

**NEW DEVELOPMENTS IN THE HUNVEYOR-HUSAR EDUCATIONAL SPACE PROBE MODEL SYSTEM OF HUNGARIAN UNIVERSITIES: NEW ATLAS IN THE SERIES OF THE SOLAR SYSTEM. S. Hegyi<sup>1</sup>, Gy. Hudoba<sup>2</sup>, H. Hargitai<sup>3</sup>, Z. Balogh<sup>2</sup>, T. Biró<sup>1</sup>, I. Bornemisza<sup>1</sup>, A. Kókány<sup>1</sup>, A. Geresdi<sup>1</sup>, G. Sasvári<sup>2</sup>, R. Senyei<sup>2</sup>, Varga T.<sup>4</sup>, Sz. Bérczsi<sup>5</sup>.** <sup>1</sup>Pécs University, Dept. Informatics and G. Technology, H-7624 Pécs, Ifjúság u. 6. Hungary, (hegyis@ttk.pte.hu) <sup>2</sup>Budapest Polytechnic, Kandó Kálmán College of Engineering, H-6000, Székesfehérvár, Budai út, Hungary, <sup>3</sup>Eötvös University, Dept. Physical Geography, Budapest, Pázmány s. 1/c, Hungary, <sup>4</sup>Aries Plus Kft. H-1111 Budapest, Bertalan u. 20. Hungary, <sup>5</sup>Eötvös University, Institute of Physics, Department of Materials Physics, Cosmic Materials Space Research Group, H-1117, Budapest, Pázmány P. s. 1/a, Hungary ([berczisani@ludens.elte.hu](mailto:berczisani@ludens.elte.hu)).

**Introduction:** The Atlas Series on space science education in Eötvös University is extended to its 10<sup>th</sup> booklet: New developments in the Hunveyor-Husar space probe models. **The main chapters are:** 1) The system of planetary materials research with space probes, 2) Hunveyor lander developments, 3) Husar rover developments, 4) New Mars analog site studies in Hungary and Utah.

Our Cosmic Materials Space Research Group (CMSRG) on Eötvös University uses the Hunveyor-Husar educational space probe models during the last 9 years in studies and forming exciting planetary science education programs. The main benefit of this program is the complexity, the activity of students involved both in planning, construction and measuring the test-table and analog site field works. Now we show this 10<sup>th</sup> booklet.

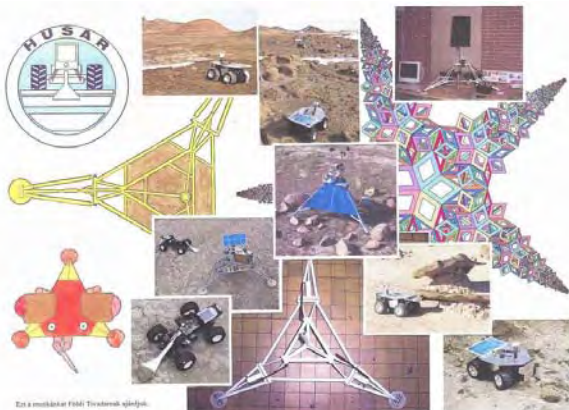


Fig. 1. The cover of the new concise atlas of Hunveyor-Husar.

### 1. The system of planetary materials research with space probes:

We summarized in 10 steps the “industrial vertical technology” description of planetary material collecting by space probes (landers, rovers) and their final studies. We focused on the activity we began and teach to carry out at those steps. (Main planets considered were the Moon and Mars):

1. **Reconnaissance and survey of the surface** of a planet by orbital space probes (i.e. Lunar Orbiter, MGS, MRO etc.) Our studies in this step: photogeology, geomorphology.

2. **Mapping of the surface** of the selected planet with geographical and stratigraphical methods. We (CMSRG) prepared thematic maps on Moon, Mercury, Mars, Venus [1] and Atlas (3) in the series [2,3].

3. **Identification of various surface materials** by albedo, spectroscopic [4], thermal IR, and other methods in order to identify the target sites. We can prepare such works in terrestrial analog sites during field works.

4. **Planning the space probe system** to reach these aims: planning the case when lander and rover units work together (MPF-Sojourner type pair). It was carried out in planning Hunveyor and Husar models.

5. **Construction and manufacturing the lander and rover units.** CMSRG Hunveyor groups built models to this phase [5].

