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Mechanical Engineering Faculty

PROCEEDINGS

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RESEARCH AND DEVELOPMENT OF MECHANICAL ELEMENTS AND SYSTEMS

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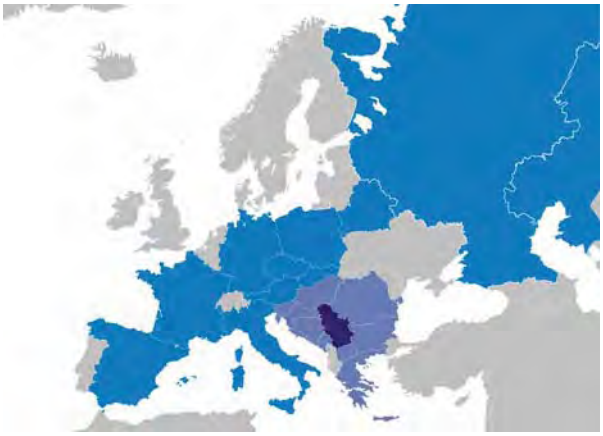
Preface

New technologies, globalization and individualization of customer demands, as well as high quality of modern products, are forcing industrial enterprises to improve their processes of product development. This implies the support of enterprise processes throughout the product lifecycle, from the product idea through product development, manufacturing, improvement and quality assurance to maintenance during operation. Processes of product development are more than just usual engineering. A product portfolio must be analyzed and product concept must be examined from the aspect of its realization. This requires linking internal domain with external teams. New products must be introduced to market with high quality and low development costs. The prerequisite for development of high quality products and high productivity manufacturing is to master the knowledge, which is a result of research in science and technology.

The aim the 7th International Scientific Conference "Research and Development of Mechanical Elements and Systems" 2011 in Zlatibor is:

- to gather experts and researchers in the field of scientific research and industrial product development;
- to present new design solutions related to energy efficiency, application of available resources, product price reduction, …
- to exchange knowledge and experience, through presentations of research results and expert information, with the aim of stimulating industrial activities in the region.



Participant countries

The best 114 abstracts were selected among 154 submitted by authors from Europe und Asia. The lectures came from Austria, Bosnia and Herzegovina, Belorus, Bulgaria, France, Germany, Greece, Croatia, Czech Republic, Hungary, Italy, Kazakhstan, Macedonia, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia and Spain. The presentations emphasize future trends in area research and development of mechanical elements and systems and cover the following topics:

- Industrial Product Development
- Computer Added Product Development - CAPD
- Mechatronics and Automatic Control
- Safety, Quality and Reliability
- Materials, Technology and Tribology
- Vibration and Noise, Testing and Monitoring
- Mechanical Systems and Components

The conference offers the possibility for participants to discuss the presented results in detail and share their experience.

Conference President

Prof.Dr.-Ing. Vojislav Miltenović, Full Professor, Machines Development and Construction Centre (CERP), University of Niš, Faculty of Mechanical Engineering, Niš, Serbia

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THE 7TH INTERNATIONAL CONFERENCE RESEARCH AND DEVELOPMENT OF MECHANICAL ELEMENTS AND SYSTEMS

A STUDY ON WORK OF DISLOCATED TEAMS: VIRTUAL PROJECT REALISATION

il ana MARKOVIĆ
Dragan MILČIĆ
Miroslav MIJAJLOVIĆ

Abstract: *Modern age requires several improvements in realizations of a project:*
interdisciplinary teams,
moveability, ductility, high adaptation and tolerance of team members,
sustainability of a project and, more important, results of a project and
fast information flow between team members.
In most cases, today's projects are realized in several cities, states, continents – team members have never met in person before, they have never exchanged opinions face – to – face but, still, they manage to fulfil demands of their superiors and create a product. They work on a virtual project realization but they develop a real product. Difficulties, conflicts, challenge – teams need to find optimal solutions for all of them. aLeP project, a cooperation project between several niversities from different countries gives significant material for analysis and improvements of dislocated team's work.

Key words*: Virtual Team, Virtual Project, Dislocated Teams*

1. INTRODUCTION

Modern age has delivered numerous advances to the society and mankind: technology, education, knowledge, but it seems that the most important one is information and extraordinary speed of information distribution. Nowadays information travel duration, from North to South or from East to West of our planet, is measured in minutes (or even seconds). This speed and information flow has influenced our mankind: everything we want to know and learn is relatively easy to find.

