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Importance of joint efforts for balanced process of designing and education

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ABSTRACT

This paper discusses importance of a strategic planning and design process when developing long-term space exploration missions both robotic and manned. The discussion begins with reviewing current and/or traditional international perspectives on space development at the American, Russian and European space agencies. Some analogies and comparisons will be drawn upon analysis of several international student collaborative programs: Summer International workshops at the Bauman Moscow State Technical University, International European Summer Space School "Future Space Technologies and Experiments in Space", Summer school at Stuttgart University in Germany. The paper will focus on discussion about optimization of design and planning processes for successful space exploration missions and will highlight importance of the following:

- understanding connectivity between different levels of human being and machinery;
- simultaneous mission planning approach;
- reflections and correlations between disciplines involved in planning and executing space exploration missions;
- knowledge gained from different disciplines and through cross-applying and re-applying design approaches between variable space related fields of study and research.

The conclusions will summarize benefits and complications of applying balanced design approach at all levels of the design process. Analysis of successes and failures of organizational efforts in space endeavors is used as a methodological approach to identify key questions to be researched as they often cause many planning and design processing problems.

1. Overview of existing and traditional international plans of space development at space agencies of USA, Russia and Europe

In the modern world space is often a field where political interests of many countries are conflicting, these countries unquestionably accept the significance of space technologies and their applications. Although only two superpowers – Russia and the USA – used to possess space potential in

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the past, in nowadays, united Europe, China, India and several other countries have space ambitions followed by serious successes. Moreover, India and China are starting to develop and use space so actively that it is quite possible that in 20–30 years they will be amongst world space leaders. However, right now the accepted and an unquestionable leader in the space field is the USA. They are performing a whole range of space programs. In accordance with the goals laid down in the document entitled "National Space Policy of USA" NASA have started preparation for a mission to Mars. Based on experts' opinions, NASA have accumulated sufficient expertise in studying near-Earth space, Moon and Mars (including results received on-board of the International Space Station) which will allow NASA to start preparations for the flight to the Red Planet. NASA plans also include an asteroid mission in 2025. The asteroid is supposed to be transferred to the near-Moon orbit by using a manned spacecraft. An asteroid may also be considered to serve as a transitional base for astronauts on their way to Mars. NASA is planning to perform first manned landing on Mars in 2030s [1].

In order to reach those goals NASA is planning to significantly modernize rockets and create a new spacecraft. Therefore, by the year of 2018 it is planned to complete modernization of super-heavy rocket Space Launch System (SLS). It is also expected that development of reusable spacecraft Orion will be completed, which will come to replace Space Shuttles, not used since 2011. NASA will use such new reusable vehicle to study a near-Moon asteroid in 2020s [2].

European Space Agency (ESA) which currently unites space development programs of majority of European countries, has conducted testing of their new suborbital reusable space plane Intermediate eXperimental Vehicle (IXV). Using this craft Europeans are planning to test several efficient and innovative technologies, which can be later used in creation of future reusable spaceships. It is also in ESA plans to colonize the Moon [3].

China National Space Administration (CNSA) has long-term development plans. At 64th International Astronautical Congress in Beijing in 2013 Mr. Hu Yafeng, Deputy Administrator of CNSA highlighted the goals of continuous lunar exploration and developing global satellite navigation, while Mr. Gao Hongwei, Chairman of China Aerospace Science and Industry Corporation emphasized plans to develop a re-usable space transportation system [4].

Indian Space Research Organization announced in 2014 their plans to continue Moon exploration with Chandrayaan-2 project planned to be launched by 2017 which will include lunar orbiter and lander–rover [5].

The document entitled "Main outlines of fundamentals of state policy of Russian Federation in the sphere of space activity for the period until 2030 and further perspective" states:

- In the field of manned space flights to transition to operating next-generation manned transportation system spacecraft; performance of fundamental research, conducting of deep Moon study missions;
- with the help of automatic spacecraft as part of international cooperation, it is planned to take part in mission to research Sun, Mars, Venus, system of Jupiter, planets and small bodies of a Solar System, asteroids. It is planned to conduct new projects, such as space electric power stations, storing nuclear waste, manufacturing of various materials in space in industrial quantities [6].

In order to implement such ambitious tasks, which require significant expenses and resources, it is important to unite at international level. And, in the first place, it is related to working out a unified approach to preparation of new generation of modern experts, who would be capable of implementing the tasks set by space agencies. In space related industry and associated branches of engineering it is especially important to consider international aspect in the work of engineers and researches, since practically all significant projects in space exploration are conducted by joint efforts of different countries. Growing world trends toward commercialization and globalization of industrial programs demand from young experts to have certain communication and organizational competencies, such as: ability to present the results of their activity, business communication skills, personnel management skills, knowledge of foreign languages and work experience in international groups and projects. Significant part of professional competencies, due to their peculiarities, cannot be obtained by students during the process of education in universities, or during professional internships at agencies, businesses and manufactures. In order to solve problems in forming professional competencies it is required to change organization, methodology and content of common training for engineers [7].

2. Research methods

This paper discusses one of possible ways to modernize methodical training of highly-qualified personnel through a project-oriented method of education, specifically allowing to form a systematic thinking process as creative practices [8]. The most efficient way to form personalities is doing it through hands-on experience, for example using specialized educational means. Such means may include: personality-oriented educational programs, lectures discussing certain critical problems, heuristic seminars, situational educational training, joint-group technical projects, scientific-research activities, experimental-design projects and other forms of activities with educational objectives, which allow to specifically form a set of subjectively independent methods of thinking, forming a basis of individual style of professional practice of modern experts [9].

2.1. International experience

Lately, leading world technical universities, use students' education at scientific international schools or workshops as efficient auxiliary form of education. Such schools are conducted during students' vacations and last for 2–3 weeks. We will address several modern examples of such educational method:

Example 1. Summer school (seminar) at Stuttgart university, Germany. In 1998 professor of Stuttgart University and astronaut of European Space Agency (ESA) Ernst Messerschmitt