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A New Approach for the Successful Team Building in VLSI Design Projects*

VAIDOTAS BARZDENAS, GEDIMINAS GRAZULEVICIUS AND ALEKSANDR VASJANOV
Department of Computer Engineering and Micro- and Nano-electronics Systems Design and Research Laboratory, Faculty of Electronics, Vilnius Gediminas technical university, 10223 Vilnius, Lithuania. E-mail: vaidotas.barzdenas@vgtu.lt; gediminas.grazulevicius@vgtu.lt; aleksandr.vasjanov@vgtu.lt

The functionality and complexity of modern electronic systems increases every year and poses new challenges not only to the industry, but to universities as well. Due to such a rapid development of complex electronics devices and systems, university lecturers and professors are forced to deliver more advanced projects based on teamwork. In order for the students to accomplish projects successfully, university professors should have knowledge and practical skills in social psychology, project management, successful team building. This article discusses an original and interactive successful team building method, called "Puzzle" method—applicable with a self-assessment test, based on M. R. Belbin methodology. This team building method has been tested and applied for four years in Vilnius Gediminas Technical University Faculty of Electronics, accomplishing VLSI chip design projects. Data collected within four years from 64 students indicates, that the most successful projects were carried out by teams consisting of dominant Chairman, Implementer, Completer-Finisher, and Specialist team roles, and as many as 84.4% of the surveyed students (26.6%—well, 57.8%—excellent) positively accepted a synergy of the team that carried out the project.

Keywords: electronics engineering education; integrated circuit (IC) design; project-based learning (PBL); interactive learning methods; team building in education

1. Introduction

Nowadays latest advances in electronics technologies are used for most of the technical and technological solutions. Fast electronics and communication technology development is created to solve new problems in a way which could not be addressed in the past. Dimensions and power consumption of modern electronic devices are gradually decreasing, so a larger number of complex circuits fit in a single chip. For these reasons, a growing demand for professionals, who are aware of the latest micro- and nano-electronics technologies, trends in embedded system development, FPGA, SoC and SiP design and their application principles, is currently present.

European nano-electronics technology platform ENIAC (European Nano-electronics Initiative Council) witnessed the growing demand of micro- and nano-electronics specialists in Europe and around the world and outlined, that through the next ten years smart electronics industry will require as much as 500 times more professionals, in its strategic research plan for 2020 [1]. Therefore, preparation of new creative designers in the field of electronics development becomes the main problem for Europe and the whole world.

There is a variety of subjects, related to micro- and nano-electronics design and manufacture in many European and world universities. Students carry out varying complexity projects of VLSI chip design, testing and research all of which require a lot of expensive hardware and software, expensive integrated circuit manufacturing costs, human resources and time. For the latter reason, university lecturers and professors face several problems. The first problem is if VLSI chip projects do not meet a deadline, students no longer have the possibility to carry out testing and further research. Therefore, in most cases these teams are evaluated negatively, or students are appointed to the teams that carried out projects successfully. However, this step can be misleading, because of the understanding that, in case of failure, a student is able to continue work with other teams, what is not a motivating point for successful teamwork. The second and more fundamental problem is that VLSI chip design projects are complex and can be done only in a team, consisting of several or a dozen students. Therefore, in order to build a successful team, university professors must have social psychology, project management, successful team building knowledge and a background of practical skills. However, a rare professor of technologies can be characterized with such capabilities, so it is necessary to use already proven successful and effective team building techniques during the whole learning process.

Furthermore, the recent increase of collaborations between different universities all around the world leads to internationalization of universities, which results in international VLSI design groups in classes. Therefore, an even bigger challenge arises

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for the teacher to successfully organize teams of students from different cultures. This also forces university professors to raise the qualification and constantly improve, deepen their knowledge and gain more professional expertise, seek for new teaching and successful team building methods.

The purpose of this article is to share the best practices of successful team building using the interactive techniques for efficient VLSI chip design.

This article is as follows: section 2, a literature review about team building methods for multi-purpose projects. Section 3 provides with VLSI chip design project specifics and peculiarities. In Section 4, the authors present a successful team building interactive method, used in Vilnius Gediminas Technical University Faculty of Electronics, the VLSI chip design projects. Section 5 is intended to review the existing four-year statistical data in order to assess the effectiveness of the used method, and finally, Section 6 summarizes the most important aspects of this work.

