

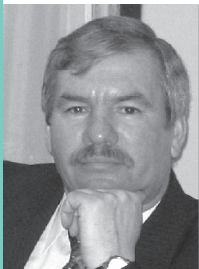
Experience in Implementing Interdisciplinary Project at TGU in Terms of “Formula-Student” Team Work

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Implementation of an interdisciplinary project at university may only be possible when a student team for a task to be completed is organized and there are appropriate facilities and software. The main condition for sustained student design activity is the presence of regulations which enable to handle a permanent inflow of new participants without replacing the key ones. Besides, the instructional material and modules incorporated into the current education programs guarantee the highest quality graduate training within various subject areas. Such interdisciplinary project is being implemented in terms of “Formula-Student” at Togliatti State University.

Key words: educational programme, the project «Formula-Student», team, training module, learning results.



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One of the main objectives in implementing the Development program of Togliatti State University (TSU) is to develop an effective and competitive education system in accordance with the state education development policy, specifically a concept of science and education integration. To accomplish this, particular emphasis is placed on developing active learning techniques, as well as enhancing international cooperation in terms of launching new education programs and recognition of qualifications. Most universities are striving to provide continuous improvement of the quality of education adjusting the current curricula to future engineering activity, as well as technical, technological, economic and social development prospects of the society [1]. It is new content of engineering education program, as well as active learning techniques and prac-

tice-oriented training that guarantee the achievement of new learning outcomes which correspond to a set of engineer's competencies.

Project-based learning and student teamwork when they have the opportunity to work in team on a design project are of great importance in innovative engineering education. The conditions that support project-based learning should correspond to real-world engineering so that students will have the opportunity to gain experience in solving complex engineering problems, distributing functions and responsibilities. At TSU, such learning technique is being implemented in terms of “Formula-Student” project.

Interdisciplinary project “Formula-Student” is an international competition for engineering students which combines the elements of education, engineering and sport as it contains not only

competition itself but also the elements of technological creativity, economic calculations, managerial decisions and presentations, marketing and business. The project was launched by the Society of Automotive Engineers (SAE). According to the regulations, a student team is allowed to be involved in the project for a year. Next year the team is partially renewed with young students and a new task is set. Except for "Formula-Student" project, there are also similar projects as "Buggy" and "Formula Hybrid". "Buggy" project is aimed at designing, planning and manufacturing a buggy. "Formula Hybrid" is a relatively new and fast growing project and its aim is to build a hybrid race car based on the standard cars manufactured within "Formula-Student" project. Usually, students take the race car which was manufactured last year.

The key concept of the project is as follows: during an academic year, students must organize a team themselves, share their responsibilities, find sponsors and draw up a business plan, design and, finally, fabricate a racing car which is presented to a panel of leading engineers and PR-managers. One of the obligatory phases of the project is to judge the cars in a series of static and dynamic tests which demonstrate car characteristics and participate in the most spectacular event – the final racing competition.

The main peculiarity of the project is that students should design and produce innovative and high-tech car race products to a strict set of rules, technical and cost restrictions. Despite being supervised by a skillful "master", students must design and manufacture a race car by themselves. In work process, from the very beginning up to the final stage, i.e. car production, each participant gains valuable experience in teamwork and various aspects of automotive engineering, which in its turn promotes careers and excellence.

The objectives of the interdisciplinary project:

1. To design a race car according to the rules of «Formula-Student» SAE project.

2. To provide additional financial support through different grants, sponsorship, new manufacturing process, and etc.

3. To fabricate a competitive race car.

4. To participate in the international competition «Formula- Student».

5. To develop and implement practice-oriented training model based on «Formula- Student» project.

«FORMULA-STUDENT» PROJECT TEAM.

At the first stage of the project students must organize a team themselves. As the project consists of a number of stages, starting from the design of a race car and ending with car testing at the racing competition, including budgeting, marketing and PR issues, the team must be made up of students with different education background and from different subject areas. As in any team, a team leader is selected.

