

# System Safety Award



## Application

**German Space Education Institute  
Moonbuggy Team 2008**

[www.spacepass.de](http://www.spacepass.de)

## **Prolog**

The German moonbuggy was from the outset succumbed of special safety criterias. They were mainly assigned of the transatlantic flight. All 400 individual parts of the moonbuggy have to conform the safety criterias of the airline company and the immigration terms of the United States. Furthermore it had to have a license for the German streets to make proper training. With this reasons it was constructed under strict safety instructions. In some parts we get help from safety experts.

The safety of the buggy had to be locked in following aspects:

- official approval and homologation for road service
- safety criterias of the flight, baggage transfer and tram transfer
- safety of the riders (helmet, gloves, protectors)
- telemetry (real time tracking of the buggy)
- general construction
- used material

### **official approval and homologation for road service:**

To get an official approval and homologation for German road service, the vehicle has to be equipped with following:

- standardised and licensed brake
- a generator which produces energie for the lights
- a robust and solid construction

Because of our four wheel disk brake, the integrated dynamos, lights and our robust frame, the buggy is officially approved to German streets.

### **Safety regulation while the flight:**

A difficult problem by constructing the buggy was, to account for packing all assemblies safe in cases and travel with it to USA. We had to heed about the safety regulations from the airline company and the entry appointment of Atlanta. These rules applied the weight, height, flammability, toxics, compression filling and sharp edges. In addition to this, we had to speak about the import appointments with the chamber for external trade and sent a description of the Moonbuggy assemblies about 200 pages. Because of that, we had not made other descriptions about the construction, because the safety of flight is the basic of transporting the moonbuggies to the race. That are the causes of our moonbuggy is according the highest Safety regulations.

Hiermit erübrigen sich viele weitere Beschreibungen der Konstruktion, da die Sicherheit des Fluges die Grundlage des Transports des Moonbuggies zum Rennen ist. Daraus folgt, dass alle Teile höchsten Sicherheitsanforderungen gerecht werden.

### **Safety of the drivers:**

From the experience of the previous year only one injury was determined. These are scratches at the forearm of the first pilot. After an exact analysis of this damage, a too soft chassis was recognized as a cause. The chassis was changed and air-fitted with springs, oil-absorbed dashpot was used. Now a too deep immersing of the vehicle and thus the reduction of the driver cell are no longer possible by the camber. There is no more danger of injury.

So that the pilots are additionally protected during the race, the clothing are used with inserted hard bowl treads. Also therefore, injuries of any kind at skin and body are now no longer possible. The tread clothes are certified for Mountainbike and Downhill sport.



*Both drivers use as prescribed helmets, gloves and bound trousers*

### **contruction:**

This vehicle was designed on a white sheet. 2007, it won the Rookie Award and the Best Design Award. There was no accident, no large injury and it failed no safety assembly group. The vehicle drove as only Rookie in both races by the finish. The construction is thus safe and must only optimized in this year. The details are in the following described, as well as in 25

## Analysis of the previous race



*Here a construction fault has been made*



*These teams did construction faults*



The most important aspect of the preparation for the construction of our moonbuggy was the analysis of the races in the years 2006 and 2007. Here we have seen in foto and film which parts of the construction count. First of all it is necessary to pay attention on a low balance point and robust wheels. But the physical and mental preparation of the pilots is very important, too.

Out of the experience of our own race we have received, that the spring system has to be reconsidered. Subsequent the most important picture series is shown for that topic.

Three mistakes are shown:

- A driving mistake of the pilot
- A too smooth spring system
- Too small brake discs (in picture 4 the front brake discs glow)

But they show a deciding advantage of the konstrukcion, too:

It is very robust. The vehicle could finish the course with the best time of the rookies.



*1. Touchdown on the obstacle by late breaking and a smooth spring system*



*2. Deformation of damageable parts of the gear by stone-chipping, safety units stay strong*



*3. Dipping of the smooth springs (but the vehicle is still on high drive without destruction!)*



*Glowing of the front brake disc (temperature about 660 Grad is still in range of tolerance)*

**Single Variances** are listed in detail in the application of the most-improved-award (length 20 pages).

To make the construction as save as possible, a **low situated balance point** is essential, that the buggy does not overturning like the one of Team New Mexico. As well the construction has to provide as much guard as possible to the pilots and still is opened enough that they can get free in case of an accident. There were problems in the Team Puerto Rico. A specific feature are the belt. **Roll belts** like them in cars are used. They can be opened and closed very easy.

That the vehicle does not deform by strong stresses, two **pneumatic-hydraulic dashpots** stored by two motion links are attached at the front axle. At the rear axle **2 fiber glass compound springs** are used (S-Ply, Mercedes-Benz).