2. Literature review

Teamwork in the modern world—one of the key success factors. A team that focuses on one purpose, and uses all its skills and energy, can always achieve better results than while working individually. However, in order to allow the team to work effectively, it is important to know that its success depends on workers division of roles, mutual cooperation and the ability to manage emotions and/or possible conflicts. A successful team building process, aimed to improve synergy and operation efficiency, has been a topic of studies in many scientific researches around the world.

2.1 Teamwork theories

B. W. Tuckman was among the first to start analysis of team development and behaviors of its members [2]. He formulated and researched four team development stages: Forming, Storming, Norming, Performing. In the forming stage team members investigate and monitor each other, try to understand real project goals and its members. Storming stage is based on a conflict. This stage focuses on the first disagreements and objections related to the division of labor, leadership and responsibility. In Norming stage, the atmosphere calms down and a constructive discussion related to the same labor organization takes place. Performing stage starts with specific activities. B. Tuckman later added a fifth team development stage Adjourning, the successful (or not) dissolution of a team after completion of a project [3]. These five stages of team development were considered the best and also sometimes slightly modified by many other scientists around the world [4–7]. Furthermore, there are many other theories describing the stages of team formation and individual behaviors in the team. These theories were formulated and researched by E. H. Schein, M. Woodcock and other scientists. Team efficiency, synergy and its impact on activities of a team was also studied by number of scientists. According to S. M. Henry [8], team effectiveness can be measured in two ways: a task execution quality and viability, based on personal satisfaction and willingness to collaborate within a team. Effectively working team, says R. Heller [9], is a living, constantly changing, dynamic force that unites people to work together. The team members jointly discuss tasks and ideas, make decisions and work towards a common goal. M. McCrimmon [10] states that every single team member should be able to suggest ideas, critically evaluate and participate in the implementation of the ideas, while maintaining group harmony and synergy.

Teamwork and learning benefits have been proven in numerous research studies [11–17]. While learning in a team, students achieve better results, enter into the subjects of studies deeper, remember the information longer, gain more communication and teamwork skills all of which works in their favor in future workplaces. However, these results do not appear automatically. In an inefficient or ineffective team, learning results can be even worse than when applying traditional learning methods. Therefore, the main goal of professors should be a creation of successful team building methods and its use in the study process.

Different team building methods used during the study process: students can create teams on their own; professors create teams based on various criteria. The article [18] states that in order to form a successful team of students, two main criteria must be taken into account. The first criterion—students have to be divided according to their knowledge, skills and Grade Point Average (GPA). The second criterion—to avoid teams created by students themselves. These groups are less efficient than those created by professors. As these teams show more progressive abilities, character, diversity, this leads to more effective performance.

An interesting method of forming student teams is presented in article [19]. This method is named "Elimination Auction". This method uses a web based program where students can select project topics and desirable team members, provide them with priority points. After selection is made, a lecturer specifies the size of a team and runs the program, which forms a team and topic of a project. However, sometimes only one or two students are satisfied with the program designated topic. When the majority of team members are not satisfied, the chances of project failure increase. The team-building method presented in article [20] suggests how to eliminate this problem. The essence of this method is as follows: at the beginning of the semester, students fill out a form in which they rank colleagues with whom they would like to carry out the project; then all the choices form an array, from which, according to the algorithm priority, scores teams are formed. Finally, the newly formed team chooses a project topic proposed by the professor. Similar team building algorithms can be found in other scientific articles [21, 22].

However, the above methods have one major deficiency: students temper and role in a team is underestimated. And these qualities have very significant impact on successful outcome of a project.

2.2 The Belbin team roles for teamwork

The roles and the division of roles in teams is examined by the role theory. Role theory pioneers are social psychologists G. H. Mead, J. Moreno and R. Linton. They tried to explain the role theory through personality integration into the group process, also known as the personality socialization. Subsequently M. R. Belbin [23, 24] studied roles that become apparent in a team or by the team members when sharing their contribution and relationship with the rest of the group. M. R. Belbin talks about successful team model and names different roles that together help create a perfect team. The brief description of the roles is presented in Table 1.

As shown in Table 1, only 8 main roles that are necessary for the ideal team are listed. M. R. Belbin also includes a ninth role—when the team needs to add a specialist (SP), the professional becomes the main character in projects which are based on specialized work, engineering skills and knowledge. In terms of engineering projects, the role of the professional could be named as the most important one, compared with the other team roles.

