Perhaps there is no industry that would experience such stormy development as cars. Thanks to Henry Ford, it has gradually shifted from manual to automated production. The automotive industry is today the most important industrial sector in many developed countries. Similarly, it is in Slovakia, which has dominated the world ranking for several years in the number of cars produced per 1,000 inhabitants. For this reason it was often named as the "Detroit of Europe".

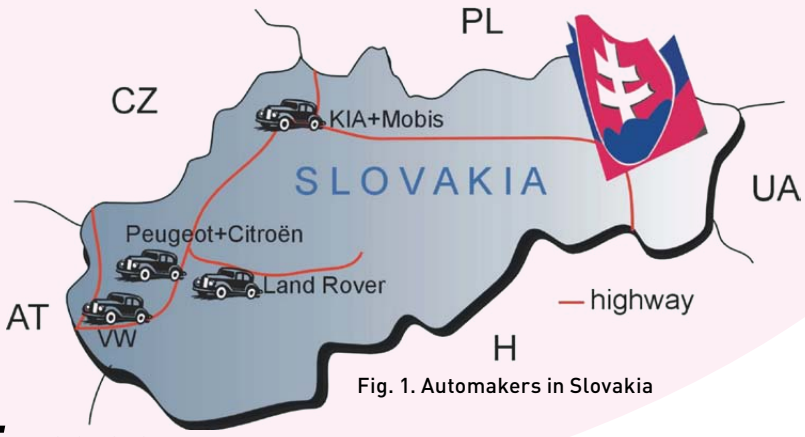


Fig. 1. Automakers in Slovakia

"Detroit" in the Heart of Europe

by Jozef Dominik

Prologue

Slovakia's attractiveness lies primarily in the strategic position in the heart of Europe (Fig. 1) at the crossroads of major transport routes between Krakow - Budapest and Berlin – Moscow, in addition to the relative sufficiency of skilled labor force and last but not least in a solid infrastructure, either road or rail. It is noteworthy that all Slovak carmakers are located in the northwestern part of the country, which is already starting to activate national labor migration.

As can be seen from Fig. 2 approximately 44% of the total industrial production of Slovakia consists of the production of cars. Brands such as VW, Peugeot, Citroën, KIA have been established for a long time here and now Jaguar Land Rover. Overall, more than 10^6 cars are produced in Slovakia a year. There are plenty of reasons to pay adequate attention to this industry generally.

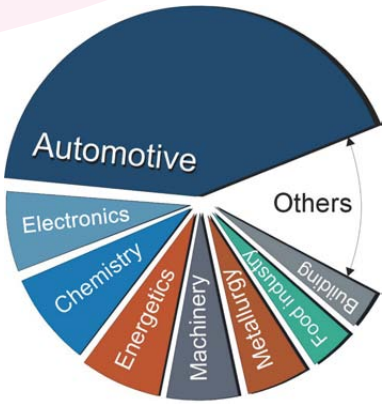


Fig. 2. Slovakian Industrial Production

Automotive Production in Terms of Assembly

The characteristic features of automotive production are:

1. **High series**
2. **High degree of automation of production**
3. **High demand for quality and safety**

Considering that the dominant assembly technology of car manufacturing is welding and screwing and that one car contains as many as 2,000 different screws, nuts and other fasteners, then it is globally a gigantic consumption of fasteners that must meet the conditions of automatic assembly. In the next text, therefore, attention will be paid to the specificities of vehicle assembly in terms of the screw connections used.

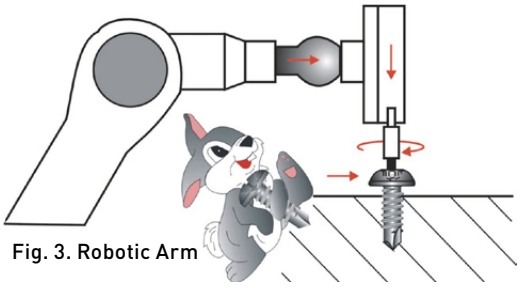
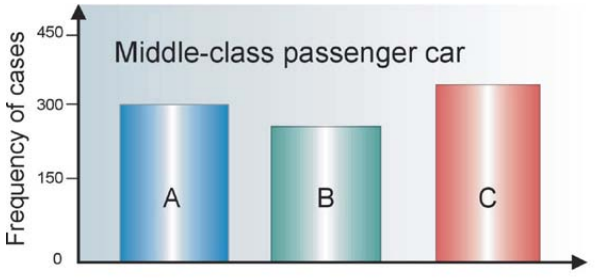


Fig. 3. Robotic Arm

As can be seen from Fig. 3, the mounting robot screws must have at least 3 freedom degrees. It is important to supply components that have to be properly oriented. The necessity of orientation has caused that wherever there is no need for a demountable joint, welding dominates automotive production.

