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PNEUMOBILE COMPETITION AND EDUCATION

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Abstract. Those students who study at the University of Miskolc at the Faculty of Mechanical Engineering have a lot of possibilities that improve their experience during the university-years. Usually the companies are entrusted simple tasks to the trainee. Pneumobile competition was initiated by Bosch Rexroth and they have organized it fifth times this year. Those students who participated this competition have to solve complex tasks are needed to know a lot of areas of the technical sciences. Pneumobile competitions are described and introduced by this paper through an example that confirms what kind of practical development it was for those students who attended this program.

Keywords: Pneumatic vehicle, compressed air, competition, education

1. INTRODUCTION

Frequent problem is in our University that some students do not find practical place in the industry where they could use and improve their knowledge and skills. Pneumobile competition was organised fifth times this year, which is particularly a good chance for us. They need a lot of knowledge to the successful preparation. This knowledge is deepening during the vehicle design and build. Especially important it is that they have to document their activities. As the documentation is one of the most important tasks of the mechanical engineer practicing it is indispensable within the education. These competitions are international so many participants come from the Czech Republic, Poland and Rumania. The aim of this paper is to increase the reputation of the Pneumobile competitions. The students can build relationship with each other and learn a lot during the competition.

2. THE PNEUMOBILE COMPETITION

The Pneumobile competition is announced for students who come from the higher education. The task of the students is to design and build a kind of vehicle, which is driven only by compressed gas (air or nitrogen). The announcement of this year competition [1] includes the task detailed.

3. THE PNEUMOBILE COMPETITION FROM THE VIEWPOINT OF THE UNIVERSITY OF MISKOLC

During the design and produce of the vehicle the following knowledge/skills are needed.

3.1. Designing of the elements

3.1.1. Frame – mechanical engineering studies, CAD, FEM
The driver's weight, effects of motor forces and forces that are resulted from the movement are loaded the frame. As the performance of the motor is small the minimal mass should be reached, but in the interest of driving inflexibility is also important.

3.1.2. Suspension – additional researches, CAD
Our students have not got any information about the suspension when they start to design the vehicle, because they do not learn such type of subjects during their studies. They have to look for the suspension in the required literature and on this basis they have to design it. They have to take into consideration what kind of elements they can buy in the shop after all to produce the wheels and brakes are beyond quote of budget. They have to use the CAD to fit the suspension and the frame together.

3.1.3. Steering – knowledge of the mechanical engineering, CAD
Mechanism of the steering has to ensure the movement of the wheels so the steering-force will not be too high.
To the calculations of steering-force mechanical engineering knowledge needs. CAD software is suggested to use to fit it into the system.

3.1.4. Pneumatic system – mechanical engineering or mechatronic engineering studies
It is basically a mechanical engineering task to define force-effects of the pneumatic system. According to the documentation the students who learn on other special mechanical engineering fields can approximately calculate the forces too. The control is a very important element of the system. Operation of valves is able to be mechanical or electrical. Setting up the system that works with electrical valves is easily, but electronic control is needed.

3.1.5. Electronic system – mechatronic engineering or electrical engineering studies
Electronic control can be used for controlling the valves. The mechatronic engineering students learn PLC programming at our University; the electrical engineers are able to build controls with microcontrollers when they are in their second-year. Colleagues of the Bosch Rexroth gladly help using the PLC.

3.1.6. Powertrain system – mechanical engineering studies
Characteristically powertrain system combines the special elements of the bicycle and unique torque converter. Sizing of them is very important from the point of view of safety.

3.2. Racing team

The racing team consists of four persons. The practical benefits of the competition can really succeed if these members are able to develop according to their own territory and the vehicle is suitable for physical implementation. The team has to obtain suitable skills at work. According to our experiences students participating in the challenge it is usually succeed, after the race the need for further development evolves in them.

