Startup of a student organization for educational purposes

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ABSTRACT

The mechanical engineering program at Chalmers University of Technology in Sweden has a long history in offering project courses where gained knowledge can be tested in an applied environment. These courses are sometimes characterized by a high level of dynamic where the content is changed depending on the students' progress. The teacher might therefore also have to take on the role as a project leader which creates a substantial work load. This might lead to a reduction in effort from the teacher and in worst case the course might be ended when no one wants to take the role as the next teacher due to the high work load. It is therefore desirable to let students take a more active role in the project course and allowing the teacher to focus more on teaching. This paper describes such a process where a team of students were formed around a former project course in order to create an environment where the students take an active role in pushing the project forward, thus reducing the effort necessary by the teacher while still maintaining educational quality.

This article describes the process that occurred during 3 years to utilize the tradition of students forming a team that would gather around a common project in order to create a "self-learning"-environment. The article discuss how the team was started, how it evolved during three years until it became a team of students that actively took part in the next part of the educational process where the supervisor end up in a role where only small directives had to be given to the team. The article also describes how the project course work as a source for satellite projects that would work well as for example thesis projects. The article is written from both the view of a supervisor and the view of a student who has been part of the project course since the beginning in 2012.

The main conclusions in this article are that it is possible to utilize students to create their own long term project courses where the work load for supervisors is reduced. It is also shown that the students can actively take part in the deciding the next phase of the development of the project course. The students can also run the project course as a student club with a relatively high level of autonomy. Long term project courses can also be used as a source for projects that can be utilized in other contexts.

KEYWORDS

Student organization, self-learning, project course, Eco marathon, Formula Student

INTRODUCTION

At Chalmers University of Technology two large automotive project courses (among others) have been run in parallel, Formula Student and Eco Marathon. In 2002 Chalmers participated for the first time in the well-known Formula Student competitions and in 2006 Chalmers participated for the first time in the competition Shell Eco Marathon. Both of these competitions form a perfect base for project courses that fits well in the CDIO syllabus (Bankel, o.a., 2003). Chalmers participation have been successful, both with respect to results in the competition and in terms of increased educational quality. Educational benefits associated with project courses have been proved previously. Even though project courses are advantageous in terms of allowing the students to practice their theoretical skills, they tend to create a heavy work load on the involved teachers, supervisors and possibly also the examiner. As identified by (Malmqvist, Young, Hallström, Kuttenkeuler, & Svensson, 2004), the design of project courses is a challenge due to the different nature compared to traditional teaching. The large amount of work could in some cases be the result of lack of planning or a bad organization of the course but sometimes it is the nature of the project course, such as in the case of Formula Student and Eco Marathon. For example (Schramm & Mikkelsen, 2012) at DTU in Denmark identified that the organization for their Eco Marathon course was crucial for the outcome of the students' learning progress but also the demand for a strict organization. Even though Chalmers University of Technology is a fairly large university by Swedish measurements, there have been a struggle to find suitable teachers willing to put down the amount of work needed to operate such comprehensive courses as Formula Student and Eco Marathon. In 2011 the project course around Eco Marathon was lacking a teacher and the course was about to be terminated and focus were instead put on Formula Student. However, an idea was formed that it might be possible to run the Eco Marathon courses as a volunteer organization of students that would not gain credits but would still be able to compete with the vehicle and gain valuable knowledge along the way as well as adding valuable experiences to their CV. Since the students do not earn any credits they are also not graded. They are however given a written recommendation letter depending on their performance in the team at the time they quit. The students should be allowed to participate in the team for as long as they want but in order to make sure that too many students doesn't quit the team at the same time they were recruited from different years with an even distribution. It was regarded crucial that there would always be enough students left in the team that could teach newly recruited team members.

Chalmers University of Technology has a proud history of students taking an active part in the student life by organizing and running various clubs. The student clubs deal with various subjects, ranging from building robots and flying hot air balloons to creating parties for other students. Such student clubs have an important role in uniting students and create bonds that will last even after the students have graduated. The clubs also play an important role in the personal development of the student as well as in building up the students' social network. Most of these student clubs are created on the initiative from students and the educational divisions of the university has little or no influence on how they are operated. The inbuilt power of students gathering in such a club could however be utilized in order to create a "self-learning"-environment.