Team structure (Fig.1) is defined in relation to project tasks. These tasks can vary from project to project but in most cases they remain the same. The number of students and post-graduates who participate in the project can vary every year. However, the team is never completely dissolved even at the end of a definite stage of the project. The number of TSU team members usually ranges from 15 to 35. For example, in 2012, when it was the fourth year of project implementation, TSU team was made up of students from the following departments:

- Institute of Mechanical Engineering – 8 students: 2 students - 230303 "Operation of Technological Machines and Complexes"; 4 students - 230202 «Ground Technological Complexes»; 2 students - 150301 "Mechanical Engineering".
- Institute of Electronics and Electrical Engineering – 4 students; 2 students - 110304 "Electronics and Nano-electronics" and 2 students - 130303 "Power Engineering".

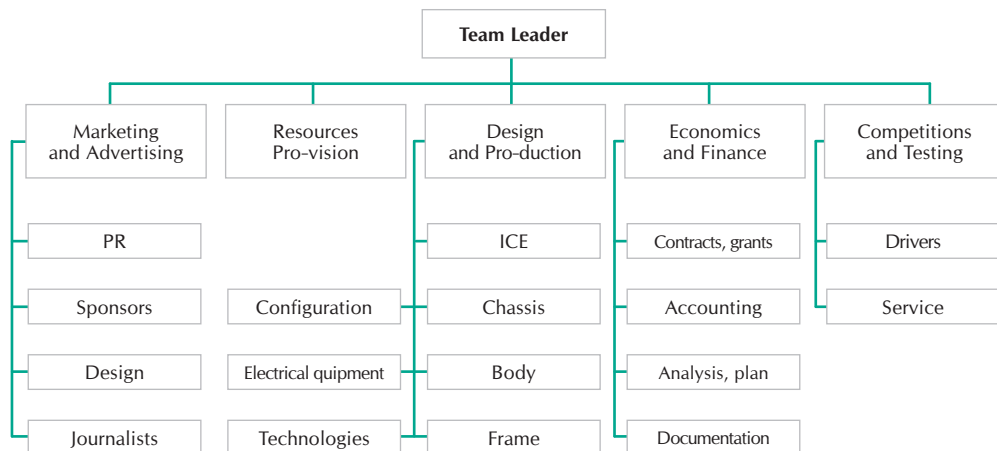
Besides the above-mentioned departments, TSU team usually includes the students from other subject areas. They are as follows:

- Institute of Architecture and Civil Engineering – 1 student
- Institute of Mathematics and Information Science – 2 students
- Institute of Humanities and Education – 3 students
- Institute of Economics and Finance – 3 students
- 1 Post graduate

Each sub-team is accountable for its definite task set by the team leader in cooperation with the scientific advisor of the project, who is typically a faculty member. All the problems which arise in a definite sub-team during the project implementation are stated in terms of technical tasks and discussed at general meeting of project members in order to find the most appropriate solution. Performance efficiency of each sub-team is evaluated in accordance with the obtained results and these results, in turn, anticipate the final goal achievement. For example, the sub-team "Sponsors", a part of "Marketing and Advertising" division, became involved with approximately 20 companies and organizations to attract financial and technical assistance during 2011- 2012. Among them are the following distinguished sponsors:

- Delcam – granted the license on the use Delcam software;
- Process Flow – also granted the license on the use its software;
- Lada-Credit Bank – provided financial assistance;
- Auto Center "Premiera" – provided free painting of the race car body;
- "Togliatti" Foundation – gave grant funding in the project development;
- JSC AvtoVAZ – made its testing grounds (Sosnovka village) available to team members;
- LLC "MZSA" – provided free transportation of the race car;
- SPEEDFREAK – assisted in website development;
- LLC "AKtis" – presented car batteries;
- Expo-Togliatti – provided free participation in trade fairs;
- LLC "TorgMash" – presented sport facilities for testing the race car;
- Automobile Newspaper «Sem Verst» - provided free informational support;
- Magazine «AvtoSreda» - provided free informational support;
- The innovative-investment fund of the Samara region – gave a grant of 600 000 rubles.
- In 2012, the sub-team "PR" promoted the participation of team

Fig.1. «Formula-Student» Project Team Structure at TSU



members in different regional and national events:

Special flash mob and “Formula-Student” promotion action organized within the framework of the regional extreme sport festival “Panika” by team members and TSU students in May, 2012.