Very important is the **cross stabilizer**. This component has not be seen at a buggy at the NASA-Moonbuggy-Race. The cross stabilizer effects, that the vehicle stays stable and horizontal to the ground in a turn. It avoids an overturning in extrem banks.

**The wheel camber** is the inclination of all wheels to the inside. This has not be seen at a buggy at the NASA-Moonbuggy-Race, too. It avoids that the wheels are overstrained by side powers and break or be destroyed. Like every bicycle turns into the turn, we use in our buggy a "simulated bank". The inclination of 8 degrees avoids that wheel-overstraining.

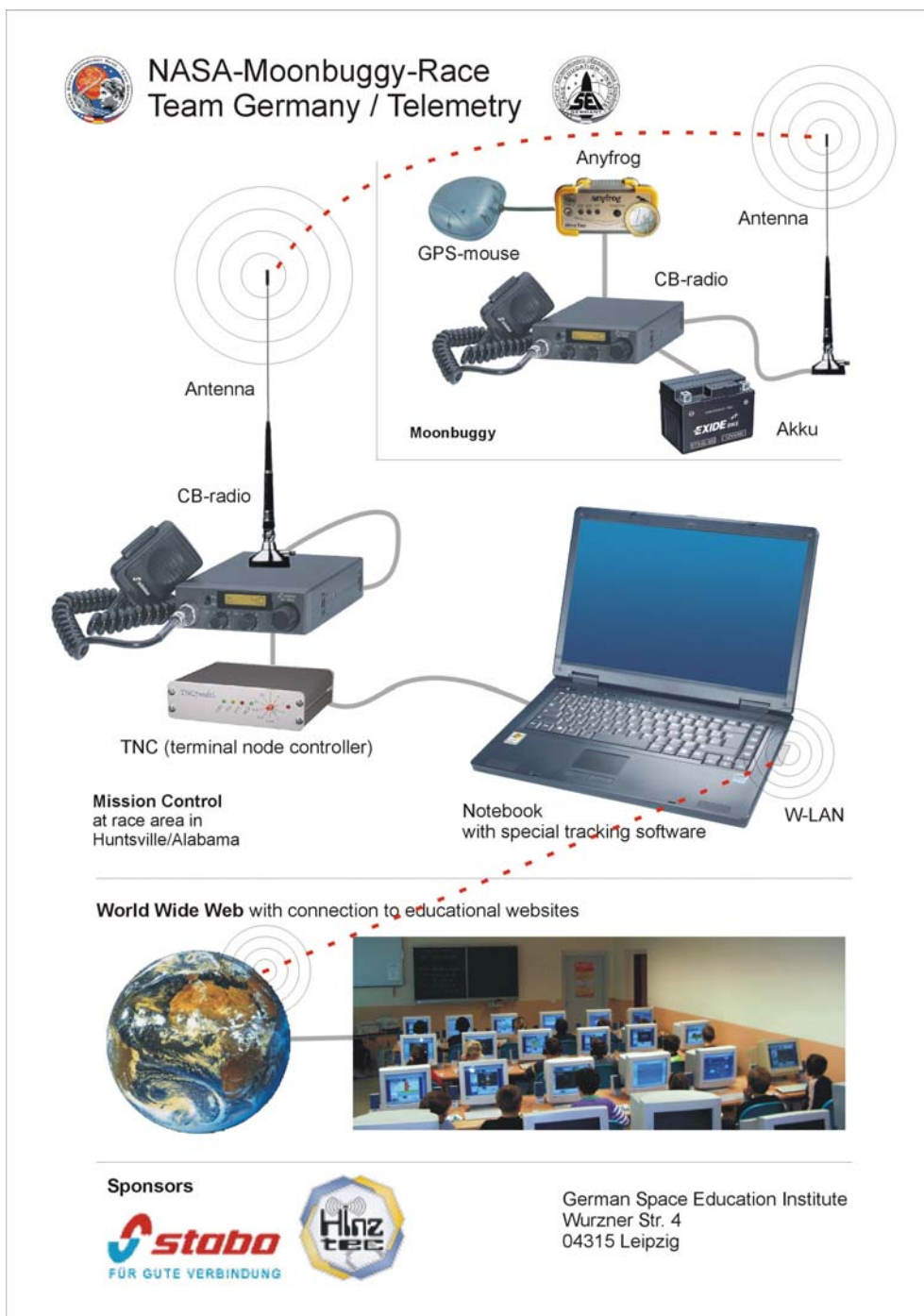
**The wheel axle** is made of stainless steel and has a bore of 20 mm. Because the wheels are suspended on only one side, there are high bending forces on the axle. We doubled the standardised bicycle-axle in the bore to dissipate the appearing forces. Because of the use of high-strength stainless steel it is not possible that one wheel or an axle breaks. The strain of the axle was tested with the fivefold force.