A team must be disposed to take any of these roles, but according to M. R. Belbin it does not mean that the number of team members is fixed. It is not limited to eight or nine persons. Team roles are closely related, so it is said that one person does not have to perform only one function, e. g., a team member can have features of Chairman and Implementer at the same time. Everyone has distinctive personality traits, and it is not objective to say that each role representing a member will match M. R. Belbin specifically described types.

Although, M. R. Belbin did his research in business organizations, his set principles are effectively used for engineering projects with educational purpose as well. According to M. R. Belbin theory, the following sections provide an interactive successful team building method used in VLSI chip design projects.

3. Features of VLSI chip design projects

Many universities include modules related to VLSI chip design in the program of study. These modules consist of lectures, laboratory practice and course projects [25–30]. The main goal of such a coursework project is to teach students to design, simulate, analyze and test complexity of various integrated circuits and to introduce students to reasonable selection of engineering solutions in a team. To achieve this, perhaps one of the most difficult tasks is to conduct teamwork. This section will introduce a standard VLSI chip design project and discuss the problems faced by professors in accordance with students and their project implementation.

As previously mentioned, the most common VLSI chip design study module consists of lectures, laboratory work and course project. At the beginning of the semester, there are several lectures, which provide students with theoretical and practical, project realization, skills and knowledge. Also, at the beginning of the semester the professor presents new coursework and project tasks. After completion of the theoretical part and practical work, students begin to implement the course project tasks. Fig. 1 presents the course project execution stages, which are virtually identical in all universities. In detail view:

1. Before starting the VLSI chip design project, the teacher proposes project topics, presents and explains main topic objectives, requirements and technical tasks. After having ana-

Table 1. Description of the Belbin team roles

Belbin Team Roles	Brief Description
Chairman (CH)	Acts as a chairperson
Plant (PL)	Presents new ideas and approaches
Monitor-Evaluator (ME)	Analyses the options
Implementer (IM)	Puts ideas into action
Completer-Finisher (CF)	Ensures thorough, timely completion
Resource Investigator (RI)	Explores outside opportunities
Team Worker (TW)	Encourages cooperation
Shaper (SH)	Challenges the team to improve

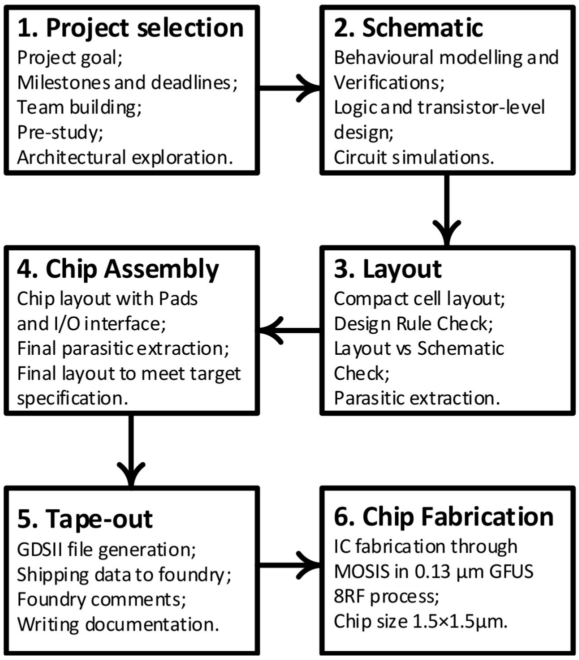

Fig. 1. Typical VLSI chip design flow.

lyzed the information students divide into groups. A typical VLSI chip design project team consists of 4–5 persons. Depending on the complexity of the task, the team size may differ. Later, after team is created the professor is informed about elected group leader. The project leader is the intermediary between the professor and the team, he usually solves more complex problems and tasks. Sometimes the project leader is the person who presents projects test and measurement results at the end of the work. The project starts only when a full team is formed. From this point the professor becomes an observer.