- Participation in public demonstration run “Avtoparad-2012”, Togliatti.
- Participation in TSU event “Vy-pusk-2012” where the race car was demonstrated.
- Participation of «Formula-Student» team members in Russian Youth Forum “Seliger-2012”.

Due to the software granted by DELCAM Company, students of the sub-team “Design and Production” developed a mathematical model of Honda RR engine in order to use it in the newly designed frame of the race car (Fig. 2a). The race car frame chassis design requires not only careful calculations of load bearing capacity of the elements (Fig. 2b), but also determination of the most convenient positioning of the pilot and control elements, as well as thorough understanding of race car safety and ergonomics.

The students from the sub-team “Transmission Line” designed a driven sprocket of the differential gear and calculated its strength applying ANSYS program (Fig.3). Also, they calculated the break system of the race car and determined the minimum diameter of the caliper piston required to lock the wheels.

The sub-team “Race Car Configuration” generated the conceptual design of the race car and defined the positioning of the basic and integral units.

The primary configuration of the race car integral units which was carried out in accordance with weight characteristics and total weight distribution on front and back axles is given in Fig.4.

Besides, the students of this sub-team found the optimal solutions for wheel base problem, diameter of wheel

rims, clearance and general height of the race car.

The students of the sub-team “Competitions and Testing” ran a series of static and dynamic tests in a special testing ground of JSC AvtoVAZ (Sosnovka village) and together with other members of “Formula-Student” project members participated in the analogous Russian (Moscow, Togliatti) and international (Italy) competitions.

Training Process and interdisciplinary project «Formula-Student»

Previously, we fully considered the list of the modules incorporated into TSU education programs for those students who participate in “Formula-Student” project [2] and outlined the procedure for the introduction of these modules into the educational process (Fig.5).

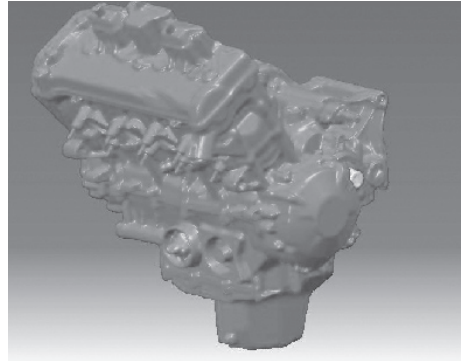
The tasks which students must solve working within a definite project team define the structure and contents of each module. Each module contributes to the achievement of education program outcomes. One of the main advantages of module learning outcomes is that students can apply textbook theories to real work situations and, doing so, acquire corresponding skills and competencies that are closely linked with their future workplace. In work process, students must organize PR actions, draw up a business plan, provide race car structural and conceptual design, defend their project in the English language, publish research results in newspapers and scientific journals, and etc.

The following is the list of disciplines and courses which modules were taught to the students participated in “Formula-Student” project in 2012. If students complete these modules independently, the instructors can grant students credits for this discipline or course paper.

1. English Language.
2. Documentation and Operations Management.
3. Computer Technologies and Networking.

Fig.2. Design of New "Formula-Student" Race Car .

a) Engine Mathematical Model



6) 3D Model of Race Car Frame Chassis

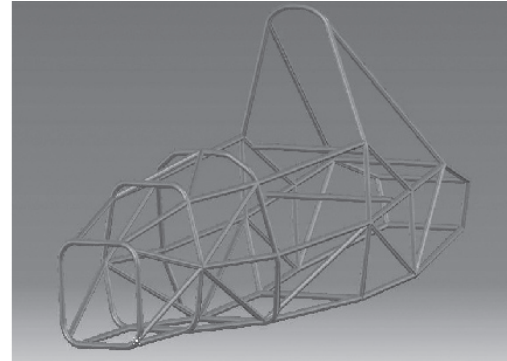


Fig.3. Race Car Sprocket Strength Calculation.

