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SPEAKING DESIGN: DEVELOPMENT OF CROSS-DISCIPLINARY UNDERSTANDING IN DESIGN, BUSINESS AND ENGINEERING EDUCATION

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ABSTRACT
In this paper, observations are presented from an educational program that has 15 years experience in teaching the multidisciplinary approach in design, business and engineering. We first discuss the concept of "functional wall" that is often formed between disciplinary experts. Next, the approach of problem-based learning is introduced as a solution to break such walls within multidisciplinary teams. To illustrate PBL in practice, we explore a multidisciplinary student project on package design. In the project, team of four students was assigned the task to study communicative elements of packaging and provide new innovative package design solutions. The paper presents a successful approach to train and manage multidisciplinary teams, providing students with ability to understand the approaches, special know-how, and terminology of other disciplines; the ones with which an expert is supposed to work together in the future.

Keywords: Multidisciplinary education, team work, problem-based learning

1 INTRODUCTION

There exists substantial scientific evidence that design can bring several kinds of benefits to business performance. Such benefits can be found both in externalities (end products), involving better functionality, enhanced usability and aesthetics, and in internalities (processes), through lower costs and enhanced manufacturing. The communicative benefits of design in terms of brand and corporate identity are also widely acknowledged.

Despite this, managers and management scholars still tend to underestimate the role and benefits of design in the business context. The topical yet confusing notion of "design thinking" may have entered the business discourse, but its concrete application has remained a major challenge for many. This is because many design-related questions are "wicked" in the sense that they do not really have a single clear, unequivocal answer.

One aspect that is widely acknowledged as integral to design thinking by virtually all authors in the literature on design thinking, however, is the collaborative work between different stakeholders [1], [2]. Collaboration most typically takes the form of using interdisciplinary teams [3], [4], [5], [6], [7], [8], [9]. Such a collaborative work style is seen as important in tackling those complex and wicked problems that otherwise are difficult to approach, as knowledge from many fields and disciplines are integrated [10] and merged in a meaningful manner [6].

We have also observed through our years long collaboration with a number of companies that design intensive success stories often emerge from the good use of multidisciplinary team practices. Multidisciplinary approaches bring together experts from different professional backgrounds and contribute to creation of business through design. That being said, there is also the downside: the lowest value outcomes are also produced by heterogeneous teams, and the low value outcomes clearly outnumber the high value ones. Therefore, we need to know how to train and manage multidisciplinary teams. Along with the high disciplinary expertise usually comes the inability to understand the approaches, special know-how, and terminology of other disciplines; the ones with which an expert is supposed to work together. Even in the companies that embody a common understanding that "design is a good thing" as such, designers, managers, and engineers seem to speak quite different languages and value different aspects of design. This may result in ineffective use of

design resources.
In the paper, we present our observations from an educational program that has 15 years experience in teaching the multidisciplinary approach in design, business and engineering. First, we discuss the concept of “functional wall” that is often formed between disciplinary experts. Second, the approach of problem-based learning is introduced as a solution to break such walls within multidisciplinary teams.

2 THE WALL BETWEEN DISCIPLINES

Designers, business managers and technologists are working together in cross-functional teams to develop new products and services, and to achieve operational effectiveness [11]. Effectiveness and outcomes occur through the (measured) performance, attitudes, and behavior [12] created within and by the team. Our observations suggest that, in essence, differences in team members’ attitudes and behavior are a notable factor affecting the performance and effectiveness of a particular team. Those differences effectively create a “functional wall” that surrounds individuals and hinders interaction among team members. The wall comprises many epistemological and methodological challenges, or “language barriers”, that need to be overcome before any multidisciplinary diffusion is effective. A key challenge is to create a common language for those involved in multidisciplinary teams, to cross the wall, while maintaining their distinct professional profiles at the same time.

2.1 Dominant function

The thought of the functional wall builds on the notion of dominant function [13]: The dominant function of team members is the function in which they have worked most of their career. Team members from disciplines like engineering, design and business think, act and behave differently. Every team member thus has a certain functional perspective that is acquired through work experience and/or education. The extent to which the dominant functions of team members are balanced or broadened within a team is one of the factors determining the effects of the functional wall in cross-functional teams.

2.2 Jointness

To overcome the functional wall, team members must integrate and synchronize strategies and activities to achieve the objectives of the team [14]. In order to achieve such integration, a specific principle of “jointness” [14] must be adopted by the team. Jointness concerns four important aspects: (1) functional competences, (2) reciprocal understanding, (3) cross-functional communication, and (4) trust. We propose that, together with behavioural norms and organizational capabilities, these aspects are seen as factors to overcome the functional wall.
First, effective cross-functional teams must consist of functionally competent team members, able to successful achieve their task work. If functional competence is missing, reciprocal understanding, cross-functional communication, and trust are unlike to emerge [14].
Second, reciprocal understanding is created when team members know each other’s skills (strength and weaknesses), goals and concerns, as well as team members’ dominant functional knowledge and their usefulness for the team [14].
Third, cross-functional communication denotes the “interoperability” [14]. To operate successfully in a cross-functional environment team members must know how to communicate timely and effective with each other [15] and operate together. Cross-functional communication and reciprocal understanding can be acquired through education, training, and cross-functional team experience [15].
Trust builds upon reciprocal knowledge. While its presence does not guarantee success, its absence increases the probability of failure [15]. When functional competence exists, reciprocal understanding occurs and communication is enabled, trust can be build and the team will be effective. With the absence of any of the four factors team will fail [14].