One of the socio-results of such an improvement is laziness – it is in human nature to be lazy, to use all the comfort and to neglect the fact that some other (human, animal, machine, nature) has to work hard for the comfort that humans use. But, laziness is a fact that has to be left behind for a moment. Engineers are humans that work hard to develop something new, innovative, useful, something that will help other humans to work less and be more progressive and satisfied. Unfortunately, information flow has delivered to them tremendous issue: since information travel fast, humans easily adopt new designs, new products and it is harder and harder to create a new product that completely fulfils "global standards" (delivered by market, for example), stays low – cost and eco – free. Triangle "price, value and eco-influence" is always an issue of greatest kind.

Solutions are various: from complete changes of products/habits to modes or minimal adjustments of the existing. An example might be "selling use instead of product approach" [1]: preserve resources, reduce costs and provide needed service.

Like always, economists and mangers react first recognizing the financial costs of information flow, recognizing how easily money can be re-directed in a product development process, they organize virtual teams – persons scattered around the Globe working on the same problem (or same problems of a problem), responding only to the one centre/person.

2. VIRTUAL TEAM

Definition of a virtual team is quite simple: "A virtual team (a geographically dispersed team or GDT) is a group of individuals who work across time, space and organizational boundaries with links strengthened by webs of communication technology". A bit specified definition defines a virtual team as "groups of geographically, organizationally and/or time dispersed workers brought together by information and telecommunication technologies to accomplish one or more organizational or other tasks" [4].

There are several different types of virtual teams, but engineers are mostly involved in *project development teams*. Project development teams are mainly focused on creating new products, information systems or organizational processes for users and/or customers. These teams have the added ability to make decisions rather than just make recommendations. Project development teams may also add or remove members of their team at any given of time, as needed for their area of expertise.

The necessity for teamwork in product development is generally accepted because of the size and complexity of most design projects, design which are usually accomplished by teams, rather than by individuals. The

results of teamwork depend on qualified team members, well-structured development processes, design methods as a support to he process. Working in teams requires style of problem-solving of every team member's.

Task processes are the different functions that happen when a team is doing its work. Communication is one of the most crucial things in virtual teams. It starts from selecting excellent communicators for the team members and the right technology for them to use. Some empirically found challenges in successful communication in virtual teams are failure to communicate due to wrong or lacking contextual information, unevenly distributed information, interpretation of the meaning of silence and technical problems. Because of the lack of face-to-face time, the team can miss nonverbal communication altogether. The extensive reliance on communication technology leads to reduced impact and difficulties in management compared to the traditional teams. Predictability and feedback also frequently improve communication effectiveness, creating trust and better team performance. In addition, in one study researchers tested the question of whether adding video to electronic communication helps in explaining a detailed task to another person. They found that for native speaker pairs it did not bring any additional benefits, but for non-native speaker pairs it brought significant improvement to the task.

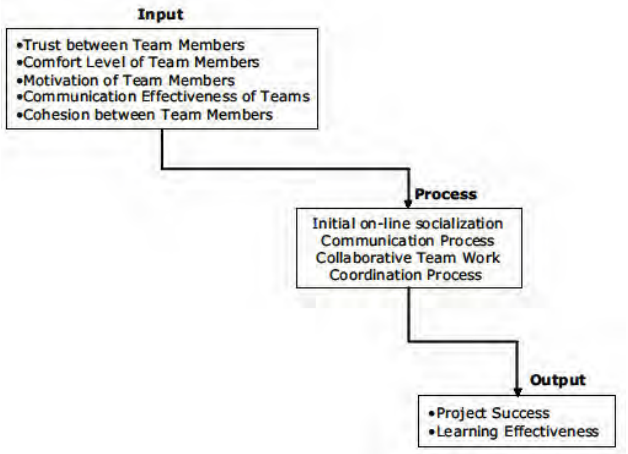

Figure 1 An example of research model

It is, naturally, more difficult to coordinate virtual teams in different time zones, cultures and mental models. Collaboration norms have to develop for the team to function well. As mentioned, periodical face-to-face meetings are a good way to form relationships and also a good vehicle to coordinate activities and to drive the project forward. When face-to-face meetings are not feasible, one alternative is to develop coordination protocols with communication training.

