PLANETARY AND SPACE SCIENCE EDUCATION BY MATHEMATICA DEMONSTRATIONS:
LUNAR PROBE PLANNING, INSTRUMENTATIONS AND FIELD OPERATION SIMULATIONS FOR
HUNVEYOR MODEL BY STUDIES OF SURVEYOR. S. Kabai¹, Sz. Bérczi². ¹UNICONSTANT, H-4150,
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Abstract By the interactive Mathematica Demonstrations of the Wolfram Research instrumentation,
mechatronics and field operation simulations of a lunar and Martian space probe were studied focusing on our
Surveyor type educational space probe model: Hunveyor.

Introduction: Planetary science education unifies
the Math, Science and Technology subjects. The new
Mathematica Demonstrations program strengthens
both fields by visualization of various functions and
helps simulations. They are effective if a simultaneous
activity of space probe model construction and build-
ing up controls the ideas. Both various spatial motions,
realized in modification of functions Mathematica through the parameters and the built mechatronical
instruments add new perspectives of planetary science
education. We used this style of work for Hunveyor,
the university space probe model based on Surveyor
robots of the 60-ies of NASA [1-2].

The mechanical constructions: The profoundly
simple but stable skeleton of the spacecraft was a tetra-
hedral structure. In a stable position of the tetrahe-
dron the Surveyor was a tripod and on the fourth tetra-
hedral vertex hold the pair of two sheet-like objects:
the solar panel and antenna. At the ends of the tripod
there were the three footpads. In our first study 8 pa-
rameters of this skeleton, the tripod with the footpads
were varied as shown in Fig. 1.: deploy legs, level pad,
platform height, elevate junction, shift junction, pivot
width, frame width, top joint.

For Surveyor the 3 legs and footpads were col-
lapsible and they stayed in a closed form during
launching. On the voyage to the Moon later they were
opened. With the effective simulating programs longer
and longer sections of the space travel of a lunar or
Martian probe can be demonstrated with student activi-
ties [3-4]. By motion operations (rotations) in space
the instruments can be observed during the final mo-
ments of the landing (Fig. 3.) Spatial rotations make
visible the structure from various points and help
studying the arrangement of the main frame elements,
instruments, their positions and motions relative to
each other.

The basic instrumentations: The field work simu-
lations play important role in preparations of planetary
space probes. The Surveyor probe of NASA was the
learning example for the Hungarian university sur-
veyor, the Hunveyor. It was supported with three in-
struments in order to simulate field works on the test-
field lunar surface in the university laboratory (Fig. 3
and 4.). Solar panel gives energy, radio antenna serves
telecommunication, extending arm (Fig.2.) manipu-
lates the soil. Realized versions are shown in Fig. 5. a
and b.
Fig. 4. The Hunveyor-Surveyor demonstration at: http://demonstrations.wolfram.com/HunveyorSurveyorFieldWorkSimulations/, with the operations on instruments:
rotate antenna and solar panel
rotate antenna
tilt antenna and solar panel
tilt arm
grab
extend scissors
mast height

These three instruments give the furniture of a minimal lander type space probe. The parametrized motions of the three instruments are simulated activities on Hunveyor [1-3].

Fig. 5. Two realized versions of the Hunveyors. Hunveyor-1b (left), Hunveyor-4 (right).

The mechanical construction of the Luna landers: The instruments of the Luna-9 and 13 landers were composed into a sphere. The cover of the spherical container was divided to two hemispheres of which the top hemisphere was divided further into four lobes on Luna-9. These lobes formed petal like opening structure, which were stabilizing the container after the landing. This scheme was used in the Russian space probe Luna-9, in this form, however, in the case of Luna-13 this scheme was developed to use 8 petals of which also 4 ones turned down to form legs. Both Luna-9 and Luna-13 soft landed on the Moon. (Fig. 6.).

Fig. 6. The Luna lander demonstration at: http://demonstrations.wolfram.com/LunaLandersOnTheMoon/ with the four stabilizing spherical petals.

Summary: The interactive Mathematica Demonstrations [5] of the Wolfram Research help planning instrumentation, mechatronics and field operation simulations of lunar and Martian space probes as it was shown for the Surveyor type educational space probe model: Hunveyor. At the same time historical planetary space probes are and can be in the future demonstrated by their essential elements, instruments, motions and spatial arrangements. This way the Wolfram Research’s Mathematica program found a new way of teaching instrument operational aspects of planetary science education and simulating robotic activities, planning student experiments and probably these demonstration will have further sophisticated applications in planetary science.

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