3.2.1. Responsible team leaders

The responsible team leader's tasks are the coordination, checking the work and handle the occasional conflicts. She/he Examines the design and manufacturing process steps, check the plans and construction. Sometimes self-control is needed to responsible team leader do not force their ideas to students, because the competition is primarily to serve the development of students. She/he also have to provide of distributing the tasks among the students according to their capabilities. The responsible team leader is responsible for the safety work in the workshops of the university.

3.2.2. Other persons

In the Hungarian educational system students are not allowed to use certain machines still not with supervisor because of security reasons. Therefore turning, milling and welding of aluminium in the university workshop leader's job.

If there is a missing skill in the team members they can use outer helper, for example for designing the electrical system or programming. It is also a principle at our university that such helpers can only be students.

3.2.3. Sponsors

Vehicle building needs money and raw materials that the university cannot ensure.

The largest sponsor of the competition is the Bosch Rexroth. Typically the pneumatic system components are the most expensive parts of the vehicle.

It is a good thing that this competition is gladly supported by different companies. According to the education it is particularly useful that those companies give not only financial, but professional help for our students as well. Since student get in contact with many companies the help of these companies is might be more comprehensive than students can access during their university studies.

4. DEVELOPMENT OF A TEAM AND A VEHICLE

4.1. The first race in 2008



Figure 1. First Pneumobile at the Department of Machine- and Product Design

The first race was organized on the yard of the factory in Eger, the ready vehicles were measured in two categories by the competitors. These categories were the fastest lap and the longest distance. There were three teams from the University of Miskolc and one team from the Department of Product- and Machine Design.

The team was consisted of only Bsc. mechanical engineering students who did not have some certain skills at the moment of the entry. They were able to use CAD and VEM software but only at basic level, two of them have a basic knowledge of pneumatics as well. The vehicle was not ready in time for the race and was not working properly in this year. This vehicle was a simple construction, but they were seeking for demanding design.

The vehicle (see *Figure 1*) was made of large (and weak) bicycle wheels, the suspension was stiff and steering was elementary. The motor was a three-cylinder engine, cylinders were driving the planets of a planetary gear by crank tap. The sun gear was the driven element. The pneumatic control is electrical, but only a simple reed sensors connected to relays control the valves (see *Figure 2*).

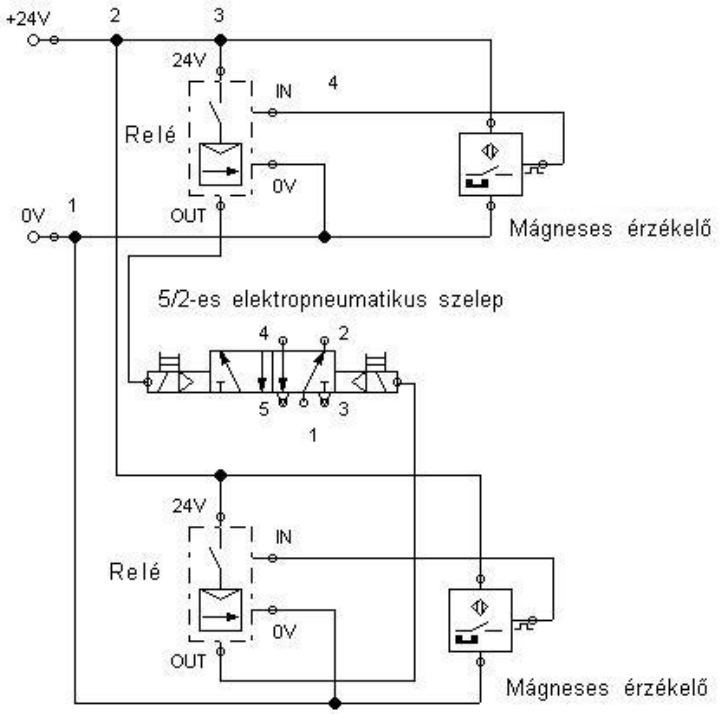


Figure 2. Pneumatic scheme of the first Pneumobile

The lessons and benefits of the competition for students:

- The development of individual components should be carefully done.
- To start work in time, so there is time to handle the problems as well.
- The selection of ready parts is also a serious job.

