

## Best Design Award



## Application

**German Space Education Institute**

**Moonbuggy Team 2008**

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

## 1. Who are the members of your team?

Reshma Anwar, 16 Jahre, Gymnasiastin, german  
Andriy Garkavyy, 17 Jahre, Gymnasiast, ukrainian  
Philipp Hanstein, 16 Jahre, Gymnasiast, german  
Markus Reichelt, 16 Jahre, Gymnasiast, german  
Alexander Uth, 15 Jahre, Gymnasiast, german  
Peggy Zinsmeyer, 14 Jahre, Gymnasiastin, german



## 2. Who was responsible for which part of the project?

Peggy Zinsmeyer:

1st Driver, 2nd telemetry, engineer

Andriy Garkavyy:

1<sup>st</sup> Driver, engineer, russian translator

Reshma Anwar:

safety-chief and recording-clerk, 2<sup>nd</sup>, Back-Up-driver

Philipp Hanstein:

1<sup>st</sup> telemetry, engineer, health, 2<sup>nd</sup> mechanic

Markus Reichelt:

1<sup>st</sup> spokesman, (foto/video), constructor

Alexander Uth:

1<sup>st</sup> mechanic, 2<sup>nd</sup> TV-camera, time-clerk, constructor

### 3. What did it cost?, What would a second vehicle cost?

The first german Moonbuggy from the year 2007 called “Ganymed 1” costs ca. 17.600 dollar. The second moonbuggy “Ganymed 2” is actually in construction and has nowadays a volume of ca. 44 000 dollar. It is planned to admit this vehicle to the competition in 2009 at the 40<sup>th</sup> anniversary of the manned landing on the moon. It should be made of carbonfibre.

The moonbuggy “Ganymed 1B“ that is presented in 2008, is a breadboard-construction made of proven devices of “Ganymed 1” and proto-devices of “Ganymed 2”. “Ganymed 1B” got as the breadboard-vehicle for the race 2008 a value of ca. 29.000 dollar. It isn’t intended to produce it in series or build it again – its just a test-vehicle. All mentioned datas are only the value of the material and the job performance of the mechanic adaption of the parts. Not mentioned are the construction, management and organisation performance. Also not mentioned is the high travel performance from Germany to the USA.

**bruno banani**  
NOT FOR EVERYBODY

**Gold**

- MADLER (GEGRÜNDET 1882)
- Rohloff
- WITTENBECHER MASCHINENBAU GmbH
- cNC Dreherei G. J. GmbH & Co. KG

**Silber**

- RAYONIC LASERIONNIERTECHNIK CNC-BLECHVERARBEITUNG
- schlumpf innovations
- HASE SPEZIALRÄDER
- BIKE DEPARTMENT OST
- HeiterBlick
- KIESER TRAINING
- MAGURAN
- PRAUSE DIJROTEC
- HEXION SCHWALBE

**Bronze**

- AISCHMANN
- Singlespeedshop bei & mit singlespeed -retro -o ladschoel -newschool
- Althaus Galvanik- und Pulverbeschichtungs GmbH
- HinzTec
- stabo PER GUTE VERBINDUNG
- ROTOR
- terracerca

Amika Apotheke, Velowelt Leipzig GbR, Fotostudio Knabe Reichenbach, Adams Laden- und Messebau GmbH  
 Autohaus Burkhard GmbH Liebertwolkwitz, Hydro Aluminium Extrusion GmbH, Feinmechanik Moosdorf  
 toom BauMarkt GmbH Leipzig, Vogelsang Edelstähle, Land- und Kraftmaschinentechnik Stadtlim

our sponsors and donators 2008

#### 4. Where did you do the work?

In the German Space Education Institute, we got a CAD-constructionroom, an assembly building and a little factory. There we are constructing, choosing devices and adjusting the parts together after they were produced in the mechanic assembly. The mechanic assembly is done in firms (engine building, milling firms, turning shops, vehicle building). These firms are won over for the project by ourselves. After that we bring our component drawing to the firms and let them produce at the CNC-engines there. As far as we can, we integrate ourselves in the producing-process. In the holidays we combine that with an internship.



