IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems (4)

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STRATEGIES FOR RE-USE OF LAUNCH VEHICLE FIRST STAGES

Abstract

Many strategies have been proposed for recovery of launch vehicle first stage components, all of which incur a reduction in payload capacity in an effort to reduce the cost-per-flight. However, there is much debate as to which strategy, if any, can provide sufficient cost savings to justify its associated payload reduction. To clarify the situation, an analysis was performed of the payload penalty and cost of all major first stage recovery strategies under common assumptions. The analyzed strategies include propulsive landing (downrange or at the launch site), winged stages (air-breathing fly-back to the launch site or downrange glider recovery), and engines-only recovery via parachutes.

This paper establishes a general model to compare the payload capacity and cost-per-flight reductions of first stage re-use strategies. The payload capacity model is neatly derived from physical first principles; cost estimation uses analogies to similar systems and the TRANSCOST model. For generality, the models are phrased in terms of dimensionless parameters, and the sensitivity of the results to those parameters is explored. The sensitivity of payload and cost to various technological and operational factors is also assessed.

This study finds that returning the first stage to the launch site by rocket propulsion incurs the highest payload reduction, at about half the payload capacity of an equivalent expendable system. Flying a winged stage back to the launch site under air-breathing propulsion has a smaller payload penalty (15 to 45%), but adding wings and jet engines to the stage increases costs. For downrange recovery, propulsive and glider landing both incur a small payload penalty (10 to 20%). Recovery of the engines alone via parachute incurs almost no payload penalty, but only enables cost-per-flight to be reduced by about half. An order-of-magnitude cost reduction requires re-use of the entire first stage, and optimistic assumptions about refurbishment costs and market demand.

Which strategy is ‘best’ depends on the situation of the launch provider and market. Engine-only parachute recovery is perhaps the easiest to implement, and could quickly offer moderate cost savings if development resources are limited. Despite more difficult development, downrange propulsive landing and downrange glider recovery can both achieve lower cost-per-flight and cost-per-kilogram to orbit. Propulsive landing provides operational flexibility - the same vehicle can also return to the launch site in easier missions. If high enough launch rates are foreseen, the operational convenience of launch site recovery may justify the development of an air-breathing fly-back booster.
Abstract

Located on the Irish Sea coast of North West England, the Victorian seaside resort of Blackpool holds a unique place in the affections of British holiday-makers. The town’s iconic landmarks of the Blackpool Tower and Pleasure Beach as well as the three piers bound a two-mile stretch of promenade. After a busy summer season, early autumn in the resort focuses on the Blackpool Illuminations, a light show along this seafront that has operated annually since 1879 and currently attracts four million visitors.

However, for those living in large parts of Blackpool, life paints a very different picture. Official UK government statistics reveal Blackpool was ranked England’s fourth most deprived area over an extensive range of metrics. The percentage of pupils achieving good school exit examination grades is declining annually and less than 12% of young people will enter university. Blackpool is the prime example of a region with exceptionally “low science capital” - the concept of science capital being a science-related form of cultural and social capital employed as a theoretical lens for explaining differential patterns of aspiration and educational participation in science amongst young people (Archer et al, 2015, J Res Sci Teach, 52: 922).

This presentation will outline the ambitious three-year longitudinal public engagement programme of interventions with a specific cohort of young people in Blackpool as we journey with them from their last year in primary school (10/11 years old) through to their early years in secondary education (12/13). Funded by the UK’s Science and Technology Facilities Council Leadership Fellow in PE programme, this work consists of school visits and community events plus trips to specialized facilities. This includes the UCLan/Ri Young Scientist Centre (a vibrant laboratory space dedicated to offering interactive and inspirational STEM workshops) and Alston Observatory (a purpose-built teaching and public outreach facility that comprises a group of both modern and historical telescope and a planetarium).

The overall aims are to (i) improve the experience of space science for this targeted cohort; (ii) inspire them through activities that increase their exposure to, develop their knowledge of and enhance their confidence in engaging with STEM; plus (iii) raise their aspirations of being scientists themselves by meeting real-life space scientists. The approach to relationship building with the cohort of young people as well as to evaluation of the potential improvement of their science capital metrics will be discussed and compared to UK and international benchmarks.
SPACE EDUCATION AND OUTREACH SYMPOSIUM (E1)
Lift Off - Secondary Space Education (2)

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COMPUTATIONAL THINKING: THE THINKING PRECEDES THE DOING

Abstract

As positions in global industry evolve, so does the demand for individuals with multi-disciplinary skills. One such skill that has been identified in literature is that of Computational Thinking. For those individuals to truly implement and master these skills, remaining relevant on that international stage, they must be developed and fostered within an educational environment from a young age.

A recent review of the Digital Technologies and STEM initiatives in the Curriculum in the State of Victoria (Australia) has renewed focus on the teaching of cross-curricular skills surrounding computational thinking, and on immersing those at the forefront of the global digital economy: our students. To encourage teachers, and their students, to recognize that coding is one small part only of computational thinking, in 2016 the Victorian Space Science Education Centre (VSSEC) introduced a half-day scenario-based program, for students in Years Five to Eight, titled Tickle My Droid. This program challenges students to use flowchart algorithms, placing an emphasis on analysis and design of their proposed solution and its evolution towards implementation using a block-based programming language; the thinking precedes the doing. The program is supplemented by a teacher Professional Development course that outlines the underlying principles of Tickle. The course aims to encourage students to think computationally, drawing on their developing skills in collaboration, critical thinking, mathematics, basic physics and programming. Both the student program and the Professional Development have been provided for Teachers in Mexico and Adelaide during the 67th and 68th International Astronautical Congress.

