A STUDENT SATELLITE PROJECT

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ABSTRACT

Student satellites are not new. Many such projects are represented at this colloquium. We report on the Student Satellite Project at the University of Arizona that is unique in its science-driven initiative and broad-based participation. In addition to describing the satellite, we shall emphasize the importance of interdisciplinary collaboration in science, the cross-fertilization between science and engineering, the leadership role of the students, and the partnership among the university, the community and industry. The progress of the project will be described in terms of its procedures and structures. Presently, it is too early to set a launch date for this particular student satellite.

INTRODUCTION

A satellite carrying out its mission in orbit is truly a marvelous work of our minds and hands. It harnesses the energy required to keep it functional for a purpose. It has sensors connected to an onboard computer to collect and process the data it was designed to gather. It delivers the gathered data to its operators on Earth. It obeys the commands sent from Earth to perform specific tasks required of its mission. Yes, an operating satellite is truly a marvelously complex system. The marvel of a microsatellite is perhaps best described by a Chinese saying about sparrows, “Small though it is, it is complete with all its organs.” Such a small and yet so complete a complex system and our innate fascination with space invite us to consider seriously a microsatellite as a useful tool for education.

Student satellites are not new, but how each one comes about from inception to operational makes it unique. Here is a story of a beginning and the beginning of a story of a student satellite project, the Student Satellite Project at the University of Arizona, which is just one year old since its inception on 7 November 1996. We shall describe the project’s present status, the process that brought it about, its features and the favorable conditions surrounding it, and finally, what we expect to benefit from it.

WHAT DO WE HAVE?

On 22 November 1997, the Student Satellite Project at the University of Arizona -- SSP for short -- passed its Conceptual Design Review conducted by the Evaluation & Selection Panel (ESP). The satellite, yet to be named and built, will be one suitable for inserting into a low Earth orbit by the Hitchhiker Ejection System (HES) on NASA’s Space Shuttle. The HES is chosen from the outset for its frequent and predictable schedule and orbit, and its well-defined design envelope, in comparison to some of the “piggy-back” rides.

Figure 1 shows the dimensions of the HES. Our satellite will be a circular cylinder 42 cm in diameter and 52 cm in length with a mass of 68 kg, all of which befits the HES. Carrying out the designated scientific objectives of the mission, i. e. a) Detection and observation of lightning, b) Detection and observation of sprites and c) UVBRI stellar photometry, a refractive optical system shall use the central axis of the cylindrical satellite as its primary axis. A block diagram of the science instrument is shown in Figure 2. This single optics system will provide for all of the science observations, as well as serve as the system for the laser communications experiment.

Viewing the lightning and sprites is best done by looking at Earth's limb, at the proposed orbit of 400 km in altitude. Performing stellar photometry, on the other hand, requires the instrument to look the night sky further above the limb. If laser communication with ground is to be tested, the instrument must then be nadir pointing. To accommodate the three different pointing requirements, the three-axis stabilized satellite will be steered by two pairs of student-designed reaction wheels with a pointing accuracy of approximately 0.5˚. The satellite will determine its attitude through a suite of sensors including a coarse sun sensor, magnetometer, micromechanical gyros, and a crude star tracker utilizing the science instrument. A state diagram of the GNC system is illustrated in Figure 3.

Processing the data and controlling the satellite requires an onboard micro-processor that will be able to address the many activities being carried out on the satellite, each with their own priority. Of particular challenge is the bursts of high data rate that the laser experiment and science instrument will produce. Trade studies are currently underway to determine what approach (centralized or distributed) will provide the best solution to this challenge.

Our telemetry system is fortunate enough to have a head start on the SSP, as the ground station was already under construction at the time of the inception of SSP. Members of the University of Arizona Students for the Exploration and Development of Space, and the Ham Radio Club had begun a satellite ground station project in support of another student satellite: SEDSAT (Maier and Wu, 1998). SSP is modeling as much of its approach to its ground station as possible after the SEDSAT approach, to limit duplicate development. A picture of the ground station under construction is shown in Figure 4. The satellite portion of the telemetry system is currently planning to utilize wavelengths in four Amateur bands (2m, 70cm, 23cm, 13cm). The lower frequency bands will provide a packet store and forward service to the amateur radio community, while the higher frequencies will be used for command uplink, and data downlink. In particular, it is hoped that the S-Band (13cm) link along with advanced modulation schemes can provide data rates in upwards of 1Mbps!

