group objectives and how to implement it.

The discussions that arose during and after the MGD process led to several interesting insights. Forging a uniform goal is a key element to effective collaboration in an interdisciplinary research project, as mentioned by Mattessich and Monsey [14] and Huxham and Vangen [15]. They empirically stated that sharing a common goal is relevant. Moreover, independent of whether there exists agreement, the nature of the project goal is arguable. First of all, the term ‘goal’ might be too fixed in this context, and a better term to use could be the ‘direction’ of the project. This enables higher flexibility, in the case that the goal is not feasible due to for example changing research conditions. Flexibility is particularly important when being time constrained during a PhD traject. It was discovered already at this point in the project, each individual interpretation of the individual goal was changed since the start of the project. Furthermore, there was a difference between individuals in the interpretation of flexibility. More specific, there was disagreement on what factors should be kept constant and what factors can be flexible. One example is to keep the use of research methods constant while focusing on the specific technology, while the application, e.g. the prosthetic user in PACER, is flexible. On the other hand, the target population of the research could be constant, while the need to apply different technology could be considered.

The difference in the project-related interpretation of priorities, as mentioned above, can be explained by the rigour of the independent traditions in the PhD fields. The tension between the overall project and the individual disciplines is a result of the different approach and requirements of each discipline and is therefore inevitable. Consequently, the collaboration between different disciplines requires that project members develop T-shaped competence [16]. T-shaped researchers are experts in their own field while having a broader perspective on other disciplines. However, it can also be an advantage when PhD students are not yet fixed in their field and can be shaped to a larger extent.

This can, in particular, be challenging for PhD students with little research experience. In the PACER project, some techniques will be applied to investigate the understanding of each other’s discipline. First of all, all four PhD students follow the same PhD programme in health sciences to create a shared understanding of principles in this field of research. Furthermore, during weekly PACER group meetings, topics from individual disciplines that are relevant for the other members to become familiar with, will be presented and discussed. Being educated in a certain field does not only mean that academic languages are different between group members, but also a different interpretation of research, approaches to methodology, and cultural background leads to challenges in communication. It will, therefore, be of high importance to continue investing in meetings and reflections on the process during the whole duration of the project. For this purpose, the four PhD students work in a shared office, which is expected to facilitate their engagement. Lastly, there will also be focus on other research activities, like attending conferences and seminars with topics that are relevant for all PhD students. This will, in particular, become relevant later in the project and depends on institutional financial support.

Nonetheless, not all topics are relevant for each individual PhD project, and it will be challenging to find a balance between focus on individual PhD projects and the whole PACER project. As mentioned before, a PhD traject depends on certain requirements and is limited in time and financial support. This pressure could become a reason that PhD students sometimes will prioritise the individual PhD project, which can bring the progress of the whole PACER project in danger. Therefore, proper supervision and management are very important for the students to determine right priorities, to ensure results of high quality from both the individual project as the PACER project.

4 CONCLUSIONS

MGD can be used as an assessment tool of performance and convergence of all members of the project. It gives insight in agreement and disagreement between members, that can be used to develop new strategies to improve collaboration, and therefore, offer an additional tool in education in engineering and design. In this case study, the MGD led to many fruitful discussions, that clarified misconception or unclearness related to individual projects or the PACER project. Without this method, the group should not have had discussions of the same level and quality. The discussions resulted both in direct improved collaboration, as well as investment in future collaboration by enhancing mutual understanding. It has to be noted that the presented diagrams in this study act as a snapshot of the total duration of the project. It helps the members to have a better perception of their position at that moment, and results might be helpful for the manager to keep the overview of the project. It is, however, expected that interactions between members, mentors and external conditions will change over time, so a re-evaluation of the diagram will be inevitable during the progress of the project. By taking care of previous diagrams, changes over time can be observed that can serve as a visualised process of the collaboration between members and the overall functioning of the project.

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