This presentation outlines a qualitative case study of the development, teaching and evolution of Tickle My Droid. Through thematic analysis, the following categories associated with computational thinking were identified: developing teacher confidence, empowering students to think before doing and creating open-ended, problem-based units of work with variable foci. These categories are further discussed, introducing a computational thinking framework that focuses on developing teacher capacity in these three areas. A further study is proposed with two components: one that analyses the efficacy of this program in terms of whether the skills acquired continue to be used by participating students, strengthened by their teachers, in the classroom, and a second analyzing the applicability of computational thinking in non-traditional STEM subjects.
SPACE EDUCATION AND OUTREACH SYMPOSIUM (E1)
Lift Off - Secondary Space Education (2)

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STUDENTS TEACHING STUDENTS: DESIGNING AND LAUNCHING A SUBORBITAL EXPERIMENT AT A U.S. MONTESSORI SCHOOL

Abstract

During 2017, a group of middle school students at DCS Montessori School in Castle Pines, Colorado, working in partnership with DreamUp, the provider of space-based educational opportunities, designed a suborbital payload that was successfully launched to space on a Blue Origin New Shepard launch vehicle in December 2017.

While the act of students launching a suborbital experiment to space was not new, the approach taken by the students, teachers, and mentors to involve more than 500 students in the process was unique. DCS Montessori School is a public charter school that includes student from preschool through 8th grade and follows the Montessori philosophy of grouping and teaching students. This philosophy was critical to the success of the curriculum developed for creating a payload and involving all the students.

DCS Montessori School contracted with DreamUp, NanoRacks, and Blue Origin to provide payload integration services for the future launch of the suborbital reusable launch vehicle known as New Shepard, which operates from the West Texas Launch Site. Once a contract was established, the middle school students were split into four groups. Group 1 was responsible for designing and building the payload enclosure. Group 2 was responsible for developing and testing an experiment. Group 3 was responsible for generating and organizing a school-wide art project to enable all students at the school to create something that would be sent into space. Group 4 was responsible for conducting educational outreach and developing an age-appropriate lesson to share with the preschool, lower elementary, and upper elementary students. By engaging the entire school in various aspects of the suborbital experiment, the project exposed students to a real-world challenge that incorporated Science Technology Engineering Art and Math (STEAM) in a powerful and effective way.

The student payload consisted of two parts. The first was an Arduino Nano with a sensor package that was designed and programmed by the students. The second part was the school-wide art project that all student participated in. Upon landing, the data from the experiment was analyzed and the art has been returned to the students. Through the active engagement of leaders at DCS Montessori and the support of DreamUp, NanoRacks, and Blue Origin, the students had a once in a lifetime opportunity to send, recover, and analyze science conducted in microgravity.
SPACE EDUCATION AND OUTREACH SYMPOSIUM (E1)
Lift Off - Secondary Space Education (2)

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FROM THE CLASSROOM TO THE FIELD AND BEYOND: AUTHENTIC RESEARCH EXPERIENCES FOR EDUCATORS

Abstract

Ongoing Professional Learning is a concern for educators in every setting, investigating opportunities to maximise the learning opportunity and to be involved in a fulfilling, meaningful and impressionable experiences that has lasting impact for them and their students. With the many demands beyond the classroom, teachers are highly selective when examining professional learning opportunities.

In recent times, development of intensive experiences, going beyond a workshop session or a conference, immersing the educator in scientific research and with researchers have been established. Opportunities for educators to be in the field, working alongside scientists and engineers, conducting authentic research, while under instruction. With a research immersion experience, teachers collect and assist with data analysis, utilising apparatus in the field or a research site, often handling resources that are not found in school laboratories and interacting and engaging in dialogue with scientists and engineers in real-world science, being a part of a science team, working on real-time solutions, involving everyone.

One of these opportunities is NASA Spaceward Bound. The mission of Spaceward Bound is to train the next generation of space explorers by having students and teachers participate in the exploration of scientifically interesting but remote and extreme environments on Earth as analogues for human exploration of the Moon and Mars, with expeditions to the Atacama Desert, Mojave Desert, Namib Desert, Australia and India.

Teachers involved go through various nomination and selection procedures to secure a place on an expedition team. Over the last ten years, numerous field programs have occurred and with six expeditions, data has been collected from participating teachers, which have identified and monitored various factors; measuring teacher’s attitudes, enthusiasm and self-confidence with creating, developing and explaining cutting edge science research that links with and compliments the curriculum.

Data was conducted through surveys and interviews prior to the commencement of an expedition, immediately at the end, approximately one-month later and then around one-year after returning from a field experience, identifying features such as classroom strategies and curriculum implementation in addition to motivation and interest leading to self-efficacy of their secondary classroom practice.

The aim of this research is to identify a process of effective practice in developing professional learning. The research data generated has identified clear goals to maximise impact and long-term meaningfulness and relevance of the experience. This research not only impacts the structure for agencies offering these experiences, but also to teacher associations and the teachers themselves.