2. The next step is the implementation of the project. After tasks are distributed the team members design and test circuit schematics and perform computer modelling. Modelling results are compared with predefined terms of reference. If the computer modelling results match the predefined terms of reference, proceed to the next step—the topology design.
3. The third stage is based laying out the electrical circuit schematics. Layout images can then be used and reused in designing of the final VLSI chip layout. When drawing a layout view of an element, the team takes into account the manufacturer's design rules and guidelines that help not to deviate from the chosen process geometric standards and to detect any error.
4. During the next stage, the full VLSI chip layout is designed, including computer modelling and performing final verifications.
5. After the last computer modelling stage is finished and parameters meet all terms of reference, the team prepares a draft for manufacturing: exports the project to GDSII, CIF and other standard production file formats. After analyzing the files, the foundry company may demand to correct any mistakes or make some adjustments related to the project. While handing the project over for manufacturing, the team presents its final report, and, together with the professor, discusses the findings and further preparations for produced chip testing. At the end of this phase the professor evaluates the project results.
6. Depending on the manufacturer and the technology that was used, the chip production from GDSII file to the packaged chip can take from a one to several weeks. In this stage, students prepare for manufactured chips test phase. In many universities, this is done in other course subjects.

In this type of projects, students are required to distribute work, organize time and resources, assess the risks, manage performance, quality and communication rationally. Students in technical universities usually do not have subjects explaining the importance, nuances and specifics of project management. Also, these study programs are not available or there is only a few large-scale team projects that would allow to acquire and consolidate this knowledge. Therefore, before starting the VLSI chip design projects, students need to build project management knowledge that would help to achieve final goal successfully.

Another important factor of successful project outcome is effective team building, where unconditional participation of the professor is equally important. The professor must help students form a team according to their skills and character traits. Improper or independently gathered team has a great chance of failure and can make a negative impact on project outcome. It would be right to discuss the most common problems related to inappropriate team building that can lead to failure in designing a VLSI chip project.

A team does not have a specialist. Students usually elect a team leader when candidate has one or all three of the following characteristics: active, good learner, possesses very deep technical knowledge. However, it turns out that the student does not have leadership, team building and motivation skills. These important characteristics hinder the successful achievement of the project objectives, or, at worst, can even lead to a failure of the project.

A team does not generate enough ideas. The absence of creative, broad minded and strategic members can lead to a stagnation related to maintenance and development of ideas. As a result, stagnation can also be a first step to failure. The best option is when a team leader or specialist has all above-mentioned positive qualities.

A team does not have a diligent executor. While carrying out VLSI chip design projects it is essential to have a team member who performs his tasks thoroughly, effectively and efficiently. Such a person is necessary for careful drawing of the circuits, complex and large layouts, conducting complex and lengthy computer modelling.

Possible psychological problems that can emerge in a team. Improper allocation of work can make some individuals believe that the remaining part of the team can accomplish the project without their participation. Team member's passive attitude and as a result increased workload on other members can cause unforeseen problems: a new work and resource reallocation, time reorganization, etc. Another common problem is the controversy and a bad atmosphere in the team. The reason for this can often be mistrust to the leader decisions, dispute and divergence among members, absence of communication between team members. A strong team leader is capable of solving all of these psychological problems. However, if team leader is incompetent, problem solving should be initiated by professors.

In order to solve above-mentioned problems, it is necessary to look for team building methods that allow technology science professors to form teams for successful implementation of the project.

4. Team-building methodology

Before starting to carry out the VLSI chip design project, the professor must evaluate students' character traits and help to create a successful team. For this purpose, the professor has to devote a few introductory lectures in which he should explain the importance of teamwork, features and advantages, and use a variety of interactive successful team-building techniques.

4.1 The Belbin test

Perhaps one of the most widely used team-building methods is a self-assessment test concluded by M. R. Belbin's methodology. Often abbreviated as BTRSPI (the Belbin Team Roles Self Perception Inventory), this approach is based on providing persons with questions, answers to which would determine the nature of tasks those persons could perform best when working in a team. M. R. Belbin's questionnaire consists of seven statements, each of which has eight possible behavior types. The test questions, possible answers, and answers methodology of assessment is explained in detail in the following sources [31–34].

The person answering each proposition has (a ten-point system from 0 to 10, where 0 is the least significant) to assess all eight types of behavior, distributing points so that the most accurate statement conforming behavior would have the highest score. After completing the test, a self-evaluation result sheet is to be filled out, which helps to judge the person's role in the team. A team role that collected the most points describes a person the most, one that collects lowest amount of points—the least. This table also provides results suitable for dealing not only with primary, but also with the secondary and tertiary individual team member's role.