#### **Used materials:**

The Moonbuggy consists completely of high-quality materials, which become more than fair the extreme requirements during the race, as for example s-Ply leaf springs (glass fiber feathers/springs), noble and spring steel and aluminum. Because a break during the race, which could endanger the security of the pilots, can be avoided, only by the use of high-quality materials.

## Telemetry

The automatic sending of current measuring GPS-data via 2-way-radio from the Moonbuggy till a Mission Control Center near the race, extend the potential of safety of the Moonbuggy. The conductor of the Mission Control Center (a student) can observe the position of the Moonbuggy in the real time. It's like a camera would be fixed in an altitude of one mile above the race track. Additionally from transaction data the speed, direction and height of the vehicle are determined. In the case of an accident or a stop, the conductor of the Mission Control Center can inform immediately via voice transmission (Walkie Talkie) its team colleagues. These can immediately appropriate accordant supporting measures in a before specified order. There is thereby no disorder.



Sponsors

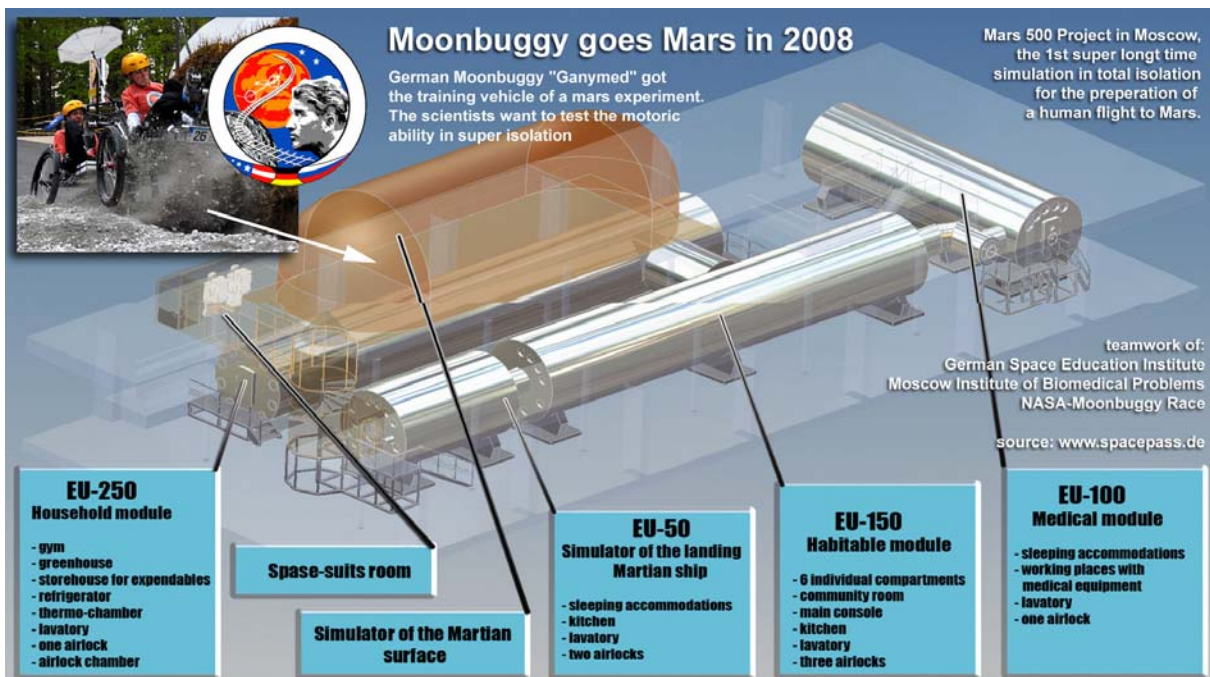


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## German Moonbuggy "Ganymed" has got a licence for the Mars 500 Project

The German moonbuggy "Ganymed" was licensed from the Moscow Aviation Institute and the institute for biomedical problems in Moscow as a training apparatus in the Mars 500 project. The Mars 500 project is composed of three biomedical super long-time experiments in the super isolation. In each case six crew members are tested during a time by 500 days on all abilities of the life and working in a Mars spaceship simulator. The German Moonbuggy functions thereby as training apparatus for the motor abilities on an after-arranged Mars surface for two crew members. It is used only, if EVA's are planned.

Our Moonbuggy existed as the only applicant for such an important mission under nearly real conditions all safety-relevant examinations. The Mars 500 experiment will be accomplished under international participation and ends in the year 2016. It is a component of the Russian space exploration under the national space travel agency ROSCOSMOS.



*The Mars ships simulator at the institute for biomedical problems will be occupied*

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**Sideboard of all award applications 2008, Team Germany:**

Best-Design-Award	<a href="http://www.spacepass.de/mbr08/best-design-award-en.pdf">www.spacepass.de/mbr08/best-design-award-en.pdf</a>
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