#### 5. What materials did you make the Moonbuggy from?

Because of the high resistance-coefficient, the Moonbuggy is still made of steel. Steel has the highest resistance, is easy to handle and easy to fix. The retractable construction necessitates that. But in the future of the Ganymed series we want to lighten the buggy at the same resistance-coefficient. For that we are going to make the construction of aluminium-carbonfibre-composite. The mainparts of this construction will be seen on the race 2008. Test-devices are integrated in the vehicle. A distinctive feature is the rear axle suspension made of laminated carbonfibre (S-Ply material of Mercedes-Benz).

#### 6. How did you design it?

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)*

First we designed the units with the computer and with the following programs: Solid Works and Corel Draw. Then we built some units with paper and board to measure and discovered their function and design. After the production and provision of all parts we assembled them, adjusted them and optimized the whole construction. Often the several parts have to be given back again to the production to adapt them, because the exactness of the parts can be 0.000118 Inches (0.003 mm).



*Solid-Works-Construction of the gear, all of these elements are integrated in the race 2008*

## 7. How did you build it?

teamwork, multi discipline, safety, missionsuccess

We worked in cooperation with small and center-supported engineering buisness companys.

- first we are analysing and constructing
- between we get hints and suggestions from concerns
- we try to work as much as we can with standart parts
- we discuss with the industry about the production of specific parts
- we controll the production in the industry
- we construct by ourselves
- we hold a vote together and with the industry
- we train with the buggy until the fine adjustment



*Mr. Hase explains the cutting by laser to us, Rayonic GmbH, 12/28/2007*

## 8. How did you pay for it?

The whole construction (value of raw materials and machinery editing) was sponsored. The value of ca. 30.000 \$ will be classified in gold- silver and bronzesponsors. That is why we wear our team clothes with the logos of the buisness companies. They are namend on our website and on print products, too. We had not to employ own money. The flight/transport/overnight stay to Huntsville is a financial barrier. We badly find sponsors for that. The charges of ca. 2.700 \$ per person can not be assumed of all of the families. We had to take a credit and we have to discharge it with lectures at schools, firms and masses with the presentation of the moonbuggy.



*Presentation at a business meeting of the association for the middle-class in Saxony*

## 9. What design features enhance the robustness of the moonbuggy to ensure survival on the race course?

Here the most important things in an outlook:

- spring system forward pneumo-hydraulic
- spring system behind, fiber glass in thicknesses
- roll belts
- very robust wheels (downhill-doubletubefellies)
- turning workpieces made of stainless steel
- 0,787 inches thick axles made of stainless steel
- cross stabilizer made of spring steel

- retractable elements made of lasered steel and 0,472 inches steel spikes
- 0,472 inches thick interlocks to arrest the construction
- wheel camber 8 degree
- torsionframe (twistably of both axles in the transversal plane), +-30 degree

To make the construction as save as possible, a **low situated balance point** is essential, that the buggy does not overturn 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 belts. **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 0,787 inches. 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.

10. Why did you design it that way?

- to displace the centre of gravity downward
- to assure the safety of the riders
- to obtain the best driving dynamics
- to become the moonbuggy more robust and more lightly

11. What part is most likely to break? Why? What can/should be done to minimize the effects of this failure?

We lokalised 25 weak points and correct them. A detailed description of this is in the application of the Most-Improved-Award. It contains 30 pages.

The weakest points were the the chaingear. It is very sensitive to vibrations. We exchange them for a second cogwheelgear from switzerland. This is completely insensitive.



left: the old chaingear, right: the new cogwheelgear

12. What is the most important lesson learned on the project to date?

We learned that we should never give up even if the problems appear very big. If you stay hard, aim the objective and everytime give the best - then nothing is impossible.