2.1. Virt al team advantages disadvantages and challenges

Virtual teams are a great way to enable teamwork in situations where people are not sitting in the same physical office at the same time.

Virtual teams are governed essentially by the same fundamental principles as traditional teams. Yet, there is one critical difference. This difference is the way in which the team members communicate. Instead of using the full spectrum and dynamics of in-office face-to-face exchange, they now rely on special communication channels enabled by modern technologies, such as e-mails, faxes, phone calls and teleconferences, virtual meetings, and alike.

Due to more limited communication channels, the success and effectiveness of virtual teams is much more sensitive to the type of project the group works on, what people are selected, and how the team is managed.

Not every type of project is suitable for a virtual organization. One challenging case is projects that rely heavily on sequential or integrated work, as often the case in manufacturing. In particular, when each person's work depends much on what someone else is doing at the same moment, there is an ongoing heavy exchange of information in real time, and/or the tasks have to go through a strict sequence of workers within a short time.

Not everyone can perform well in a virtual team environment. The members should be self motivated and able to work independently. They need to be able to keep working effectively without much of external control or structure. The next important quality is strong result-orientation. Unless the person shows clear results, there is nobody around to see how intense his or her work activities are. Another critical factor is communication skills. The team member should be able to communicate clearly, constructively, and positively even through the more limited channels of technology, in spite of the loss of many nonverbal cues of face-to-face communications.

Managers of virtual teams also need to pay much more attentions to maintaining clear goals, performance standards, and communication rules. People have varying assumptions on what to expect from each other. To avoid build-ups of misunderstandings, in a virtual organization it is critical to replace those implicit assumptions with clear rules and protocols that everyone understands and agrees upon, especially for communication.

One of the biggest challenges of virtual teams is building and maintaining trust between the team members. Trust is critical for unblocking communication between members and sustaining motivation of each person involved. The issue of trust needs special attention at any stage of team existence.

At the end it is necessary to point advantages ( ) and disadvantages (-) of virtual teams:

+ *Increased productivity*: Virtual teams often see an increase in productivity because more personal flexibility is achieved, commute time is reduced, and work is not limited by the traditional 9-5 work day schedule. In turn, the company never sees an off hour. The team on the other side of the globe simply picks up where the prior team left off. This approach is commonly referred to as "Follow the Sun Approach". This advantage can translate to a much faster time to market for new products and technology.
+ *Extended market opportunity*: This is a major benefit of geographically dispersed teams due to direct access to different market opportunities. With work teams located in different parts of the globe, organizations are able to establish their presence with customers worldwide. This also gives small business owners the

ability to compete on a global scale as well without being limited to a particular customer base.

+ *nowledge transfer*: This is one of the most important benefits of a virtual team utilizing people with different types of knowledge spread out across the globe can be very beneficial to any organization. Online meetings, remote computer access, wireless technology, and conferencing systems offer a way for participants to join a complex discussion from anywhere in the world. This benefit can enable most companies to compete on a global scale.
– *Communication deficiency*: The biggest disadvantage that any virtual team can suffer from is the lack of efficiency in communication, partly due to constraints in virtual communication mediums. This is also primarily due to the fact that humans communicate better when they are able to communicate with their body language. Inevitably, virtual teams may face obstacles due to restrictions of the Internet which in turn may lead to incorrect assumptions if a message is not laid out clearly. Failure to properly communicate and clearly address messages or emails could lead to frustration and eventually failure.
– *Poor leadership and management*: Poor leadership can result in the failure of any team, whether virtual or not however, it becomes much more prominent problem in virtual teams. Messages must be sent across accurately and clearly. Inability to effectively communicate to members of the team can all greatly affect a project.
– *Incompetent team members*: Virtual teams should only consist of competent and experienced team members due to the distance factor which can overtly affect the timing and completion date of a project. Projects are more likely to fail if the team consists of individuals who are lazy or lack sufficient knowledge to complete their assigned tasks. It only takes one incompetent team member to have a negative effect on the rest of the team.