3 PASSING THE WALL THROUGH PROBLEM-BASED LEARNING

Creating common understanding and language between disciplinary experts in design, business and engineering has been the key challenge in our educational program (IDBM Program in Aalto University) We have noticed, first of all, that the students, future team members and experts, must be exposed to multidisciplinary thinking through the principle of jointness, so that the functional walls, once created, will be overcome more easily. Secondly, this exposure is best achieved through practical multidisciplinary projects in which students can tackle real problems with real companies.

3.1 Project management challenges

In terms of project management, engineering students are in the favor of linear models, while designers tend to an iterative planning process, where many levels of observation exist concurrently. Students also have varying strategies concerning the implementation of projects, ranging from hands-off to hands-on approaches, with great differences in terms of the roles assumed. To support planning and implementation, control is the third important management element and the one that we argue to be the key to creating the common language. The means through which control is achieved seem to unify the distinct planning and implementation practices and thus facilitate the multidisciplinary team work.

To imply the practical problem solving within our multidisciplinary team projects, the approach of problem-based learning (PBL) has turned out to be a useful method. Problem-based learning emphasizes a "real world" approach to learning: it is a student centered process that is both constructive and collaborative. It is also based on the premise that students will be motivated to "want to know" and solve the problem posed because it is presented in a context that simulates real situations [16]. PBL has been applied to different fields of education in many countries for over 20 years. It has spread worldwide to various disciplines of higher education such as architecture, economics, engineering, mathematics and law.

The basic premise of PBL is that learning starts from dealing with problems that arise from professional practice. In other words, the aim of problem-based learning is to build a bridge between working life and education. PBL gathers and integrates many elements regarded as essential in effective, high quality learning, such as self-directed or autonomous learning, critical and reflective thinking skills, and the integration of disciplines [17].

3.2 PBL in practice

To illustrate PBL in practice, a multidisciplinary student project on package design is next discussed. A team of four students was assigned the task to study communicative elements of packaging and provide new innovative package design solutions. The students had their undergraduate degrees in business management, marketing, engineering and graphical design. The learning objective of the course was to provide solutions for more efficient and intensive package communication by integrating technology, business and design knowhow. Specific emphasis was placed on visual brand recognition and package design's role as a medium of communication.

Typically the PBL process involves four principal phases: (1) selecting a problem, (2) designing actions, (3) determining learning objectives and (4) linking contents [16]. These phases are described with regard to the package design student project in figure 1.As shown in the figure, the purpose of the fourth phase in PBL process is to link all the contents and state the questions students are expected to answer by the end of the project. The teacher is mainly responsible for conducting the fourth phase, whereas the three first phases can be worked together with students and industry partners.

This process framework provided the general guidelines for the package design project. The three modules of the second phase (Designing actions) basically formed the practical structure of the student project during the 9 months academic year:

3.3 Phase 1: Selecting a problem

The first phase is often the most difficult one as a good PBL problem must engage students' interest and motivate them to probe for deeper understanding of the concepts being introduced. An effective problem should also be complex enough that cooperation from all members of the student group will be necessary in order for them to effectively work towards a solution.

In our exemplary package design project, the PBL problem was rather easy to find. Package design issues were interesting for students who could identify themselves as buyers and users of packaged consumer products, and the multifaceted nature of package design provided a teaching platform that required participation from all student members: in order to complete the project, the knowledge-base of each student was needed.

During the first three months of the project, students studied literature on branding, package design and research methods. The studied material was discussed together with academic teaching staff and the team made several visual analyses on case products. Students also wrote a blog diary on their reflections on literature and on the packaging observations they had made in supermarkets and contexts of use. Blog diary also included sources of inspiration, such as links to web-pages, magazines, and other visual media. The team even visited Packaging Museum in London and attended the *Emballage* trade fair in Paris in order to understand the history and the current trends in the packaging industry. To define the strategic intent and brand essence, in-depth discussions and interviews were conducted with company representatives. In addition, a detailed review on current packages was performed to identify strength and weaknesses in visual communication.