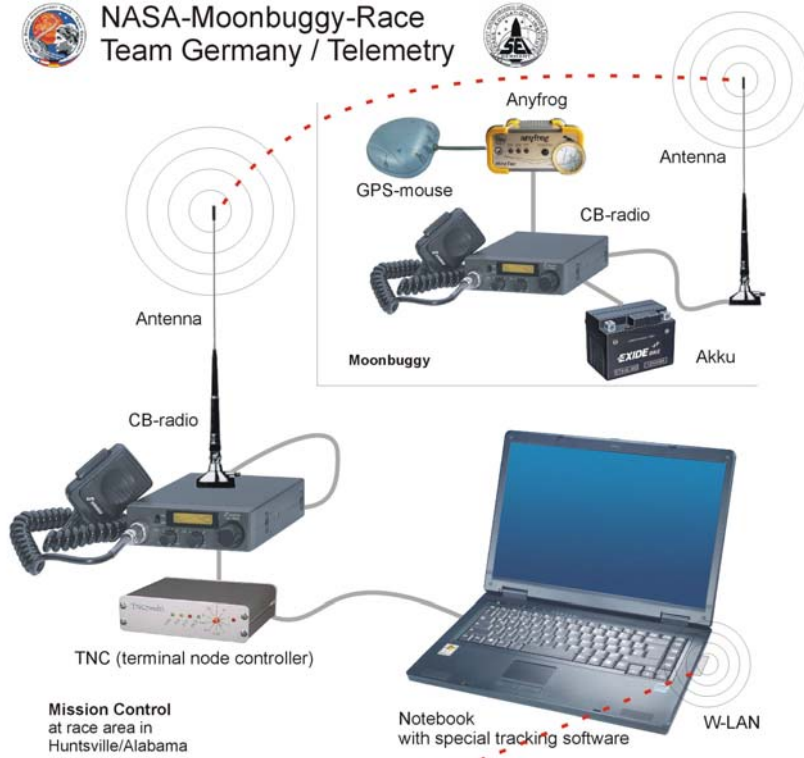
Add on:

### 1. Telemetry

The automatic sending of current measuring GPS-data via 2-way-radio from the Moonbuggy until 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.



NASA-Moonbuggy-Race  
Team Germany / Telemetry



World Wide Web with connection to educational websites



Sponsors



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04315 Leipzig

## 2. Planed longtime application to the moonbuggy regatta

In order to publicize the spirit of the moonbuggy we have the vision of the moonbuggy regatta. Our goal is to round the world with the moonbuggy. The stations of the aeronautics (Space Center, places of production, universities) should be linked. We imagine that one or more moonbuggies are driving together. The wheelers could be tested about their toughness.



We will do a first test run in summer 2008 from Berlin to Moscow (ca. 1200 miles). There is a big receipt meeting planned in Moscow. Therefore our moonbuggy has got a transmitting station. That sends GPS-telemetric data. An escort vehicle receives them and transmits them to the Internet. So every moonbuggy-fan all over the world can see the movements of the moonbuggy. It is possible for the escorting team to be in case of emergency (accident, repairing) directly on the spot.

Our team was trained for such somatic stresses and strains of a professional trainer (Kieser Training).

We want to make our experiences and cognitions of this first moonbuggy-regatta available for the NASA-Moonbuggy Race, so they can reproduce them and call other teams out for joining in.

Our dream is a complete America-regatta (all NASA Space Centers + all Moonbuggy-Schools) in year 2009 at the 40<sup>th</sup> anniversary of the lunar landing of Apollo 11.

Join all in – it will suffice sections, too. We come with the moonbuggy from Moscow. Later we would go with it around the world. We already have interested people at [www.terracerca.de](http://www.terracerca.de). They drove this course with a bicycle:



### 3. 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.

## Moonbuggy goes Mars in 2008

German Moonbuggy "Ganymed" got the training vehicle of a mars experiment. The scientists want to test the motoric ability in super isolation

Mars 500 Project in Moscow, the 1st super long time simulation in total isolation for the preparation of a human flight to Mars.

teamwork of:  
German Space Education Institute  
Moscow Institute of Biomedical Problems  
NASA-Moonbuggy Race

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

**EU-250 Household module**

- gym
- greenhouse
- storehouse for expendables
- refrigerator
- thermo-chamber
- lavatory
- one airlock
- airlock chamber

**Space-suits room**

**Simulator of the Martian surface**

**EU-50 Simulator of the landing Martian ship**

- sleeping accommodations
- kitchen
- lavatory
- two airlocks

**EU-150 Habitable module**

- 6 individual compartments
- community room
- main console
- kitchen
- lavatory
- three airlocks

**EU-100 Medical module**

- sleeping accommodations
- working places with medical equipment
- lavatory
- one airlock



The marsshpsimulator at the institute for biomedical problems will be occupied

**School:**

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**Teamleaders:**

Ralf und Yvonne Heckel, Space Camp Ambassadors

**Members of team:**

Reshma Anwar (16)  
Andriy Garkavyi (17)  
Philipp Hanstein (16)  
Markus Reichelt (16)  
Alexander Uth (15)  
Peggy Zinsmeyer (14)

**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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