In 2012 the idea of running the Eco Marathon as a project course by a student club was realized. 9 students formed with support from the educational division, the initial base of what would during the next three years develop to a fully functional organization where the students were taking active part in the development of the course. This article describes the process from start and three years ahead as well as issues and considerations related to group dynamics. Today the team consists of 12 students working towards the goal to achieve a top five position in the largest European competition held by Shell each year by developing

a fuel efficient gasoline powered vehicle (Figure 1). The team meets on a weekly basis and works with various projects identified during the year. All expenses related to the competition is paid by the university. The team is today supervised by one faculty member and one former member. The team shows a high degree of autonomy and drives the development of the project course mostly on them own. The team continuously identifies areas they need to work with in order to be more competitive. Some of these areas turns into projects that becomes thesis works or project courses for additional students whereas the others are developed by the team itself. Since the students are showing a high degree of autonomy, the teacher has been able to take a step back and still have a group of students gaining skills comparable to those of a normal project course.

Figure 1. The vehicle during a competition.

THE THREE YEAR PROCESS

In the beginning three supervisors were involved in the project. These supervisors had a clear idea of how the team should be organized and a clear strategy on how to get there. The strategy consisted of three phases; 1. Providing the team with a target and leading by pioneering, 2. Allowing the team to fail while achieving the target themselves to raise awareness and 3. Increase the level of autonomy. All three phases took part during one year each with the goal to achieve a team that would act with a high level of independence towards the goals set by the supervisors. These three phases fits well in a normal group development process such as the Firo model (Schutz). The reader is assumed to be familiar with such models on group dynamic developments and it will therefore not be described further.

Year 1

The team was initiated in 2012 with three former members that took the responsibility of being supervisors. In the initial phase 9 students from the first three years of the mechanical engineering program were recruited. The reason for choosing nine people was because it was a suitable amount of students for this type of project but also because that was the amount of seats in a normal-sized European minivan. The cost of transporting the team back and forth to competition sites should not be underestimated and should be considered in the startup phase. It is also worth to consider the size of the group due to group dynamical matters. A too small group might experience a to high work load whereas a too large group might deteriorate into smaller sub groups. This is a consideration that cannot be underestimated.

In this phase the group is characterized by the fact that the members are unsecure and haven't found their role within the group. All groups develop in similar ways and the supervisors should be aware of the fact that members of a newly formed group seldom take initiatives. It is more likely that the group members will stay quiet during group discussions and does their best to not "step on each other's toes". This should not be regarded by the supervisors as unwillingness to act but merely a fully natural phase in the development of the group. It is worth to remember that the group members had no previous experience in competing in the Shell Eco Marathon and therefore lacked a clear goal of what was expected. The way the team will develop in the future is likely to be decided during this early phase. The three supervisors therefore decided to act as pioneers in order to show the path for the students. One way of doing this was to participate in the work the students were expected to perform. A concrete example was that the supervisors took part in manufacturing work together with the students in the metal workshop facilities at the university. Leading as a pioneer was regarded as one of the key factors that made the students realize their possibilities in the team. However, just leading as a pioneer will probably give the supervisors a too heavy workload since the team members are not expected to take initiatives in a this early phase. Therefore it is also important that the supervisors set up goals that should be fulfilled and are prepared to point out what has to be done. To some extent this can be described as "pointing with the whole hand". It is also crucial that no team members slip away so that the workload will be biased with some students doing more work than others. This will undoubtedly create unwanted frictions within the team. The supervisors also have to be present when the group gathers and should be enable to analyze the group members state of mind in order to adapt the leadership.

The first competition the team attended was the Shell Eco Marathon held in Rotterdam in May 2013. The supervisors had a vast experience in these competitions since before. The team was told what to think of and what not to do in order to make the competition run as smooth as possible. The supervisors had taken an active decision not to let the team fail during this very first critical competition and the students were therefore not allowed to learn by their mistakes. From an educational point of view, this might seem irrational but this was an active decision and the explanation will be revealed later in this article.
The competition was a success and the team achieved a result of 1011.5 km on one liter of gasoline. The vehicle didn't suffer a single break down and worked flaw less in the whole competition. Later that summer the team participated in a similar but smaller competition held in Finland, again with a successful result of 1178 km/l. The latter result was close to the Swedish record of 1243 km/l and the team was now eager to increase the result even further and break the record.

This is a critical phase where the supervisors have to be prepared on putting down slightly more effort than in the following phases. The supervisors provided the team with a target by showing them the process from ideas to realization and how various tasks were carried out in reality. It is always possible to allow the team to find out ways on their own but in this case the supervisors already had a clear goal of what the team should act like during competitions and during the various processes such as development, testing etc. taking place in between the competitions.

