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INTERNATIONAL SPACE COOPERATION FOR PEACE

Scientific and cultural cooperation through student space experimentation

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ABSTRACT

This paper will describe current efforts to utilize microgravity space missions as a unique means of fostering student involvement in space research to achieve multicultural understanding toward global peace. The first "Peace" experiment by Israeli and Palestinian students: "Growth of Bacterial Biofilm on Inorganic Surface During Spaceflight – GOBBSS," which was performed on the ill-fated STS-107 mission, will be highlighted as a model for future international cooperation. Upcoming flight opportunities for international experiments will also be discussed.

INTRODUCTION

One of the most important issues facing our world is the challenge of achieving global peace. A unique way to foster international cooperation and cultural understanding is through space experimentation. Students from different countries collaborating on a real experiment in space can not only make new discoveries from the space environment, but also obtain a greater understanding of diverse cultures and languages. It may also, in a small way, help the general public see a concrete example of people working together from diverse and sometimes opposing countries.

For the past decade, the author has been facilitating and organizing student-designed microgravity experiments on the Space Shuttle, sounding rockets, and Mir, and has experienced first-hand the positive effects these experiences have had on young people.

It has been demonstrated that space experiments are a good way to bring people together, often from diverse cultures and backgrounds. Space research can be a fantastic tool for:

- learning about science
- learning about space subjects
- working together in a team
- international understanding (different points of view)
- fostering self-confidence and creativity

Materials processing and biological experiments in space are ideally suited for hands-on education because the students themselves develop the experimental protocol, prepare the materials and biological organisms for flight, and analyze them after exposure to microgravity. These projects involve many stages: planning, research, procurement, preparation, ground control, post-flight analysis, etc. They also teach students to deal with the practical limitations of science and engineering, especially with respect to the challenging spaceflight environments such as launch/reentry acceleration and vibration, the quality of the microgravity environment (on-orbit perturbations), reliability, safety precautions (especially important for human-tended experiments), and mass/volume/power limitations. By its very nature this type of experimentation requires team effort, cooperation, and a multidisciplinary approach; which parallel the way most projects in science and engineering are conducted in our technological era.

BACKGROUND

Space Outreach™ is a non-profit organization based in the United States and formed as a spin-off to ITA's (Instrumentation Technology Associates Inc.) successful student hands-on microgravity experiment program [Ref. 1, 2]. Space Outreach™ works in partnership with ITA utilizing ITA's standardized space hardware and payload flight opportunities. Over the past 12 years, the program has to date involved thousands of students by engaging them in a real-world experience of conducting scientific experiments on the Space Shuttle, the Mir space station, and suborbital rockets. This program has helped motivate thousands of students toward a greater interest in math, the sciences, and technology as well as work in close cooperation with other students in different states and countries.

EXPERIMENTS ON SPACE SHUTTLE COLUMBIA: ISRAELI-PALESTINIAN "PEACE" EXPERIMENT

The most recent experience to be discussed is the "Peace in Space Experiment" – Growth of Bacterial Biofilm on Basaltic Surfaces (GOBBS), sponsored by the Planetary Society, mentored by Dr. David Warmflash (NASA Johnson Space Center – JSC, Astrobiology Division) and Dr. Eran Schenker of the IAMI (Israel Aerospace Medicine Institute), involving two students (one from Israel and one from Palestine) coming together to develop and fly this joint experiment.

The GOBBSS astrobiology experiment was designed to advance understanding of the evolution of life in the universe and to help build peaceful international cooperation. The research was also a demonstration to show how people, united by a common goal, can work together to answer questions that have intrigued humanity for ages. The experiments were designed to determine whether bacteria would grow as biofilms in meteorite-like material -- a useful and original experiment that may contribute valuable insight into the question of life in the cosmos.

Background/History of the GOBBSS Project

The Israel Aerospace Medicine Institute (IAMI) was instrumental in bringing forward the experiment as well as providing science guidance and consulting. The Planetary Society, dedicated to the study and exploration of space, was the sponsor for the GOBBSS experiment [Ref. 3, 4]. Other organizations working with the Planetary Society included: Seeds of Peace, an organization dedicated to increasing understanding and cooperation between Israeli and Palestinian youth; and the Peres

Center for Peace [Ref. 5]. Seeds of Peace and the Israel Aerospace Medicine Institute advertised the experiment to university students in Israel and Palestine to seek their participation. David Warmflash of NASA JSC, helped students design the experiments and was responsible for bringing it to the Planetary Society as a peaceful science initiative.