- The team members learned to work together, to handle different personalities of each other.
- Students began independently to explore the potentials of the pneumatic system.
- They have thoroughly studied bearings in order to reduce the friction.
- They have learned to use basic machine tools, tried to design according to correct production, as they soon faced with the failures of the design during the manufacture of the components.

4.2. 2009 – The second race.

Two team members left, two members remained of them to continue their studies at MSc. level. Two new members were joined. They have already paid attention to the team's work. It was recognized that planning is only in consequence of precise knowledge of the case is worth, so they began to work by searching for sponsors. The engine was retooled on the basis of their experiences and researches, so it seemed to be excellent without any physical changes. They concentrated to modify the suspension. Due to the modifications the vehicle was able to reach higher cornering speeds and was able to safely break from higher speed as well (*Figure 3*). This vehicle each event carried out in the first half of the field and it was second in the event of original construction.



Figure 3. The modified Pneumobile

The lessons and benefits of the competition for students:

- They have improved their communication skills, learned how to present their activities to the sponsors.
- They have become capable of independent work, not waiting for constant confirmation.
- They recognized the need for careful documentation.
- They have obtained new knowledge on the field of pneumatics and bearings.

4.3. 2010 – a brand new vehicle

Two members left the team again, because they have finished their studies. Two new members arrived, one of them was beginner and the other one was experienced, because he was also the racer of the last two years but his team was closed down. I decided as the responsible team leader that they have to build a new vehicle that is much more difficult than the earlier ones because they were to graduate as MSc students. The engine had to be capable of expansion mode; it was unique and was designed with tottering disk (*Figure 4*). Very careful design was essential in case of this vehicle, the usage of CAD, VEM and the computer modelling. The control could not work without electronics, the students prepared control computer is based on microcontroller; so all-new skills were needed. The design and the production of this vehicle was such a higher level job that is neither given to a beginner in the industry. They could apply their previous experiences that they had to share with the new team members. Some pictures probably say more about the development of the vehicle as the text. All of the following figures are made by our students.

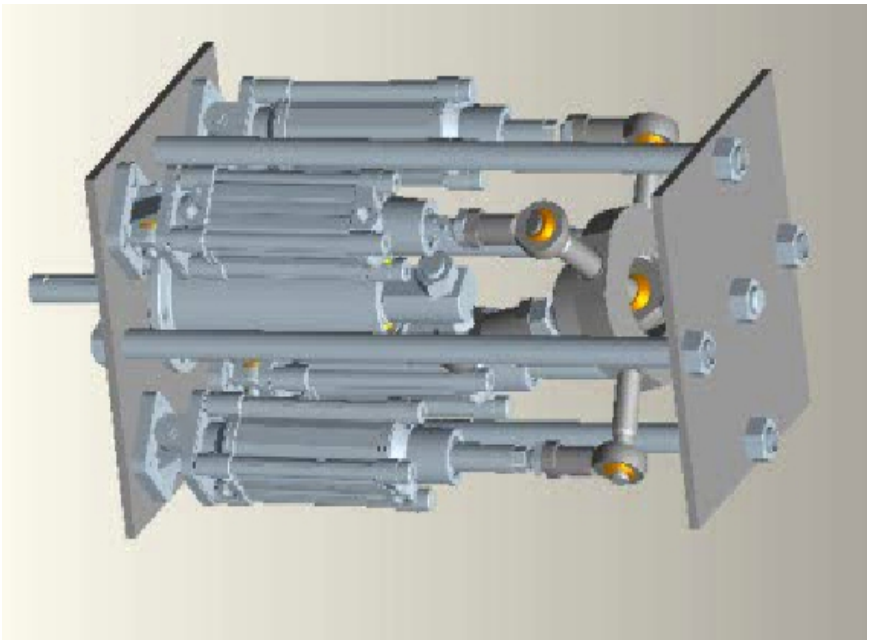


Figure 4. Tottering disk pneumatic motor (2 kW & 10 bar and 95 1/min)