However, there are a number of cases where the screws are indispensable. For example, engine surroundings, gearboxes, chassis, brake systems, wheel attachments and many other construction nodes require detachable joints to service and maintain. According to VDI 2862 "Minimum restrictions for the application of fastening systems and tools in the automotive industry" there are three categories of screw connections in cars (Fig. 4).



A - Safety criterion, risk of accident (danger to body and life)
B - Function criterion, broken car (product does not work)
C - Non-critical criteria (either A or B at worst annoying)

Fig. 4. Automotive Screw Types

The most dangerous category is "A" because it is responsible for car accidents. This includes, for example, fastening wheels. It is the most critical operation, not from the manufacturer's point of view, but from the point of view of the user, because he is sometimes forced to do it himself, amateur in the field, without the use of the appropriate professional tools. Statistics show that wheel fastening bolts are most likely to loosen after 50 to 100 kilometers of ride from repeated assembly. In such cases, it is advisable to visit an authorized service center as soon as possible and have the tightening torque checked. Fig. 5 shows a cautionary example of the amateur mounting of the wheel bolt. The broken thread indicates that the bolt has been tightened with a tightening torque that is too high. The consequences are not hard to guess.

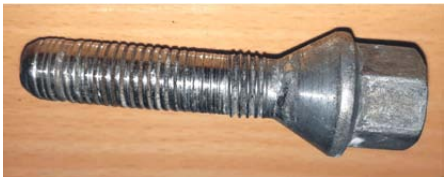


Fig. 5. Autotmotive Bolt

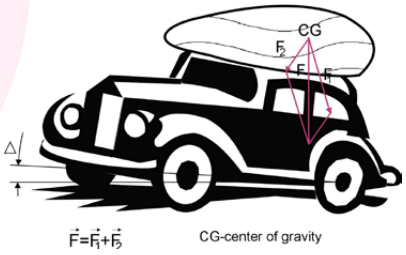


Fig. 6. Excessive Load

Fig. 7. Deformation of Automotive Screws

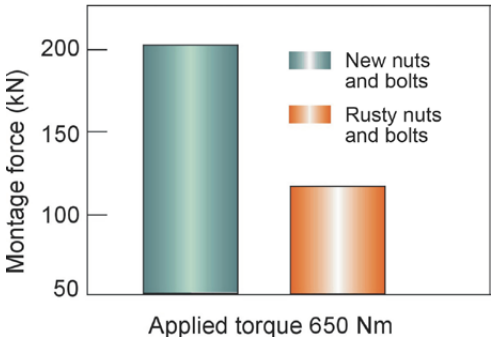


Fig. 8. Impact of Surface Condition of Screws and Nuts

Drivers mostly ignore it, but it is enough to see statistics of motor vehicle crashes as a result of loosened driving wheels. Loosened wheels threaten not only passengers of vehicles but also the unsuspecting surroundings.

Dangers can also be caused by overloading the vehicle. Around 7.5% of trucks checked by VOSA (Vehicle Operators Services Agency) were found to be overloaded. Excessive load of one (**Fig. 6**) or both axles causes deformation of the screws (**Fig. 7**), to dislodge the mounting holes on the discs and gradually to disengage the nuts and, in the extreme case, also the driving wheels. This type of stress is defined as a rotating bending, and it is one of the most complicated and most dangerous combined stresses in elasticity and strength.

The only effective measure is to strictly adhere to the load prescribed by the manufacturer and to ensure uniform loading. Often the weight of the crew, which may exceed the weight of the luggage in passenger cars, is often ignored.

It should be remembered that even for incorrect assembly of wheels after their replacement or overloading the vehicle, the manufacturer is not responsible. Likewise, a garage can not be responsible for what it can not influence. However, driving schools should include at least a montage minimum in their syllabus, focusing in particular on wheel assemblies. The reason is simple - this is the most common operation that a driver must sometimes perform. Such training would, for example, help to learn about the importance of friction when tightening. It does not matter if an oiled or dry, new or rusty screw connection is tightened. Impact of surface condition of screws and nuts is well confirmed in **Fig. 8**.

Therefore, it is important to entrust this work to a specialist workshop that not only controls the theory and practice of wheel assembly, but also has professional tools.

Summary

In the world, the number of cars and the number of crashes are rising. As the statistics suggest, the causes of a crash are not just the non-compliance with traffic regulations, but the state of the vehicle is also important. ■