One Palestinian (Tariq Adwan, a Palestinian biology student from Bethlehem), and one Israeli (Yuval Landau, an Israeli medical student from Tel Aviv) (Figure 1) were selected for the experiment based on research proposals that each submitted and on the requirement that the two work together on the experiment which was created based on aspects presented in each of the two winning proposals [Ref. 6]. Both students came to Cape Canaveral, Florida to prepare their samples for flight. They saw each other as scientists instead of from politically opposing nations [Ref. 11]. This was observed by the rest of the launch team as to how closely they worked together on the experiment preparations. In addition, the two were on a continuous search for Kosher food for Yuval all over Orlando, Florida!

Figure 1. Israeli student Yuval Landau and Palestinian student Tariq Adwan join forces on a Space Shuttle experiment. Image: Cape Canaveral, Florida, The Planetary Society.

The GOBBSS experiments were carried out in sample cavity wells in the Dual Materials Dispersion Apparatus or DMDA manufactured by Instrumentation Technology Associates, Inc. (ITA) and carried in ITA's CIBX-2 payload. CIBX-2 (Commercial ITA Biomedical eXperiments) is a Shuttle Middeck locker payload performing Cancer and commercial research and student hands-on experiments [Ref. 7]. Within CIBX-2 were two DMDA's or Dual Materials Dispersion Apparatus. A DMDA consists of an aerospace aluminum container housing two blocks with fluid wells machined into facing sides of the blocks. A single well on one block has one or two corresponding wells on the opposite block. The blocks are offset so each well on one block faces the inert wall of the other block. In space, the flight crew activates the DMDA and the blocks are repositioned to align the wells with each other. On STS-107, astronaut Kalpana Chawla performed the activation of these experiments. See Figures 2 and 3.

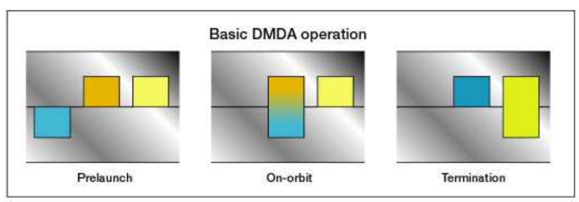

Fig. 2. Diagram depicting a cross-section of a set of DMDA experiment specimen wells and sliding block principle of operation.

Figure 3. STS-107 astronaut Kalpana Chawla (K.C.) onboard STS-107 in front of ITA's CIBX-2 payload (upper left corner) only a few days before re-entry.

Inorganic mineral chips similar in structure to meteorites that have been identified as having come from Mars and kept in sterile media, were inserted into the DMDA wells pre-flight. Once in space, wells containing sterile, inorganic mineral surfaces were put into contact with wells containing bacterial cultures in growth media. The organisms were allowed to grow on the surfaces until the last day of the mission when they were mixed with other wells containing a fixing agent in anticipation of return into a 1G environment so that all post flight observations of the growth would be the result of events that took place during weightlessness.

Peace Experiments Recovered

Within 24-hours of the Columbia break-up, ITA engineers from the CIBX launch team identified their hardware shown in TV news programs (Figure 4) and newspapers [Ref. 8]. The two DMDA hardware units miraculously survived re-entry but showed evidence of elevated temperatures and charring. However, the exterior aircraft aluminum housings and seals that isolated the sample wells held up well during re-entry, impact, and throughout the months in the KSC hangar before the data recovery efforts commenced. As of May 6, 2003, samples from the DMDA experiment in the CIBX-2 payload were recovered [Ref. 9, 10]. However, all of the science obtained was degraded somewhat between 50-75% with the exception of urokinase (primary cancer research onboard), which completely degraded due to the long time delay (3 months +) between identification of the hardware and the actual recovery of the samples, coupled with the lack of a controlled temperature environment after Shuttle break-up.

Figure 4. Composite picture of recovered DMDA hardware (containing GOBBSS experiment) in Nacagdoches, Texas. February 2003.