6. **Launching and traveling** the space probes to the planetary surface. (In our program no rocket building phase, so we can simulate [6] some events during the voyage only.



Fig. 2. The cover of the new concise atlas of Hunveyor-Husar.

7. **Measuring the planetary surface environment** on the surface of the target planet [7]. (CMSRG) groups can carry out many jobs in this phase from the test-table measurements [8] and simulations till the planetary analog field works in terrestrial conditions [9].

8. **Transmitting (or transporting) data (or samples)** from the measurements (like Apollo, Luna expeditions from the Moon). (CMSRG) groups can carry out data transmitting from field observations by the models to the “terrestrial control”, and analog site studies can also demonstrate the parallel activities at this phase.

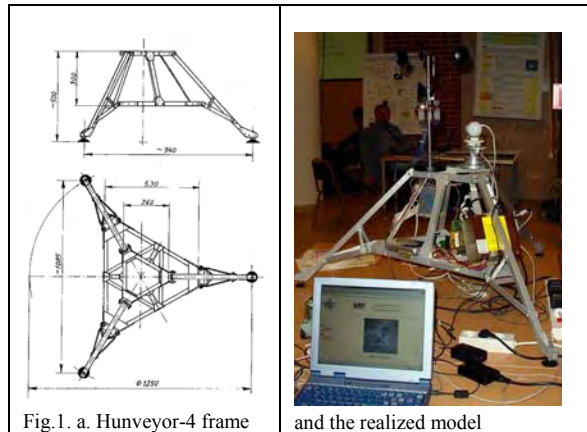
9. **Studies on planetary material samples.** We can study real NASA Lunar Sample thin sections in the set. Also, planetary meteorites fulfill the needs of this step of the activities.

10. **Comparative planetary and cosmopetrographic Synthesis** of the results. CMSRG’ outreach studies of

Concise atlas series and courses realize this last phase in the sequence of main technology steps.

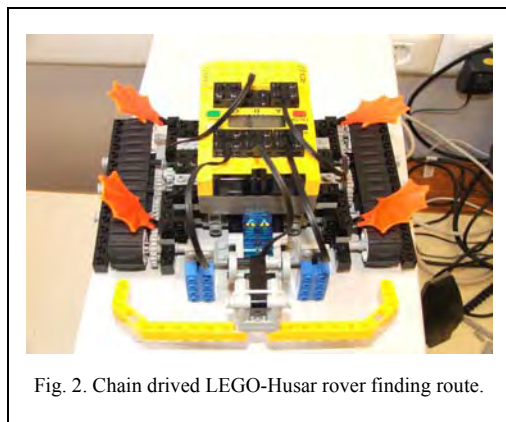
## 2. Hunveyor lander developments:

In the second chapter we describe our new developments in the Hunveyor-4 experimental university lander model and its Husar-4 rover, with several technological details about measuring units [1] (Fig. 1. skeletal frame and the realized model).



## 3. Husar rover developments:

In the third chapter the Husar-2 developments of the Pécs University are summarized. Some of them were shown on earlier LPSC-s [11] but here the systematic steps are shown from chain driven LEGO Husar till the Husar-2a, -2b, -2c variants.



## 4. Mars analog site studies in Utah and Hungary:

Husar-2b rover was delivered by H. Hargitai to the Mars Research Desert Station (MRDS) in Utah, where he took part in the work of the MRDS 42. crew. In the biancane type dry badlands the surface forms are excellent analogs to Martian landscape. He carried with him the Husar-2b and studied the interactions between the rover and astronaut during the field works. During the two weeks 11 Eva activities were carried out by him. He observed the main morphologic Mars analog units as: sand ripples, sharp pebbles, pebble-fields, buttes

(comparable to fretted terrains), the block-stone pavement surface, the slope movements, the spherules and the polygonal terrain. All the compared morphological units are shown in pairs on the back inner cover of the note-book.

In Hungary we visited cross-bedded sand layer units originated from the Miocene and Pliocene. These units were formed during the drying out of the Pannon Lake and we report these field works with Hunveyor in another abstract of this conference[12].

## Summary:

The 10th atlas summarizes both the system of educational space probe planning and construction and the field works with Hunveyor-Husar rovers. It was successfully used on our planetary science university, college, and public educational programs.

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