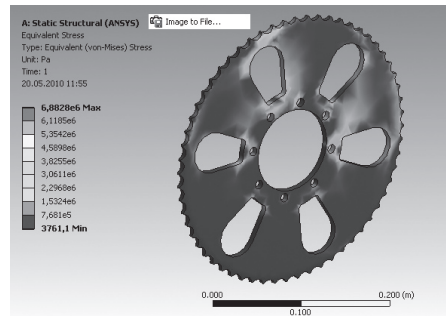
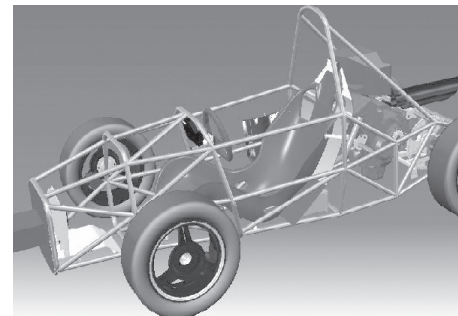


Fig.4 Primary Configuration of "Formula-Student" Race Car.



4. Branch Economics.
5. Control System Design, course project.
6. Engineering Graphics.
7. Theory of Machines and Mechanisms, course project.
8. Machine Elements, course project.
9. Mechanical-Engineering Technology, course project.
10. Motor Car Design, course project.
11. Motor Car design and Calculation.
12. CAD system in Mechanical Engineering.

Final qualification papers are considered to be an important stage in implementing "Formula-Student" project within engineering education framework.

More than 10 qualification papers have been defended since 2010. Here are a few of them:

1) The Conceptual Design of the "Formula-Student" Race Car, student – Aleksander Puchkov.

2) Development and Fabrication of the Race Car Body Parts for "Formula-Student" project, students – Aleksey Kurchev, Ivan Borisov, Pavel Chekushkin.

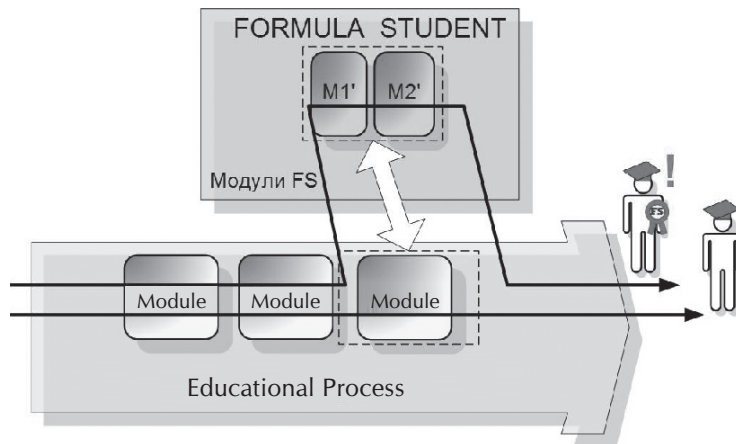
3) Calculation of Tuning Induction System for "Honda CBR600 F4" Engine in «Wawe» software within "Formula-Student" project, student – Ilya Ganyushkin.

4) Engine for the "Formula-Student" Race Car, student – Mikhail Ponizov.

5) Validation of Innovative Education Project Financing within "Formula-Student", student – Svetlana Ivashechkina.

STUDENT RESEARCH WORK

The members of the "Formula-Student" project are constantly involved in research work, participate in various scientific conferences and publish articles in scientific journals. Usually, 2 or 3 students present their research in

Fig. 5. Interdisciplinary “Formula-Student” Project in Educational Process.


annual conference “Students’ Science Days TSU” and submit their findings for publication in the journal “Vektor Nauki TSU”. In 2009, students I. Borisov and P. Chekushkin took the first place at the annual Contest for Students’ Research Works arranged by DECLAM Company [3]. In 2013, “Formula-Student” project team successfully presented their findings at the investment forum “i-Volga” of Volga federal district.

CONCLUSION

The move toward implementing the interdisciplinary «Formula-Student» project in the educational process makes a significant contribution to improving the quality of higher education in general, including not only engineering subject areas but also humanities and economic science. Above all, this project can spur the interest of school leavers, their parents, as well as employers who are proved to be “consumers” of high school graduates.

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