MONETARY OPTIMIZATION OF MARTIAN EXPLORATION BY REUTILIZATION OF EXISTING DESIGNS OR MODULARIZED SYSTEMS. M. Voelker, Institute of Geographical Sciences, Freie Universität Berlin, Berlin, Germany (martin.voelker@fu-berlin.de).

Introduction: The following abstract refers to Challenge Area 2 – Systems that enable low cost access to the surface of Mars at or below the current Discovery mission cost cap.

Since the beginning of space exploration financial problems were often the biggest obstacles in planetary research. As a result, exploration of extraterrestrial bodies was significantly delayed or inhibited. A possible solution of this ongoing problem could be a reutilization of already developed technologies like spacecrafts and rovers. Furthermore, costs could be reduced by establishing a modularized system, e.g., for martian exploration.

Reutilization of existing technologies: The most recent history has shown that NASA and its affiliates are able to send very successful working probes to Mars. For example, both Mars Exploration Rovers (MER) have shown their ability to study many different scientific topics using multiple instruments (e.g., Mini-TES, Mössbauer spectrometer MIMOS II, Alpha Particle X-Ray spectrometer APXS, Rock Abrasion Tool RAT, Microscopic Imager MI) and roving distances up to ~35 km [1, 2]. For the Mars Science Laboratory (MSL) it is expected to fulfill a traverse of at least 5 to 20 km. Furthermore, MSL comprises a comprehensive payload of scientific instruments than the MERs. Although the MER missions have greatly advanced our understanding of martian history, their abilities could be more exhausted by further missions.

Even our ancestors in economics tried to hold down costs by optimizing production through mass-production and labor division of one product [3]. So NASA could "produce" more rovers on the basis of the existing MER-design. For lowering costs once again NASA could involve in such a project other space agencies and/or countries by a kind of "franchising". Thus, these agencies or countries would supply scientific staff for research and could pay money for the delivery of technologies. In this way international cooperation in planetary sciences could be enhanced too.

Modularized systems: Another possibility for saving money is the development of so-called modularized systems. Space probes and landers could be assembled on demand for an individual scientific focus of one mission. But in contrast to the reutilization-method, this option would imply initial development costs. Main objective is to construct and develop a rover and/or a probe system that is modifiable in terms of payload depending on individual scientific objectives and repeatable in construction. This modular system can be separated into three major categories: interplanetary transportation, scientific spacecraft, and instrumental equipment.

For transport from Earth into a martian orbit there are two possible spaceship designs. One is only able to transport the payload and insert it into an orbit around Mars. The other will include a complete landing system for landing a spacecraft safely on the planet's surface (airbag or sky crane). As the weight of every single probe stays almost the same it is possible to determine one landing system. The spaceship can carry either an orbiter or a landing probe. For a lander there are two possibilities; a fixed or a mobile one. Each of these three options will be designed and constructed without any scientific payload. But they will have a fix number of ports for instruments. And every of these instruments can be easily implemented on the probe during construction works. A possible catalog of instruments is listed in Fig. 1. In this way engineers can submit any constraints for the scientists a priori, e.g. regarding landings sites. Moreover, engineers can produce global maps for all areas on the planet showing possible landing sites that are accessible by this system. Once the whole modularized system is evolved there will be a huge decrease of development and production costs. Time for realizing such a space project would rapidly decline.

Conclusions: For monetary and time reasons the reutilization-method is a cheap possibility in gaining scientific knowledge in near- and mid-term periods of time. For example, we could expect further breathtaking insights in martian research by assembling new rovers in MER design again.

A further advantage of both systems (reutilization and modularized option) is that they are not confined only for martian missions. Already designed orbiters, like the low-cost mission New Horizons could be reproduced and send to other planetary bodies in the solar system. But sending a rover to other extraterrestrial bodies would be more complicated. So we could not send a MER to e.g. Titan. But if there will be a great exploration wave induced by lower production costs, further control centers for operating space probes would be necessary.

References: [1] Cook R. A. (2005) *Acta Astronautica 57*, 116-120. [2] Webster G. (2012) JPL News Release 2012-022. [3] Smith A. (1776) The wealth of nations.

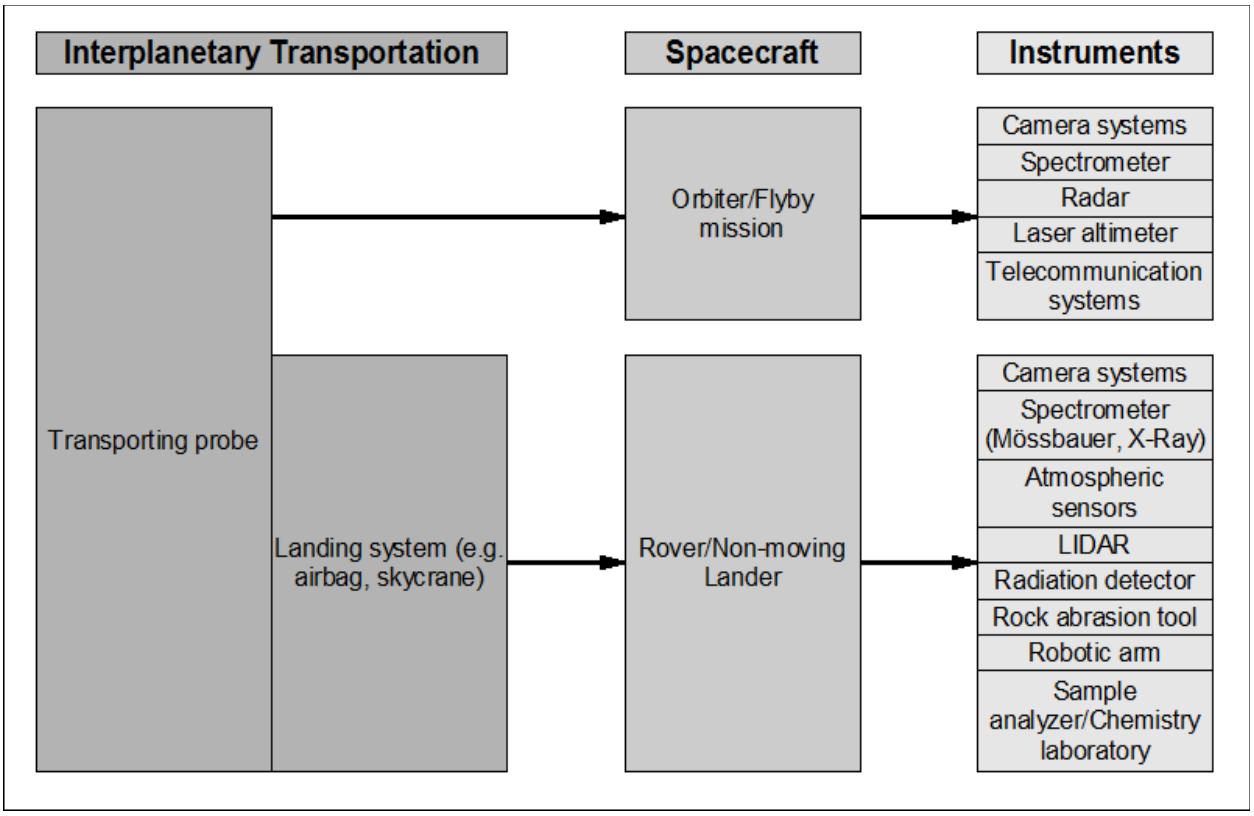

Fig. 1: Possible scheme for modularized systems.