3. Virt al ro ect reali ation

Organized by the University of Karlsruhe, Germany, University of Niš, Faculty of Mechanical Engineering has joined the project based on KaLeP education model. KaLeP is a general concept oriented to a real product development process in industry based on construction theory in education, created to improve developing engineer's competence in product development [4].
KaLeP method (Fig.2.) goal is to inform participants in complex product development environment (who are currently in the education process), about the aspects of a real working environment and teaches them the best possible basis for complex challenges development in further professional career. Also, the mentioned model is enabling work on concrete project's tasks, in working conditions which are very similar to real requirements of industry.
Details about the project must remain unknown due to privacy agreement, but KaLep project realization gives excellent data for analysis of virtual teams and virtual project realization.

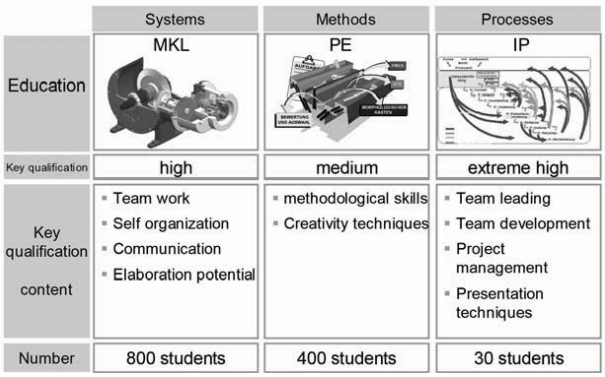

Figure 2. Elements of aLeP model: systems, methods, processes

In order to reach an innovative idea for human resource management in process of product development and to make improvement in evaluation of engineer profile competences (as team members), a real experiment had placed in the base of joint project of collaboration between Mechanical faculty in Niš (Serbia) and Mechanical faculty in Karslruhe (Germany). That project included 4 teams, 2 from Serbia and 2 from Germany, a combination of unique-culture teams with cross-culture cooperation, with common aim – development of a new product for German's industry demands. That fact was specific for this project. The manner of target realization was a unique, education model KaLeP.
Both Universities have organized teams of students (in groups, 5 to 10 students per group). An assignment for students was unique: multi-disciplinary analysis of a complex problem, solution searching and decision making, with prototyping a selected solution and proof of functionality. UNIK and UNIN teams had coordinators from their Universities and they had to coordinate only with them, while coordinators had to communicate with project managers from UNIK.
This experiment was the first time that two different faculties have been involved in. Also, KaLeP model was an aim of knowledge transfer between Mechanical faculties Karlsruhe and Niš. In that circumstances, in order to control and monitor project, it was necessary to set the same limited conditions for realization. That was also challenge and that was base for comparison of project results.
Basic education plans and programs on these faculties are very different, so basic students knowledge was very different, as their background in whole. This unique cooperation is maintained by coordination during project, at the start of the project until first turning point. Also, goal was not only education and gaining experience through work in virtual teams, but development task based on KaLeP method, in two different working and living conditions, and the output of this process is a working prototype for industry needs

3.1. Motivation o teams and team members

Results of analyses during project period are:
Reasons for applying and activation of students from Karlsruhe on this project were:

- Gaining practical experience in work

- Participation in team work problem solving,
- Finding place in a team,
- New product development,
- Application of theoretical knowledge in real working conditions.

Reasons for applying for KaLeP project for students from Niš were the same as listed, but there were some reasons that are important but different from reasons of German students:

- Possibility of comparing strengths with colleagues from different country (specially Germany), meaning competition and proving
- Possibility to visit one of the most developed countries of Europe and see everything that most people did not have chance to see, meaning motivation came from possibility to travel and see new which is not accessible in every day life.

Also, UNIN teams were fully motivated at the beginning of the project realisation – students had no previous experience in serious team work but they were competitive especially versus foreign teams students were near the end of their studies and they were willing to try their skills. Huge motivation of the students was set on the fact that they might have a chance to be seen by foreign industrials.

Due to their inexperience, UNIN teams have misjudged complexity of the problem how the project timeline was going, their motivation was dramatically falling. At first some team members have felt that they might not be capable of fulfilling all the demands and they wanted to resign. Some team members were felt neglected or they felt "overbooked" in product realisation. Teams have almost fallen apart. However, there was no delay in project realisation – all "milestones" were successful. In the beginning of joint project, while UNIK team members had a vision about future work and profile orientation, UNIN team members were "down to earth oriented".

3.2. Com etences o team members

MBTI test, which has been used during previous years in IPD projects at Institute IPEK Karlsruhe, was made on basis of experience of utilization in other fields of interest, and adapted to Institute needs as well as needs of German education system.