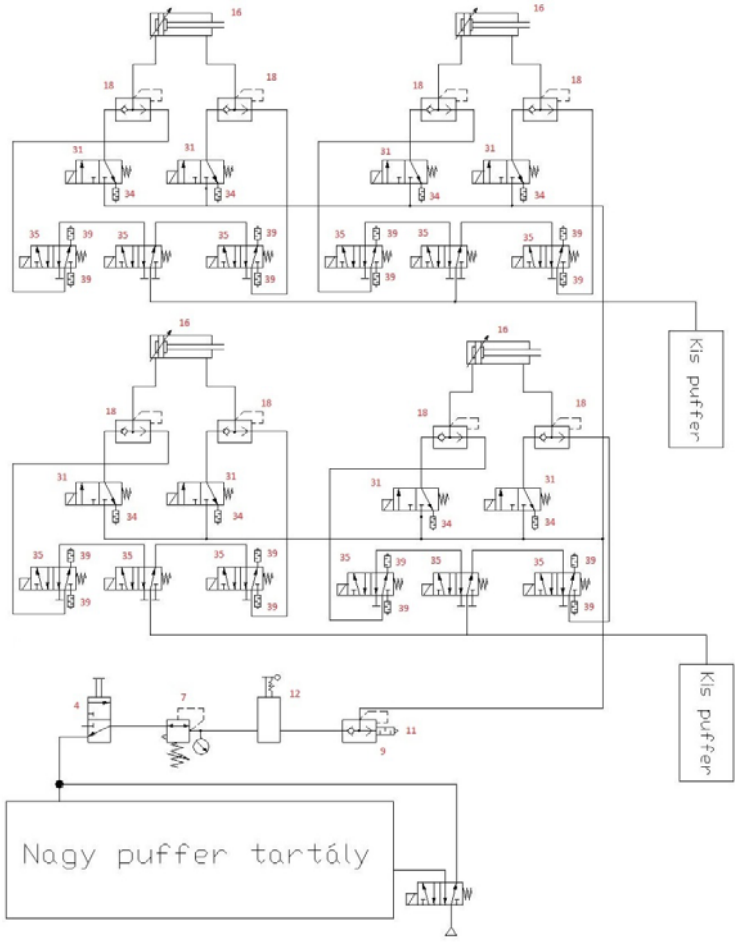


Figure 5. Pneumatic scheme of the motor

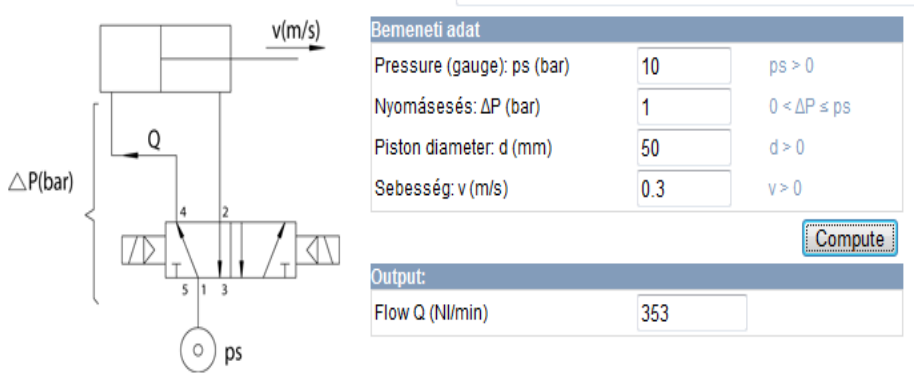


Figure 6. Computer aided calculation of the cylinder speed

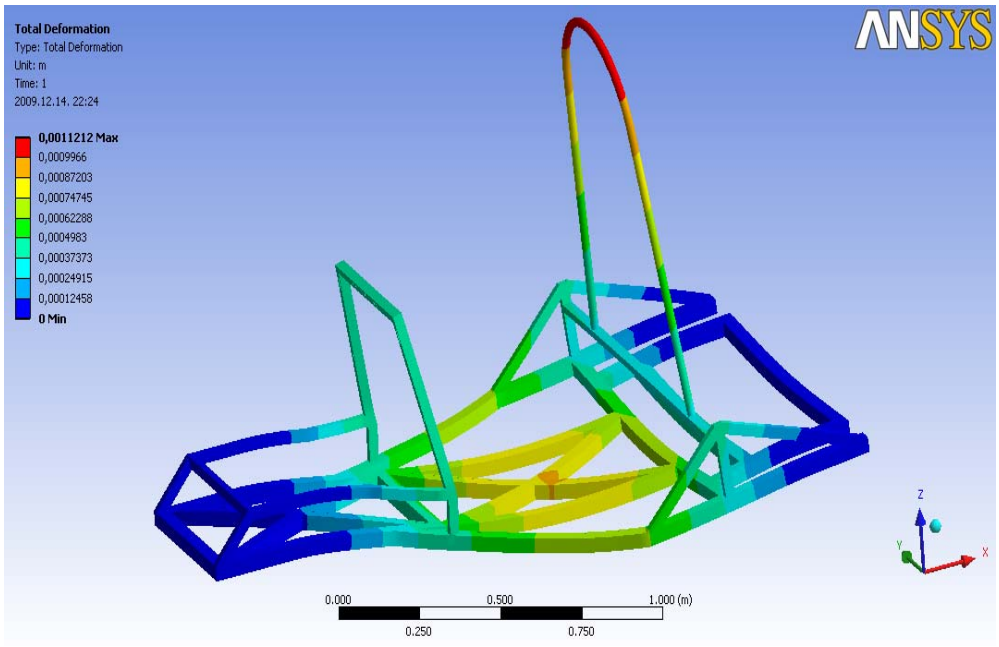


Figure 7. Deformations of the main frame

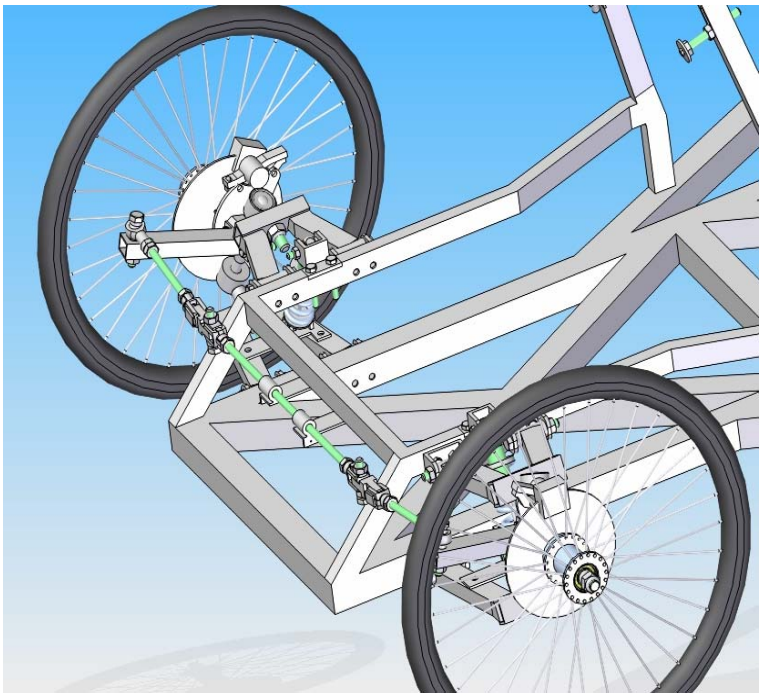


Figure 8. Front suspension and steering system of the vehicle

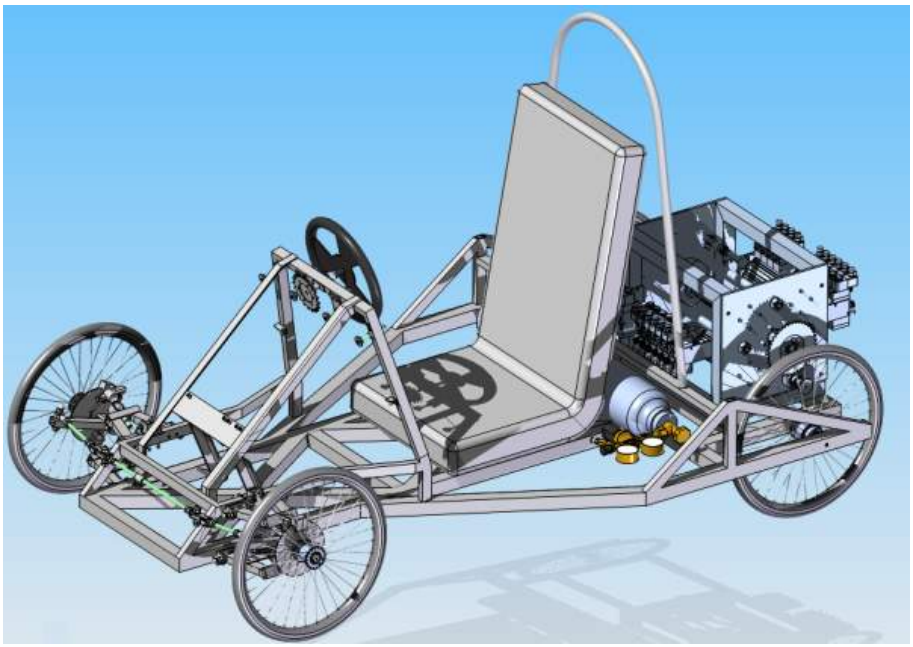


Figure 9. CAD model of the vehicle



Figure 10. The vehicle

The lessons and benefits of competition for students:

- It showed that four of them together are able to plan and carry out a complex automated industrial system.
