Using of the Aerospace Modeling Simulator in the Educational Process

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The current project is grounded on the use of Kerbal Space Program.

Nowadays 2 Course units with duration of 36 academic hours are being taught at our University, and the textbook with 470 pages has been designed.

The project is still in work.

The first try of the author's Course units took place at the Higher Engineering school of Peter the Great St.Petersburg Polytechnic University in 2018.

Course units “Space modeling” and “Space engineering” are combined inside the direction “Space technologies”.

These programs are aimed on the education of pupils, as well as students of Colleges and Universities.
In the summer of 2019, the Ministry of Education of Russia introduces a draft of the governmental Decree aimed on the modernization of the education system for the period 2019-2024 within the framework of the national project “Digital economy”.

In frames of this Decree it is proposed to embed computer games, simulators (hardware-software and audiovisual tools), as well as mobile applications, as a teaching tools in schools and colleges.
The proposed Course unit on “Space modeling” is designed for 36 academic hours, most of which are practical classes. The program includes the following modules:

1) Basics of space exploration,
2) First flight,
3) Design of a stationary satellite orbit,
4) Manned flight (sending a manned spacecraft into space),
5) Simulation of a scientific satellite for research,
6) Simulation and operation of a small manned research ship,
7) Launch of the large space crafts into orbit,
8) Design of orbital space stations,
9) Design of simulated orbital station,
10) Simulation of the creation of an orbital space station,
11) Delivery of the crew to the station,
12) Work at the station,
13) Simulation of an unmanned research apparatus, capable for carrying out a flight to the Moon.
Development of “Space modeling”: 

- Задача 1
- Задача 2
- Задача 3
- Задача 4
- Задача 5
- Задача 6
- Задача 7
- Задача 8
- Задача 9
- Задача 10
- Задача 11
- Задача 12

- Задание 13
- Задание 14
- Задание 15
- Задание 16
- Задание 17
- Задание 18
- Задание 19
- Задание 20
- Задание 21
- Задание 22
- Задание 23
- Задание 24

- Папка с файлами

Using of the Aerospace Modeling Simulator in the Educational Process

Moscow, Russia
14-17 April, 2020
The Course unit “Space engineering” is also designed for 36 academic hours, and includes the following modules:

1) A brief overview of knowledge from the initial course on space modeling,
2) First flight to the Moon with splashdown,
3) The design of a Lunar base,
4) Manned flight (sending of a manned spacecraft into the Space),
5) Construction of the Lunar base,
6) Completion of the construction of a Lunar base,
7) Breeding of large space crafts to long-range orbit,
8) Creation of a network of long-range communication satellites,
9) Adoption of interplanetary flights,
10) Design of scientific apparatus for the study of other planets,
11) Exploring of a planet and returning back home,
12) Using of returnable missiles,
13) The development of a space plane.
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Contents of "Space engineering":

- задания 2 части
- описание занятий
- программа Космическое моделирование

- задание 1
- задание 2
- задание 3
- задание 4
- задание 5
- задание 6
- задание 7
- задание 8
- задание 9
- задание 10
- задание 11
- задание 12

- вкладка 3
- вкладка 4
- вкладка 5
- вкладка 6
- вкладка 7
- вкладка 8
- вкладка 9
- вкладка 10
- вкладка 11
- вкладка 12

Moscow, Russia
14-17 April, 2020
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Contents of the Textbook:

A.V. Черновский

Космическое моделирование. Kerbal Space Program. Учебное пособие.

УДК 004.42

Черновский А.В.


Изложены вопросы, связанные с историей создания Kerbal Space Program, рассмотрено потенциальное использование программ и использования практических заданий. Текст изложен простыми и понятными языком.

Предназначено для проведения занятий по КМ в средах с образовательных программ в школах и ВУЗах.

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IEEE NATIONAL RESEARCH UNIVERSITY

CROC
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Contents of the Textbook:

16. Материалы, технологии и двигатели космонавтики будущего

Содержание
16. Материалы, технологии и двигатели космонавтики будущего... 1
Содержание......................................................... 2
16.1. Работа с двигателями для кораблей космического корабля.............................. 3
16.2. Пилотирование 3D-мультипликатора......................................................... 13
16.3. Разработка и применение космических двигателей.............................. 18
16.4. Работа с двигателями................................................................. 28
16.5. Гидравлические системы.......................... 29
16.6. Разработка и применение систем с использованием замыкания 30
16.7. Система топливопитания (Топливо) ................................................. 31
16.8. Теория использования «Звёздных кораблей»........................................... 32
Выводы........................................................... 35
Description of the Space Simulator “KERBAL SPACE PROGRAM”:

Kerbal Space Program (KSP) is a computer game in the style of a space simulator.