To perform all the above described tasks required of the mission objectives, the circumference of the satellite will be covered with a thin film solar cell that is currently under development by Global Solar, a subsidiary of Tucson Electric Power. Commercial Ni-CD D-Cells are the current plan for

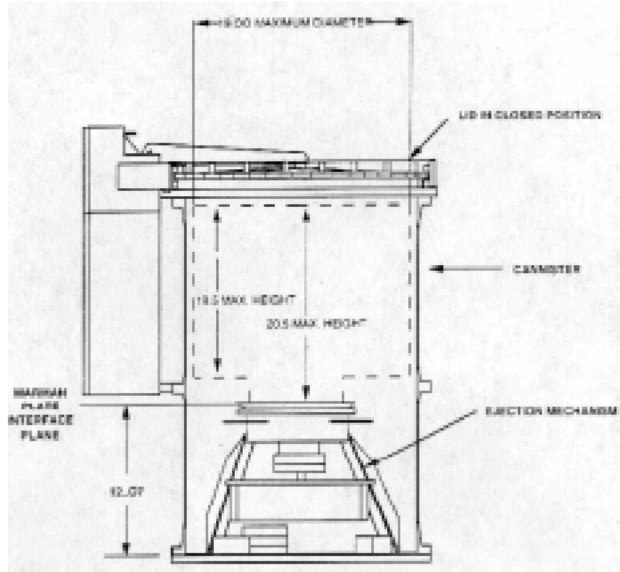

Figure 1. Hitchhiker ejection system

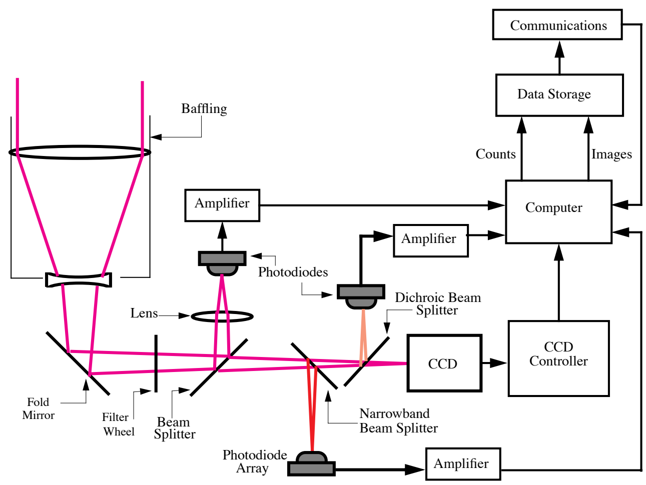

Figure 2. Science instrument block diagram.

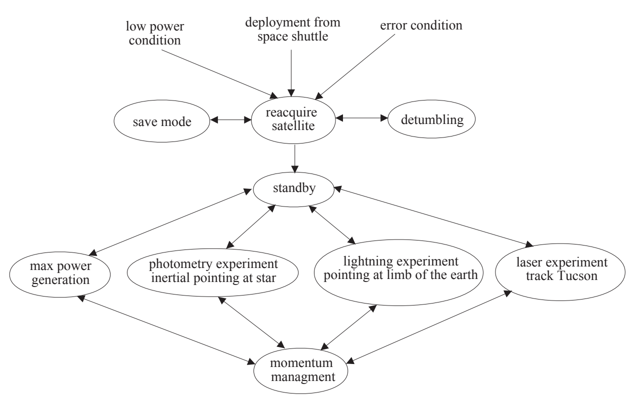

Figure 3. State diagram of GNC system.

primary on-board power storage. Additional battery capacity may be added in order to support high power draw when the laser downlink experiment is operating. This separate power block would be trickle-charged between tests of the laser experiment. The photovoltaic efficiency of the $CuInSe_2$ (CIS) cells is estimated at 8-10%, although this efficiency is comparable with other cells due to its increased performance over a wider temperature range. With the system described, a continuous power capability of between 20 and 35 watts is estimated.

Figure 4. SSP Project Lead Chris Lewicki, assembling satellite groundstation, on a cloudy day.

With the conceptual design described above, SSP will begin its Preliminary Design Phase in January 1998. The Preliminary Design Review (PDR) is tentatively scheduled for April 1998. Meanwhile, the Hitchhiker Launch Manifest Request (Form 1628) will be submitted to NASA, requesting for a launch sometime in 2000. The sequence of tasks accomplished and events yet to come is illustrated in Figure 5.

HOW DID WE GET TO WHERE WE ARE?

The idea of a satellite designed, fabricated and operated by students at the University of Arizona emerged in an informal conversation between some faculty members of the Department of Aerospace & Mechanical Engineering and K. C. Hsieh, after his seminar on 7 November 1996. What followed was a series of informal meetings involving a handful of interested faculty members from Aerospace & Mechanical Engineering, Astronomy, Atmospheric Science, Electrical & Computer Engineering, Optical Science, Physics, and Planetary Science. Although the initiative came from the Department of Physics, all participants recognized from the very beginning that this project has to be interdisciplinary in nature and in practice. The use of electronic mailing across campus enabled the rapid communication among participants, so that no paper documents were exchanged and meetings were kept infrequent.