Year 2

In the first year, tasks such as setting up goals, hold meetings etc. were undertaken by the supervisors. In the second year, the goal was to take one step further towards becoming a self-going team. The team members were therefore for the first time organized in roles where the most important ones were the team leaders. In the first year, two members had

distinguished themselves as possible candidates for the team leader role. These two were now asked to step up as ordinary and secondary team leaders and arrange the remaining roles of the team. This enabled the supervisors to step back and let the team run the show on their own. During the first year, the team members had got to know each other and also started to find roles. The newly appointed team leaders could therefore rather easy give the team members their new roles in the team. By organizing the team in roles, career paths are created. New team members see that there is a possibility to advance in the team and take on new tasks. This is in turn a motivational factor and gives the supervisors a possibility to test students in roles such as for example manager, PR-manager, technician etc. In other words, the team had now become a platform were students could develop soft skills and not just engineering skills. During this year, three team members quit the team and were replaced with three new students. The three new team members soon found their roles in the team and adapted to how the team worked.

Whereas year 1 was devoted to give the team a clear picture of how they should work, year 2 was devoted to let the team members settle in their roles on their own. This is a requisite in order to allow the team to become independent. The team must be allowed to fail and learn by their mistakes. A task with a high risk of failure was therefore given to the team in order to allow them to learn by their own mistake. The team would develop a new engine for the competition in May 2014. The supervisors aided by giving advice in questions regarding the technology but also by setting up deadlines and a time planning. However, these deadlines were always communicated via the newly appointed team leader. Early during the development work the supervisors noticed that the deadlines would not be met. This was pointed out several times but the supervisors never stepped in to take the role of the team leader. After all, the team had an appointed team leader and changing that would only disrupt the group dynamical change that was now about to happen. As expected the team failed in keeping the deadline which resulted in that the team attended that years' competition without sufficient testing of the new engine. The team failed to achieve a result in the competition due to several vehicle breakdowns during the races. This was of course regarded as a setback by the team members. However, with the success of last year the team decided to start afresh for the next competition in a couple of months from then on. In the next competition the team had learned its' lesson and made a significant improvement. By now the supervisors could start to step back slowly as the team became more and more independent. The supervisors work in this phase was from now on mostly concentrated on planting ideas and tempting the students to engage in processes that would gain the team and lead to ideas for new projects.

Even due to the failure to achieve a result in the competition, several side projects were initiated with successful result. These side projects engaged more than 30 students who were not part of the team. The team itself had also taken steps forward in their process of becoming engineers with practical knowledge on how to apply their engineering skills. Among the ideas that were realized this year were an engine control unit, a vehicle simulator and an optical combustion engine. All projects were finalized and in some cases the students were also offered to continue the development work in order to allow them to gain even more knowledge about their particular system. The vehicle simulator and the optical engine were presented as student projects during the CDIO conference in Barcelona year 2014.

Year 3

This article was written half way in on the third year. By now the team had become the self-going independent team they were supposed to be. The team got three new members that quickly adapted to the unwritten rules and behavior of the team. The fact that the three new

students quickly adapted to the team spirit indicated that the group was stable and had developed to a well working group. A decision was made to allow three new members for this year. Even these new members adapted quickly to the group and the amount of team members were now 12. The team also decided to develop and manufacture a completely new vehicle to this year's competition. This is an ongoing process but by the time this article was written all deadlines had been held and the manufacturing process was just about to be finalized. The new vehicle was developed with the experiences from previous year's competition in mind. This resulted in a significantly improved vehicle with students working with a complete range of engineering tools such as CFD, FEM and CAD. They have also gained experience in modern manufacturing techniques such as 3d-printing and carbon-fiber materials. In figure 2 a 3D-rendering of the new vehicle is shown. Figure 3 is a picture of the vehicle exhibited during a manufacturing fair together with one of the students discussing the vehicle with a visitor.

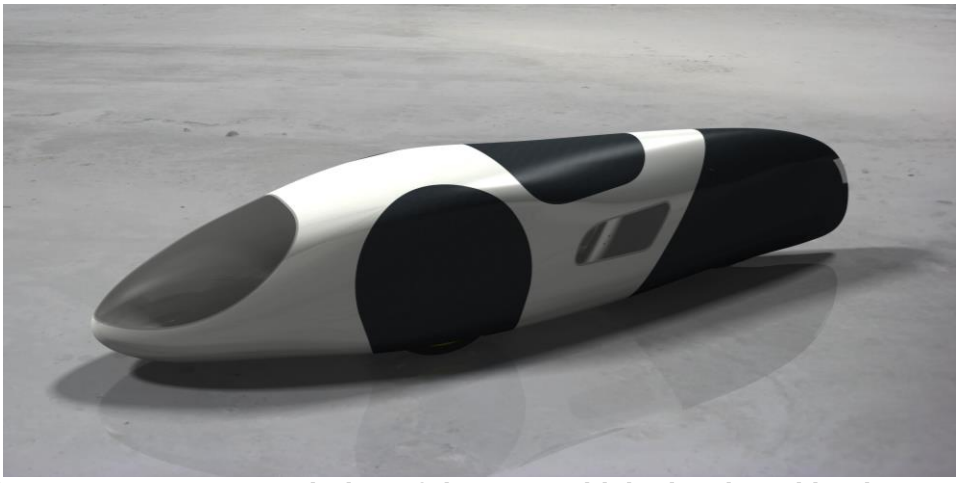

Figure 2. Computer rendering of the new vehicle developed by the team.