Vilnius Gediminas Technical University Faculty of Electronics professor, prior to the start of the VLSI chip design projects, sets out three theoretical lectures. The first taught lesson is about achieving the objectives of the project, presented and explained the tasks subjects and their technical specifications are shown and previous projects results are discussed. During the second and third lectures, the professor emphasizes the importance of project management and the characteristics of a successful team-building peculiarities, tells about the time planning, work-sharing need, the potential risks related to the project. In the middle of the third lecture the professor provides M. R. Belbin's tests and allocates 20–30 minutes for completion, pointedly noting that students should mark what they personally think is the most acceptable. From the results, the professor can have an idea about the character traits, and to build up a team of 4–5 students, having all types of M. R Belbin's team roles. However, M. R. Belbin's test cannot fully expose students' character traits. Students rushing to complete the test, sometimes make a mistake, or incorrectly understanding the question, mark the wrong answer. On many occasions, students intentionally mark a wrong answer to become a team leader. Therefore M. R. Belbin's tests should be only as an auxiliary tool for shaping a successful team and applied with other interactive team-building methods.

4.2 The "puzzle" method

After completing M. R. Belbin's self-assessment test and after student team is gathered, the professor should make sure that the team is effective. To achieve this, it would be appropriate to use a variety of teamwork mini-tasks or games. The main purpose of such tasks should be teamwork simulation, allowing team members to determine the actual roles and their mutual teamwork. One such team examination assignment method, which we named

"Puzzle" method, is successfully applied to the Vilnius Gediminas Technical University Faculty of Electronics VLSI chip design projects.

According to the M. R. Belbin's self-assessment questionnaire results the lecturer brings together several teams, estimating that each team would consist of 4–5 students having all nine team members' roles. After bringing together a team, the professor gives the task. The task is related to the designed VLSI chip block-flowchart formation. The professor presents parts that will form a VLSI chip block diagram as well as additional parts that do not relate to the latter VLSI chip. All these parts are handed out to the team members equally and students are warned not to share these parts between each other. Students must build the appropriate block diagram using the given parts and introduce it in detail to all the teams. This task is allocated 30–40 minutes. The winning team is the one which builds correct form of the designed integrated circuit block diagram in the shortest time.

Since the launch of the project, getting stuck and having no ideas, the team can take advantage of a one-time help from the professor. The team selects one person delegated to access the professor's desk or computer and see how the task should look in their final VLSI chip block diagram. It is prohibited to use smart devices to photograph, draw or make notes on paper, voice or mimic information transmit to the team members at the professor's desk. The delegated person is given 1–2 minutes to study and analyze the diagram. After time has expired, the student returns to the team and shares the learned information with his colleagues and the team continues the flow diagram conclusion. The team can take advantage of this one-time help only when the task reaches the middle of the session. While students perform the task, the professor monitors whole discussion process, and can afford to answer the following key questions:

1. Does the team have a real leader and who he is?
2. Does the team have a major part of M. R. Belbin's team members' roles?
3. What characteristics and roles do the team members have?
4. What is the team's strategy?
5. Is there a division of labor?
6. What atmosphere prevails within the team?
7. What are the relationships between team members?
8. Is there a productive and high-quality debate?
9. How time management is done within a team? And many other questions of similar type.

The answers to these questions will allow the professor to make sure of the formation of a successful team. If during this task the professor sees any team weaknesses or deficiencies, he can rearrange the teams in order to find the balance required for a successful execution of the VLSI chip design project.

5. Team-building results

The above discussed M. R. Belbin's test along with team-building "Puzzle" method have been successfully applied to the Vilnius Gediminas Technical University Faculty of Electronics for four years when implementing the VLSI chip design projects.

At the end of each school year, after carrying out the VLSI chip design projects, the students are presented with a questionnaire, which allows the professor to receive feedback on the taught subject. It should also be mentioned that the survey is conducted anonymously, without requiring any personal information from the student, also is voluntary, and if the student does not want to give his opinion, he can choose not to.

