PLANETARY AND SPACE SCIENCE EDUCATION BY MATHEMATICA DEMONSTRATIONS: LUNAR PROBE PLANNING, INSTRUMENTATIONS AND FIELD OPERATION SIMULATIONS FOR HUNVEYOR MODEL BY STUDIES OF SURVEYOR. S. Kabai[1], Sz. Bérczi[2]. [1]UNICONSTANT, H-4150, Püspökladány, Honvéd u. 3. Hungary. [2]Eötvös University, Institute of Physics, Dept. Materials Physics. H-1117, Budapest, Pázmány P. s. 1/a. Hungary.

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 building 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 tetrahedral structure. In a stable position of the tetrahedron the Surveyor was a tripod and on the fourth tetrahedral 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 parameters 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.

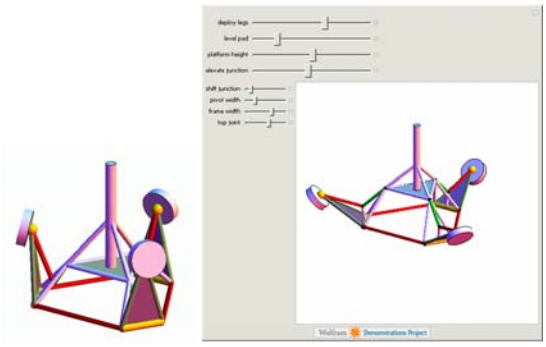

Fig. 1. The Surveyor-Hunveyor Tripod demonstration: http://demonstrations.wolfram.com/SurveyorHunveyorTripod/ about the collapsed Surveyor-Hunveyor skeleton.

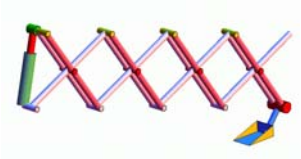

Fig. 2. The first instrument of Hunveyor-Surveyor: the Nuremberg scissors (chain of scissors), which can be extended for soil mechanics manipulation http://demonstrations.wolfram.com/NurembergScissors/

For Surveyor the 3 legs and footpads were collapsible 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 activities [3-4]. By motion operations (rotations) in space the instruments can be observed during the final moments 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.

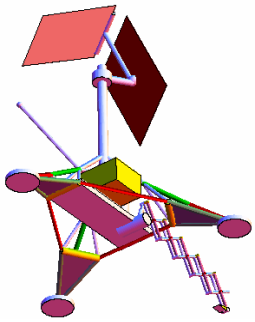

Fig. 3. Looking up from bottom, when rotating in Hunveyor-Surveyor demonstration.

The basic instrumentations: The field work simulations play important role in preparations of planetary space probes. The Surveyor probe of NASA was the learning example for the Hungarian university surveyor, the Hunveyor. It was supported with three instruments 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.) manipulates the soil. Realized versions are shown in Fig. 5. a and b.

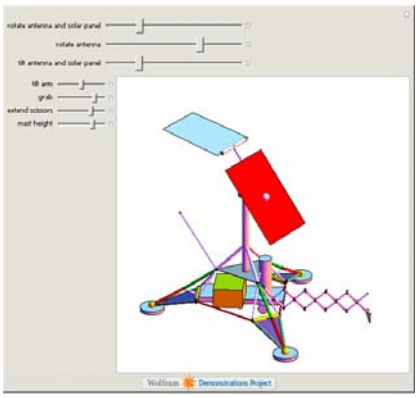

Fig. 4. The Hunveyor-Surveyor demonstration at: http://demonstrations.wolfram.com/HunveyorSurveyorFieldWorkSimulations/, with the operations on instruments:

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.).

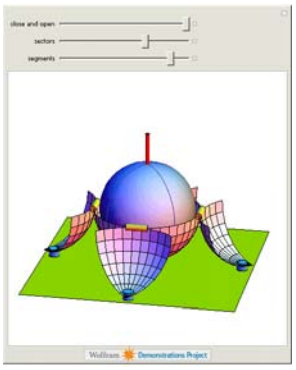

Fig. 6. The Luna lander demonstration at: http://demonstrations.wolfram.com/LunaLandersOnTheMoon/ with the four stabilizing spherical petals.

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 spatila 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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