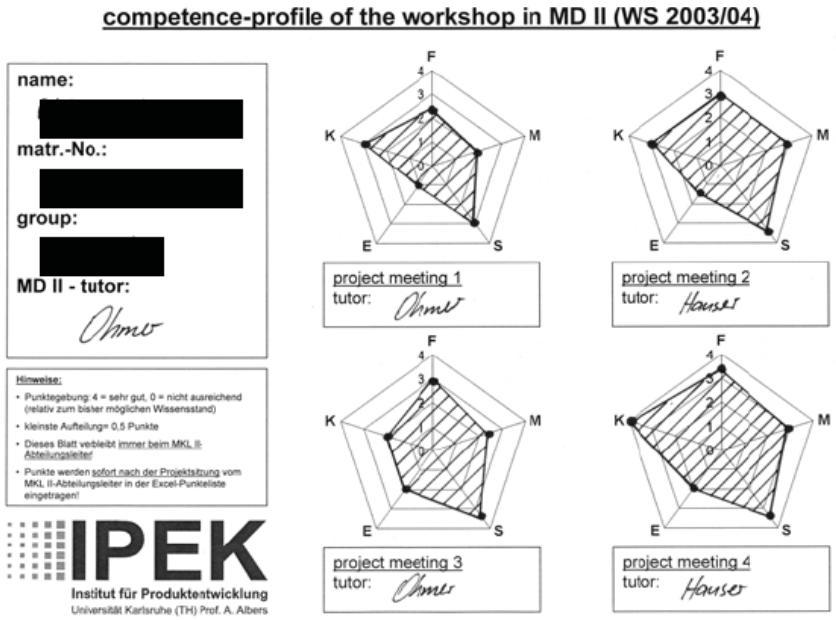

Figure 3. Competence assessment scheme (an example from the project 2003/2004 – IPE)

This test was not applicable to students from Faculty of Mechanical Engineering in Niš, because they were not able to answer many questions. Reason for this problem is in completely different education systems in Serbia and Germany, different subjects, different field of exploration within subjects. More over, there was possibility to adjust this test to knowledge of Serbian students based on number and contents of subjects, but that was not done because of knowledge transfer and setting identical starting points for project starting and candidates (student) selection.

Also, in order to achieve project goal, but also to collect as many information as possible from this project, students had to conduct one more test, Balbin personality test. Students from Niš didn't have any problems with writing their personal data, as well as grading and determining which team roles are suitable based on this test. Based on student's opinion, analyses of the two tests and conducted interview, it can be deducted that Balbin test has much better results then MBTI test, meaning that all project participants gave positive mark to Balbin personality test, but not to MBTI test. Based on the example of some students from Germany who participated in conducting Balbin test as well as MBTI test, and by comparing their roles in these two tests it can be concluded that results from Balbin test are much more efficient and consistent way of personality determination.

UNIN had too few students to make an adequate selection of team members. After competence tests, UNIN teams had way too many "workers", or too few "leaders", "problem solvers" etc. Team members had to adapt and to give more than expected.

Selected team leaders were strong persons with abilities to coordinate and motivate team members. This was fully seen at the end of project realisation, when, after severe failures (caused by many external and internal factors) they have managed to provide sufficient material for developing functional prototypes of products.

3.3. C lt ral di erences bet een team members

Review of relationship between the students from Germany and the coordinator of the project and the students from Serbia, and according their interest to be a part of investigation which has performed through project is like this:

- Surprise from the project start was minimized after time, and that was a fact only. German students' mentality is specific it is very difficult to detect any kind of emotions. From their side, it was adopted a fact that they will do with students from different country on same task, which roused their interest and fighting spirit.
- Students didn't know each other before project start, and that fact is not important. They were working like team, without any enter of emotions inside of team. From their aspect, it is better that team members are not friends.
- Their experience before start of project has given a much better base for work, from viewpoint of possibilities for future development, knowledge acquirement and progress. The most of them had work experience through student's practice, student's interchange, even with different countries, which gives possibilities for higher level of foreign language knowledge and usage (not only English language, other languages from Europe also).
- Before the first presentation, German students didn't show any interest to meet their colleagues from Niš. But, presentation "State of art" motivated their attention because they noticed a hard work and high level of care from side of students from Niš. They noticed that including notable professors and scientists from defined field in joint work, it was very essential for project progress.
- After establishing first mutual contact, on coordinator's initiative, they realised necessity of information exchange and usage of different resources, which could be accessible to anyone by information server, in order to avoid time loss for finding information, to avoid danger that results (outcomes from project) could be identical or similar in both sides.
- Students, team members from Germany, showed a good mood for testing, which was performed during the project, what was different from the will of their assistants. Assistants, students managers, didn't want to cooperate in this field, they had an attitude that questionnaire is of personal nature and that students will not give any answers to questions. But, students were quite communicative, with open mind for cooperation, more flexible and ready for joint work then their assistants and managers, who had a noticeable dose of reserve and mistrust towards project participants from Serbia.