It was developed by the Mexican company “Squad”, specialized in the development of computer games.

KSP is characterized by a genuine realism, the uniqueness of the game mechanics and physics, the depth of opportunities for creativity, fascination, expressive graphics and high-quality sound.
The significance of the Space simulator “KERBAL SPACE PROGRAM”

Kerbal Space Program has a significant impact on the public consciousness and on the choice of young people of the new generation.

Lead developer and the author of KSP, Felipe Falanghe, describes the situation as follows: “We know a lot of people who say that Kerbal Space Program inspired them to choose astronautics or something close as a profession”.

According to a survey, the following results were obtained:

1) more than 92% of participants before the development of the program never thought about the fact of the existence of the aerospace industry,

2) more than 97% said that the game increased their interest in science and space,

3) more than 95% reported that they learned something new in astrophysics and rocket science directly from the Kerbal Space Program.

Possibility of application of Kerbal Space Program in educational process on technical subjects is studied. The survey carried out by the University of Hazleton (Pennsylvania, USA) shows that this requires an integration with the main content of the academic course unit.
Testing of “Space modeling”

The implementation of the Study program “Space modeling” has been started at the Higher Engineering school of Peter the Great St.Petersburg Polytechnic University in the February of 2018.

The program is successfully implemented up to now as a program of supplementary education.

Testing of “Space engineering”

In the spring semester of 2018, the “Space engineering” program has been started, in which students, who completed the “Space modeling” Study program, took part.

In addition to the modules provided by the program, a multifunctional lunar base was constructed during the training. The creation of the Lunar base is a strategic goal of the Russian cosmonautics, as the Lunar base is a unique platform for scientific experiments, a spaceport.
Algorithm for creating and composition of a Lunar base

The algorithm for creating of a Lunar base includes the following steps:

• Scanning the Moon to select a location for the lunar base,
• Creation of a network of communication satellites in different orbits of the Moon,
• The first splashdown on the Moon surface for testing of the algorithm,
• Delivery of an autonomous complex for ore mining and processing,
• The first splashdown of the descent module with astronauts,
• Delivery to the Moon of a large laboratory for research,
• Delivery of lunar Rovers, habitable modules.

The multitasking functionality of a Lunar base needs:

a) Lunar scanner to determine the content of resources,
b) modules for long-term accommodation of astronauts,
c) small lunar Rovers to study the Moon's surface, including the delivery of Lunar rocks and meteorites,
d) versatile space laboratory to conduct comprehensive research,
e) mobile complex for extraction of the ore from the soil of the Moon and processing of the ore into a fuel (this is a prospective project, considered in “Roscosmos” and NASA).
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Participation in the XIII International Youth Scientific readings devoted to Sergey Korolev
Using the Simulator for the research

The simulation of the Mobile system’s layout:

On the platform of the Rover the 3 towers connected by tubes are placed, containing: central computer, Convert-O-Tron, 2 antennas, 2 batteries, ore container, 3 drills, solar panels, 2 fuel tankers, etc.

**Maximal energy consumption of the whole System during Per**

\[
Q_{sum} = \sum_{n=1}^{8} m \times k_{On} \times Q_n
\]

\[
Q_{sum} = (0.05 + 0.45 + 0.4 \times 30.0 + 10 \times 0.1 \times 3.5 + 2 \times 0.3 \times 0.9 + 20.0 + 0.7 \times 0.12 + 4 \times 0.02 \times 0.04) \times 1166400 =
\]

\[
= (0.5 + 12 + 3.5 + 0.54 + 20.0 + 0.084 + 0.032) \times 1166400 = 36.656 \times 1166400 =
\]

\[
= 42755558.4 \approx 42.8 \text{ MVA/Per}
\]

“Per” means ½ of the Moon’s month – appr. 13 Earth days
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Plans for future:

1) To complete the 2\textsuperscript{nd} version of a textbook,

2) To design the 3\textsuperscript{rd} Study program “Open space travelling”, in which the main idea is to construct a spaceship able to fly to another Solar system,

3) To visit the Center of cosmonauts’ training to choose the equipment needed for the 4\textsuperscript{th} Study program,

4) To design the 4\textsuperscript{th} Study program “Training of a crew for the spaceship “Eagle”, in which the main idea is to prepare students for the open space exploration, with Gagarin’s “Let’s go!”
Thank you for attention!

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