During the last four years, the VLSI chip design projects were carried out by 73 students. 64 of the latter 73 students have submitted filled in questionnaires. Table 2 provides the overall opinions on the project summed up during the last four years. The data presented in Table 2 shows that the students evaluated the teamwork concept application for the VLSI chip design projects very positively. The latter positive feedback has been received from 82.8% of the surveyed students. Such high percentage further supports the fact that teamwork motivates students to take interest in their field of study and must be included in the training process. Another trend that can be seen from the statistics is that the students evaluate the importance of a successful team formation and appropriate members selection for the achievement of joint team goals as very good (73.4%) and good (14.1%). Based upon Table 2 results, the successful "Puzzle" team-building method, described in this article, is evaluated as good by 21.9% of the surveyed students and as very good by 60.9% of the students. These figures lead to the conclusion that students welcome the team-building approach and see the benefits and efficiency of this approach. And finally, another major finding, which is seen in these statistics is that even 84.4% of the surveyed students (26.6%—good, 57.8%—very good) evaluated the team synergy, i.e. successful teamwork, interpersonal communication, as well as team members complementarity between different skills. These figures once again prove that a synergy effect occurs while working in a team, meaning that people working together achieve much more than the ones working separately.

As it was previously mentioned, during the last

Table 2. Student Satisfaction Survey Results (N = 64)

Question	Poor	Fair	Good	Excellent
How do you evaluate the teamwork in the educational process during the VLSI chip design projects?	0%	3.1%	14.1%	82.8%
How do you evaluate the need for a successful team formation prior to carrying out the project?	4.7%	7.8%	14.1%	73.4%
How do you evaluate the professor's team formation methodology, its effectiveness and benefits in this project?	7.8%	9.4%	21.9%	60.9%
How do you evaluate the size of the formed team, given for the project task?	3.1%	18.8%	32.8%	45.3%
How do you evaluate your abilities and skills to work in a team?	4.7%	9.4%	34.4%	51.5%
How do you evaluate the work done by your team?	6.2%	14.1%	25%	54.7%
How do you evaluate the work done by your team leader?	9.4%	10.9%	31.3%	48.4%
How do you evaluate the competence of the formed team (team members' skills and knowledge as a whole)?	6.2%	15.6%	34.4%	43.8%
How do you evaluate the synergy and working climate in your team	4.7%	10.9%	26.6%	57.8%
How do you evaluate the acquired knowledge from this course project towards your further professional activities?	9.4%	9.4%	25%	56.2%
How do you evaluate the professor's help provided to you during the course project?	3.1%	4.7%	29.7%	62.5%
How do you evaluate the quality of used visual and auxiliary educational measures?	3.1%	3.1%	21.9%	71.9%

four years, 73 students were divided into teams of 4 or 5 persons worked on the VLSI chip design projects. There was a total of 18 teams that carried out professors or tasks of the corporate bodies that contacted the university. Out of 18 projects, 14 have been implemented successfully and 4 were not implemented, or implemented with certain discrepancies: did not meet the technical specification requirements of the task, the designed chip was not timely provided for production or the manufactured chip did not work.

As noted above, prior to start of the project course the tutor gives the students to fill out the M. R. Belbin's self-assessment test. According to the results, the professor elects three main roles which the student is characterized by and from which the team is later formed. Table 3 summarizes the statistics over four years, covering first three students' self-assessment roles, statistics. This table shows an interesting trend, which shows that the first three self-assessment roles distribution is sufficiently uniform and varies between 30% and 36% of the total number of students who answered the survey.

The collected statistics show another interesting trend that the most successful projects are carried out by a team consisting of dominant Chairman, Implementer, Completer-Finisher and Specialist team roles. There were seven teams of such composition and their evaluations for the project were the highest and were in the range of 86% to 100%. The latter statistical data is summarized in Table 4. An assumption can be made, that such a successful team composition is justified by the fact that these team roles include virtually all the major VLSI chip design project ongoing activities. The team's Chairman organizes and takes care of teamwork, knows the team members pros and cons, promotes decision-making, explains the goals and perfectly represents the team. The team's Specialist has deep knowledge, the ability to take complex engineering solutions and takes a key part as a developer in project engineering. Meanwhile, the Implementer is a member of the team, able to foresee the team's

Table 3. Number of students in the different Belbin team roles (N=73)

Belbin Team Roles	Primary role	Secondary role	Tertiary role
Chairman (CH)	12	6	8
Plant (PL)	7	9	6
Monitor-Evaluator (ME)	5	8	10
Implementer (IM)	11	7	8
Completer-Finisher (CF)	8	8	9
Resource Investigator (RI)	5	10	8
Team Worker (TW)	8	8	7
Shaper (SH)	4	9	11
Specialist (SP)	13	8	6