A first impression after development process was that cultural differences during process in the formal work arrangement were less visible then expected. Only obvious cultural factor which had influence on common work was verbal, language, pronunciation, which was incomprehensible for all project participants during project performing.

Generally, it looks like there are more cultural differences in informal interaction than in the formal procedure. Based on differences in language usage – it is necessary to take care of specific technical terms, gesticulation and intonation [4].

Certain interaction between team members was necessary before in order to reach a better understanding amongst them. It is a heavier and more important to place interaction between cross-culture teams, then between unique-culture teams before the project start. This could induce a problem in distributed cross-culture teams, where is heavier to realise informal interaction before the project start. Of course, few days after the project beginning, it was obvious that discussion inside unique-culture teams begins much straight, than inside cross-culture teams. There predominates a feeling that differences in created view points, in cross-culture teams, lead to the better understanding and much creative/better products. For instance, during a brainstorming training, differences of created ideas have exceeded expected variety of ideas in unique-culture teams. Probable reasons for that are differences in knowledge fields. Also, usage of foreign language are disabling a creativity because a person who is listening a foreign language should think about what has been said, then about nucleus of problem [4].

Knowledge about culture (especially in a case of target market) has notable influence on requirements which are important, and on specific focused product's characteristics (price, physical effects). It looks like the best way to ensure these demands is the understanding of the same, from the side of concrete culture. Depending on considered demands, in some occasions it will be necessary to include people from precise defined cultures in design team, in order to design a product according to specific market demands.

4. CONCLUSION

Generally, cultural differences could induce major time consumption in development process. According to that a phase of target clarifying could be much slow then expected. Separated from target clarifying, it looks like those next steps of planning can take much more time then in unique-culture teams. Strict defined planning could have a positive effect on efficient teamwork in whole. Withal, there need to be interesting how team performances could be more measurable, and in which phase of the process they could be a benefit or lack, and which performances affect it.

Knowledge and convention about design methods could be critical in distributed design. That leads to postulation that knowledge about design methodology could have even bigger influence on inter-culture teams and process. That postulation couldn't be approved because every team member has basic knowledge about design methodology

and they are usually oriented in the same way. That means - used methods and tools are very close to participants. This more by that – concrete joint project of cooperation has placed as a means for transfer of knowledge and model for education, where attempted to work in same way in all phases, by same techniques, tools and methods.

The next problem is in communication means. In situation when project is performed by teamwork, on one place, in unique-cultural teams, a means for drawing (for example – sketch, scheme) usually is a paper. But, if there is distributed project, paper isn't appropriate means of communication. A question about means (media) of communication in distributed teams begins to be dominant for successful and good work, and that question mustn't be ignored. This aspect of cooperation has performed crucial role in the first phases of product development, to the phase of concept choice, in the example of common IRP project Karlsruhe-Niš. All these facts are leading to general appreciation that culture influences are more powerful in distributed teams, then in other teams (which didn't distribute).

The success of project realization is a result of good team member selection, good project performing and project coordination. Students demonstrated strong motivation and achievement orientation. Their presence on the lectures was over 95 , so in some critical phases of the project they demonstrated the behaviour that vastly exceeded demands of classical education model. Although the involvement in this project is based on a hard work, the knowledge and experience gained in this way can be directly applied in a practical work. That makes great benefit for future development engineers once they graduate.

Results of students' development project are two products that could be instantly implemented in the manufacturing program of the company that has sponsored the project. The quality of the project and the effectiveness of the students' project and new model for evaluation of development engineer's competences are proven in the best possible way.

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