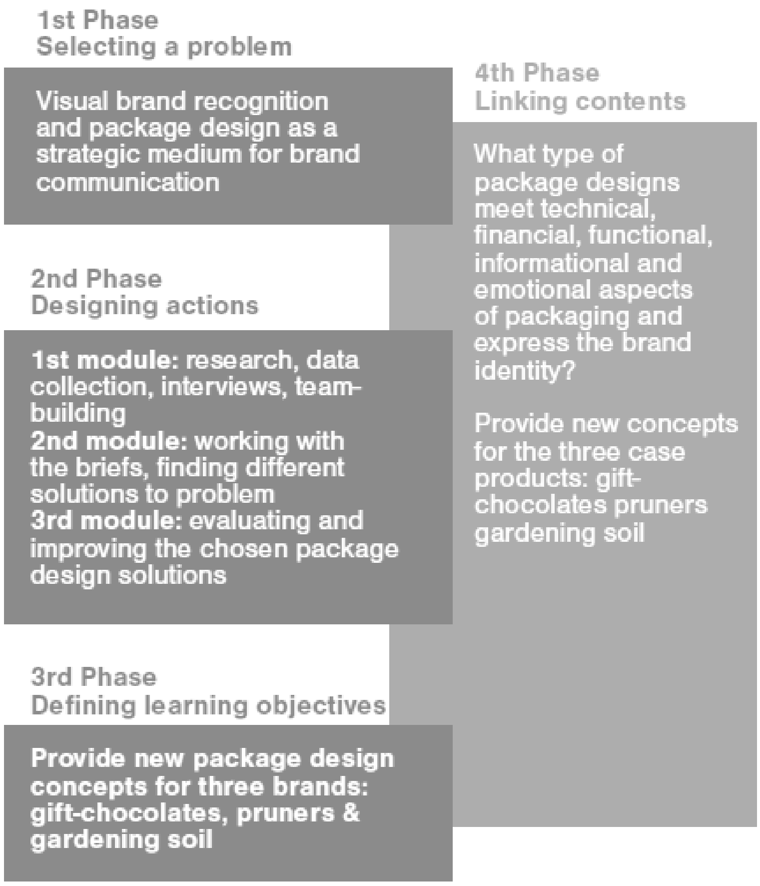

Figure 1. PBL process

3.4 Phase 2: Designing actions

The second phase in problem-based learning process deals with designing actions. During the months 3-6 of the project, the analysis of the first phase was followed by a concept design phase that was further divided into ideation and development phases. First, students were mapping out the challenges and opportunities of packaging, brainstorming for novel ideas, and selecting most prominent ideas into further development. The development phase resulted in initial sketches and concepts, which were then revised in a number of iteration rounds. Whereas the first and the last modules involved much cooperation with academic teaching staff and industry partners, the second module mainly consisted of independent working by the student team.

3.5 Phase 3: Defining learning objectives

The PBL curriculum should state what students must learn, what they should learn and what would be nice for them to learn [17]. For the package design project the learning objectives were not defined exactly in this manner, but the learning objectives were drawn from industry partners' wishes and expectations for package design, and the general course requirements. Course requirements included: active participation in the team and other course-related activities (lectures, workshops, discussions etc.), researching the topic with empirical methods e.g. interviews and observations, reporting the team activities regularly during the project, and delivering a final report and presentation by the end of the course. Students also had the chance to modify the learning objectives according to their own interest. By enabling students to take part in goal-setting, their commitment and motivation towards the project was increased

3.6 Phase 4: Linking contents

The objective of the last module (months 6-9), was to present the new package design concepts to the companies and academic teaching staff for comments. Students received feedback on the creativity and innovativeness as well as real-life practicality and feasibility of the concepts. While industry partners often advised students to consider the current packaging technology and retailer requirements for packaging, the academic teaching staff encouraged students to be innovative and not to think about possible limitations too much. Such a polarity was yet a challenge for the team but proved to result in interesting package concepts. In this situation characterized by conflicting opinions, which, in fact, also simulates the real-life challenges, the team was given the eventual responsibility to take the package design concepts into direction they found the most appropriate. Finally, prior to the final presentation of the concepts, students had few weeks for the necessary adjustments and fine-tuning of the designs. Attention was also put on the communicative contents of the new package concepts from the perspective of the particular brand in question, as this was the underlying theme of the project.

4 CONCLUSION

As an educational approach, PBL is a strategic answer to the competence needs of today’s multidisciplinary work environment. These competencies emphasize the skills of knowledge processing, communication, interaction and problem-solving. All of which are needed to overcome the negative effects that functional walls can create. The shift from knowledge to knowing is reflected in the demand for continuous learning and in the need to repeatedly develop or even change a professional orientation. It is not enough that education provides a sufficient knowledge to be applied in professional practice; education itself has to be able to produce the core competences needed in future.

The project also showed that this type of analytical and practical approaches are needed, in particular, when new ways are sought to explore the perceptual and experiential aspects of package design on a deeper level. Furthermore, this project successfully highlighted the multiple functions of product package both in low- and high-involvement product categories. It turned out to be a potential approach to tackle the multidisciplinary and multifaceted challenges of contemporary package design.

We proclaim the importance of educating prospective professionals that control worldviews of other professions while they are still students, before full sedimentation of professional values has happened. In deep interaction, they can learn to understand the value and role of other professions. This, we argue, creates insights that are valuable throughout life and enable excellence in business.

In the exemplary project, the quality of student work was acknowledged particularly by the companies involved. The ideas and concepts created during the project were highly appreciated by the companies, and some inspirations were used, and will be used, in the development of new packages. Moreover, companies were able to enhance the communication between their internal departments and teams through this multidisciplinary student project.

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