Figure 3. The new vehicle on display during a manufacturing fair.

Creating an Alumni team

The new vehicle replaced the old one in the competitions. However, the old vehicle was utilized in a new team consisting of former team members. The idea was that when members left the team (which could be due to a finalized education for example) they would not be cut of completely from the team. Instead they would be given the opportunity to join the alumni team consisting of only former members of the team. This team would then be able to participate in other Eco Marathon competitions. The alumni team offered a good solution for team members who were not able to be part of the team anymore put still wanted to keep their connection. The team would also gain from keeping contact with the former members in terms of knowledge transfer and networking. The Alumni team is also a vital extension of the career paths which are created within the team.

GROUP DYNAMIC CONSIDERATIONS

Building a community

The students are supposed to form a team with an identity. In order to do this a couple of actions were taken. The *first action* was to decide on a name and logotype for the team. This is important when the team members are communicating what they are doing to people outside the team. The difference between students being able to say: “I’m a member of Chalmers Vera Team” instead of “I’m part of a group of people working with a vehicle” is tremendous. The *second action* was to order team clothes. In this case jackets and shirts with the logotype were ordered. The *third action* was to promote group activities outside of the regular team work. Driving go-carts are an excellent team activity which the team performed several times. The important part is to have fun. All of these actions might seem insignificant in itself but combined they play a large role on the path to create a team. In the end the members should be able to identify themselves as members of the team. It should be considered a success when the students are starting to wear their team clothes at occasions outside the regular team work. It is also highly important that the supervisors take an active part in the group development by interacting with the students. In this way the supervisors will be able to gain a feeling for the current state of the group. The supervisors took an active decision to remove any kind of psychological distance that might occur between supervisors and students by creating a “flat organization”. By doing this it was also possible for the students to find the motivational factors for each student. It is highly unlikely that all students have the same motivational factors. Finding the individual motivational factors also made it possible to push the individuals in the team forward by tailor-made motivations.

Remove the magic mist surrounding the technology

When the team was initiated, the group members formed a team around an already existing vehicle. The vehicle was developed and manufactured by students a couple of years before and the new students were obviously facing a vehicle that seemed highly technologically advanced. Techniques or highly advanced technological products might induce a threshold for students that wants to learn but doesn’t dare. This could be due to several reasons such as a lack of self-esteem, a fear of breaking something or simply just a mindset that they are lacking the skills to do the job. This is an issue all educational organization encounter. It doesn’t matter how much theory the students learn. If they are not given the tools to utilize their theoretical knowledge it won’t be utilized and is therefore useless. For universities which by nature teach front line technology and knowledge, this could develop to a severe issue if not dealt with correct. From the supervisors’ point of view, this was a known obstacle. One of the first exercises held with the team was therefore to completely disassemble the vehicle and put it back together into working condition again. This exercise was performed twice in order to assure that all team members gained an understanding of the vehicle’s design and

giving them the self confidence in that they are able to disassemble and assemble things to a working condition. Within the team an expression was founded “Remove the magic mist surrounding the technology”. This expression has been used several times during meetings when a student for some reason has hesitated to undertake a task. What the expression is referring to is that technology can sometimes be considered magical since the student doesn’t understand it and therefore doesn’t dare to undertake a task related to that specific technology. It is therefore of vital importance that the students dare to challenge the technology in order to push the development forward. If they don’t dare to challenge the technology the magic mist can’t be considered removed and they will not learn. As long as the “magic” is present, individuals will hesitate when challenged with an educational task or problem.

Growing an open minded culture

Since the start of the team the supervisors had to make sure that the environment of the team should be open minded. This has to be done on many levels, from the lowest level where another team member should never be allowed to bash down another members idea to the level where the students feel that they can talk to the supervisors whenever they want without hesitating. It is also of vital importance that the students have a happy time within the team. A moody student will most likely not come up with new ideas and will most likely also leave the team. Growing this open minded culture starts with having supervisors with high amount of social skills. The supervisors must be able to joke and socialize with the team in order not to become a bystander.