Table 4. Combination of the Belbin team roles in the VLSI course project group

Combination of the Belbin Team Roles	Number of projects	Final grade of project (from . . . to . . . , %)
CH+IM+CF+SP	7	86 . . . 100
CH+IM+TW+SP	4	78 . . . 92
PL+ME+RI+SH	3	74 . . . 85
PL+ME+TW+SP	2	63 . . . 75
CH+PL+RI+TW	1	62
PL+RI+CF+TW+SH	1	54

ideas, ways in which they will be implemented and implements them in practice. The Completer-Finisher is zealous, diligent and attentive person, discovering errors, correcting them, and perfecting the work by the specified deadline.

It should also be noted that when building the team, it would be ideal that the main four team roles would be supplemented by other secondary and tertiary student roles—in such way that they would cover all nine M. R. Belbin's team roles.

M. R. Belbin's self-assessment questionnaire results should be verified with other team-building methods. During the four years, when VLSI chip design projects were being carried out using the above-described "Puzzle" method, 5 changes in teams have been made, which mainly relate to the effective team leader selection and attempt to create a proper (CH+IM+CF+SP) team members roles combination.

6. Conclusions

This article describes the interactive "Puzzle" team-building method, which, when used together with M. R. Belbin's self-assessment test, allows to form a proper team for executing the project. The core benefit of such a team-building method is fast distribution of M. R. Belbin's roles between team members. This team-building method has been tested and applied for four years in Vilnius Gediminas Technical University Faculty of Electronics, when successfully carrying out the VLSI chip design projects.

According to the data collected during the last four years it is seen that the most successful VLSI chip design projects are carried out by teams consisting of dominant Chairman, Implementer, Completer-Finisher and Specialist team roles. However, it would be ideal that the main four team roles would be supplemented by other secondary and tertiary student roles—in such way that they would cover all nine M. R. Belbin's team roles when forming a team.

"Puzzle" team-building method research was carried out for four years during which 64 students participated and filled in the feedback query. The survey results revealed, that 82.8% consider this teamwork application for the VLSI chip design projects as a very good idea, 84.4% of the surveyed students (26.6%—good, 57.8%—very good) positively evaluated the synergy in a formed team, and the proposed interactive "Puzzle" team-building approach has been evaluated as "good" by 21.9% of the surveyed students and "very good" by 60.9% of the students. Such high percentage of positive responses further supports the fact that teamwork and team building methods must be applied to the learning process.

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Vaidotas Barzdenas received the B.S., M.S., and Ph.D. degrees in Electronic and Electrical Engineering from the Vilnius Gediminas Technical University, Lithuania, in 2002, 2004, and 2008, respectively. He is currently an Associate Professor with the Department of Computer Engineering and Vice Dean of Electronics Faculty, Vilnius Gediminas Technical University. His current research interest includes the novel micro- and nano-electronics technologies, RF, digital, analog and mixed-signal VLSI circuit design and layout, and their optimization algorithms, synthesis, analysis methods. His educational research interest includes active learning methodologies, education media and technologies.

Gediminas Grazulevicius received the B.S. degree in Mechanical Engineering from the Vilnius Gediminas Technical University, Lithuania, in 1995, and the M.S., and Ph.D. degrees in Electronic and Electrical Engineering from the Vilnius Gediminas Technical University, Lithuania, in 2000, and 2004, respectively. Since 2004, he is an Associate Professor with the Department of Computer Engineering, Vilnius Gediminas Technical University. His research interests include the electromagnetic disturbances, electromagnetic field measurement technologies, computer network security and data mining. His educational research interest includes modern learning technique and methods, and their application.

Aleksandr Vasjanov received B.S. and M.S. degrees Electronic and Electrical Engineering at Vilnius Gediminas Technical University (VGTU), Lithuania, in 2012 and 2014 respectively and currently is a micro- and nano-electronics Ph.D. student in VGTU. His current research interests include novel transmitter and receiver architectures, RF IC high-end blocks (power amplifier and low noise amplifier) and impedance matching networks (lumped and distributed) as well as advanced IC analysis using OCEAN/SKILL programming language. His educational research interests include introduction of subject-specific knowledge and practices in the development of modern study programs.