FUTURE PROJECTS AND SPACE FLIGHT OPPORTUNITIES

"MISSION ZERO-G: International Student-Run Ground and Space Experiments"

With the success of the Israeli-Palestinian GOBBSS experiment, it is envisioned to continue similar such endeavors while the Shuttle is grounded. *"Mission Zero-G: International"* is a new joint collaboration between Space Outreach™ and ITA, Inc. to provide the training, hardware and continuing access to space for student experiments.

Mission Zero-G International has four primary goals: (1) to have students from different countries collaborate on designing and flying an experiment in space; (2) to use space as a motivating vehicle to interest students in pursuing careers in science, technology, engineering and mathematics; (3) to interest students in discovery and exploration and (4) to get students ready for space experiments while the shuttle is grounded. The plan is to get elementary and middle school students ready for shuttle and ISS experiments by teaching them about microgravity and conducting ground control experiments.

A wide range of experiments can be performed on a single mission using standardized hardware such as those designed by ITA. Simple experiments for younger students may involve plant and seed studies, simple fluid diffusion, and crystal growth. More advanced studies may include cell biology, film formation, microencapsulation of drugs, etc.

Mission Zero-G International is a hands-on space education program including workshops and seminars, the sharing and downlink of data from space, and the utilization of the latest information technology. Workshops will include the following:

- Briefings on the unique micro-gravity environment and the benefits of space to us on Earth;
- Brainstorming sessions and other assistance to students in designing their experiments;
- Help with setting up ground control systems.

Brazilian VS-30 Rocket Mission

Space Outreach™ is currently working with Brazilian space authorities for a flight onboard the Brazilian VS-30 sounding rocket in 2005. Student experiments from many countries including Brazil may work together to design and fly their experiments. In 1999, the first student microgravity experiments were flown on the "Operação São Marcos" mission utilizing ITA's MDA (Materials Dispersion Apparatus). Figure 5 shows the VS-30 rocket used in the Operation San Marcos Campaign.

The Israeli-Palestinian student experiment will be used as a model for the Brazilian rocket mission as well as a future mission on the ISS.

Fig. 5. Brazilian VS-30 Sounding Rocket on launch pad, Alcantara, Brazil.

International Space Station Experiments

Future *"Mission Zero-G International"* endeavors will include real-time student involvement in an ISS mission. The importance of linking students from different countries via the Internet for joint space education activities is to bring together the youth of different cultures and nationalities for a cooperative educational endeavor "with no borders". In order to achieve this, a system to provide video downlinks of data from the space experiments to a ground facility will be utilized. This will start as a pilot program onboard the ISS. Schools will access the data via the Internet. On-line forums and databases will be used to share data among the students and teachers. Any school in any country with Internet access could participate in the program (Figure 6 below). This capability may be a valuable tool to prepare future generations for careers in space and other scientific fields.

Fig. 6. Downlink of student experiment data to students around the world

CONCLUDING REMARKS

There is an urgent need for improved global understanding and cooperation as well as improving education. The microgravity environment of space is an ideal tool for furthering these objectives. This unique environment allows student researchers from different countries to come together to conduct experiments impossible to perform on Earth, such as developing new materials, products, and pharmaceuticals. By becoming involved in scientific experiments in space, and collaborating with peers in different countries, students will be exposed to an extremely powerful educational experience that can serve as a positive motivator and channel for greater cultural awareness and understanding. If young people start to truly become involved in the global community at a young age by taking part in real space missions, this may eventually contribute to improved international understanding.

Programs and flight opportunities are in place to bring together young people and educators from a variety of countries to collaborate in a multi-disciplinary, international framework leading to greater cultural understanding; and motivate young people to learn about the wonders of the Universe, helping stimulate an interest in math, science, and technology.

Through this kind of international collaborative student space research and exploration, perhaps new foundations of understanding can be built to forge peace for the future.

ACKNOWLEDEGMENT

This paper is being dedicated to the crew of STS-107 Columbia whose love and dedication will not be forgotten and serve as a reminder to never give up.

The author wishes to warmly thank Mr. John M. Cassanto, my father, hero and mentor. Without your vision of creating and making possible the hands-on space experiments program, none of this would have been possible. A warm thank you to Mr. Ulises Alvarado who has given constant guidance and encouragement to continue and develop student space education activities.

"There's no better place to emphasize the unity of people in the world than flying to space. It goes the same for any country, Arab country, whatever -- we are all the same people, we are all human beings and I believe that most of us, almost all of us, are good people." Astronaut Ilan Ramon (Israel) January 4, 2003.

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