Seize the ideas of the students

When the competitions have come to an end, the team celebrates by dining on a restaurant. This is a perfect environment where many ideas are born during the conversations. One of the benefits of the open minded culture discussed previously is that the students come up with ideas related to the improvement of the vehicle. These ideas can be seized and utilized as project works of various kinds. Until today ideas from the team has become 7 bachelor thesis works and countless of smaller project works. One of many advantages of such ideas is that they can be put in a context. The group that will work with the ideas as projects knows that their work is useful for the team which is a good motivational factor. The university will also have a powerful source of ideas for project works. In the first year the team came up with ideas for a new engine, a vehicle simulator (Figure 4) and an optical engine for development purposes. The latter two became bachelor thesis works for a total of 12 students. The supervisors work in this phase is to stimulate the students’ idea generation process by backing up with knowledge and resources.

Figure 4. A vehicle simulator developed as a bachelor thesis originating from the team.

THOUGHTS FROM A STUDENT IN THE TEAM

To be a part of a student project like Chalmers Vera Team inspires and motivates students to become better engineers.

The work undertaken by the team include many elements that can be related to the content available in mechanical engineering courses, ranging from thermodynamics, mechanics, industrial economy to materials and manufacturing technology.

The project comprises almost all steps in the product development chain, which means that students become skilled at searching and absorb new information and knowledge in many different areas of engineering. Even to design, calculate and assess whether a design is good enough.

Many tests and test runs are carried out in the project to ensure that the final product is working properly and that it meets the demands placed on it. Sometimes, either due to poor design, insufficient manufacturing quality or wrong use, parts of the construction fails. The work involving the evaluation and correction of these problems are equally important to practice the other elements of product development. To determine how and why design flaws arise and to see what actually happens when they do, provides increased understanding of why the engineering work is so important. It also makes it easier for students to understand and relate to the theory taught in the courses. Students will also become more skilled at sharing knowledge by explaining to each other, problems from their individual area of expertise.

Chalmers Vera Team consists of students who are mixed from bachelor degree up to master degree and mainly they are studying mechanical engineering and automation engineering. Since the team is a diverse group with different personalities and background knowledge it can sometimes cause conflicts and stressful situations. Then it is very important to have a good unity and good cooperation within the group. This is achieved by working with group dynamics and conflict management which is a great advantage to have in all group projects.

When the team sometimes have to recruit new team members the students arrange a recruitment opportunity which includes some preparatory such as marketing. There after the team is holding interviews before selecting the new team members. To be a student and to have the ability to be involved in marketing and recruiting provide very good experience for future jobs. Students tie many contacts with other students and companies. By contacting and visiting various companies including tying contact and asking for help and sponsorship, students are practicing to be engineers and they get many insights into what their prospective future could include.

Behind the final product which is a racing car, there are many hours of hard work done by the students that form the foundation which ultimately proves to be worth it. From the project the student gets a lot of valuable experiences which will help developing and becoming a very good engineer.

DISCUSSION

This article has described the process of the formation of a student club forming around a project as a new way educating students. Project courses are often associated with a heavy work load for the involved teachers and supervisors. The idea of running a project in the way described in this article is to reduce the work load of the teachers by encouraging a self-going environment in the group. During the three years this project has been active, more than 50 students have been associated with the project either directly in the team or indirectly through associated projects. By the time this article was written, the team was showing a self-going attitude and worked independently towards the goal associated with the project. The team has also initiated several side projects that has been utilized as project works for students not directly involved in the team.
The team has been working with a project associated with the Eco Marathon competitions held annually but several other projects would be suitable, such as for example Solar Challenge or maybe Formula Student. If there is a continuity in the projects they should be suitable for the organizational form described in this article.

The drawback of running a project as described in this article is the decreased throughput of students as compared to running the project as an annual course. This methodology is therefore not recommended to replace a project course but as a rather easy way to expand the amount of projects with a minimum of effort from the teaching organization. The authors hope that this article can inspire teachers at other universities to start up new project works.

The team can be followed on Facebook on the page “Chalmers Vera Team” or on www.chalmersverateam.se.

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BIOGRAPHICAL INFORMATION

Anders N. Johansson, is a PhD student at the department of Applied Mechanics at Chalmers University of Technology in Sweden. Anders primary work is to perform research within combustion engines and particulate emissions. Anders has been teaching in several courses related to automotive engineering. By the time this article was written, Anders was one of two supervisors for the team.

Anna Engelbrektsson, is a MSc-student in mechanical engineering at Chalmers University of Technology. She started her education in 2013 and has been a member of the team described in the article since the start in 2012.

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