- They got acquainted with the possibilities and limitations of electro-pneumatic systems.
- All students finished their studies with an excellent qualification.
- All four students immediately found job after graduation.

5. TEAM MEMBERS

Members of the team Keszkosz (2008)

László Attila Kelemen (BSc. mechanical engineering, 3rd year)
Tamás Koncsik (BSc. mechanical engineering, 3rd year)
Gábor Szenczi (BSc. mechanical engineering, 3rd year)
László Szűcs (BSc. mechanical engineering, 3rd year)

Members of the team Keszkosz 2 (2009)

Tamás Faragó (MSc. mechanical engineering, 1st year)
László Attila Kelemen (MSc. mechanical engineering, 1st year)
Gábor Szegedi (BSc. mechanical engineering, 3rd year)
László Szűcs (MSc. mechanical engineering, 1st year)

Members of the team Szélhámosok (2010)

Zsolt Bodnár (MSc. mechanical engineering, 2nd year)
Tamás Faragó (MSc. mechanical engineering, 2nd year)
László Attila Kelemen (MSc. mechanical engineering, 2nd year)
László Szűcs (MSc. mechanical engineering, 2nd year)

Helpers of the team Szélhámosok in 2010 and members of the team Entrópia in 2011

Zsombor Kiss (BSc. electrical engineering, 3rd year)
Péter Magyar (BSc. electrical engineering, 3rd year)

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References

[1] http://en.pneumobil.hu/pneumobile_2012/announcement_for_a_competition