At first, the faculty members in discussion were oblivious of the burgeoning activities of the Students for the Exploration & Development in Space (SEDS) on campus. The president of that national organization for 1996 was an Aerospace & Mechanical Engineering student in his senior year, C. A. Lewicki. It was through S. A. Brew, coordinator of the Arizona Space Grant Consortium, a state-wide NASA funded program, the connection between the faculty in planning and C. A. Lewicki was made; and student participation began in the planning phase of SSP. With the support of Arizona Space Grant, J. Rademacher of NASA's Jet Propulsion Lab, a graduate of the Arizona State University and the first student leader of the ASUSat, was brought in to describe his experience with ASUSat and programs at JPL that may be of assistance to SSP.

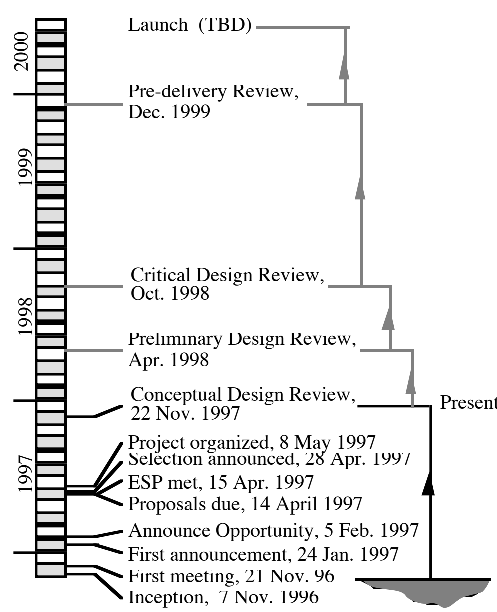

Figure 5. Milestones of SSP at the University of Arizona.

After three meetings, the basic ideas of SSP appeared sound and worth pursuing. By then, a SSP website prepared by A. Levine, Communications Director of the Physics Department, and her student assistant was ready to become accessible on campus. On 24 January 1997, SSP made its first announcement on the website. On 5 February 1997, the Announcement of Opportunity followed. Students began to register on the website indicating the areas of their respective interests and intentions. By the end of February 1997, over 100 students indicated their intent to proposed. (See Table 1 for the distribution of students in academic standings and disciplines. Students with double majors appears as 0.5 in each of the majors)

Table 1. Tally of student distribution

	Fr.	So.	Jr.	Sr.	Grad	Totals
Aerospace Engineering		1	1	4	1	7
Agr. Engineering			1		1	2
Astronomy		0.5	2	1	2.5	6
Atmospheric Physics					2.5	2.5
Chemistry			1	1		2
Chemical Engineering		2	1			3
Civil Engineering			1			1
Computer Engineering		2	5.5			7.5
Computer Sciences	1.5	2	3.5	4.5		11.5
Electrical Engineering		4	6	1	1.5	12.5
Engineering Math			1.5			1.5
Engineering Physics	1		1.5	1		3.5
English				0.5		0.5
Geosciences			0.5			0.5
Hydrology				1	1	2
MIS				0.5	1.5	2
Math	0.5	0.5	3	2		6
Mechanical Engineering		4	4	3	3	14
Optical Engineering		2		1	0.5	3.5
Optical Sciences					1	1
Physics	1	1.5	6	2.5	3	14
Planetary Sciences		0.5	1		0.5	2
Pre-Med			0.5			0.5
Systems Engineering				1		1
	4	20	40	24	19	107
17 students withdrew during semester						

Working together, H. S. Tharp of Electrical & Computer Engineering, E. D. Fasse of Aerospace & Mechanical Engineering, E. K. Hege of Astronomy, and C. A. Lewicki assigned the students from 22 departments spanning from sophomore to graduate students into 17 teams -- 5 for payload instrumentation, 12 spread among the five subsystems, mechanical structure & analysis, data & command handling, guidance, navigation & control, tracking, telemetry & command, and power generation & distribution. The teams were instructed to organize themselves, seek their own mentors, and decide on their own approaches to their proposals. The proposals were due on 14 April 1997. In anticipation of the 17 proposals, the Evaluation & Selection Panel (ESP) was formed. We are extremely fortunate to have the highly qualified experts in a variety of fields willing to serve on the ESP (see Table 2). ESP has a significant representation from the well-established space industries.

All proposals were submitted on time and most of them in electronic form. The Chair of ESP, R. D. Lorenz, distributed the copies to the ESP at their first meeting the next day. The fact that some members had to drive 200 km to the meeting did not result in any absence. At the end of the two-hour meeting, each member went home with a stack of proposals to review. By mid-night two days later, reports from all ESP members were received by R. D. Lorenz in electronic form for collation and distribution to all ESP members. After much discussion over the electronic mail, the summary of the selection process was announced by ESP member, D. R. Huffman, to the students gathered for the first time on 28 April 1997. The result of the selection set the objectives for the first SSP mission and the goal for the Conceptual Design Review, mentioned at the beginning of this presentation, and set the stage for the organization of SSP, as shown in Figure 6. The Team Mentors who helped in the preparation for the Conceptual Design review are listed in Table 3.

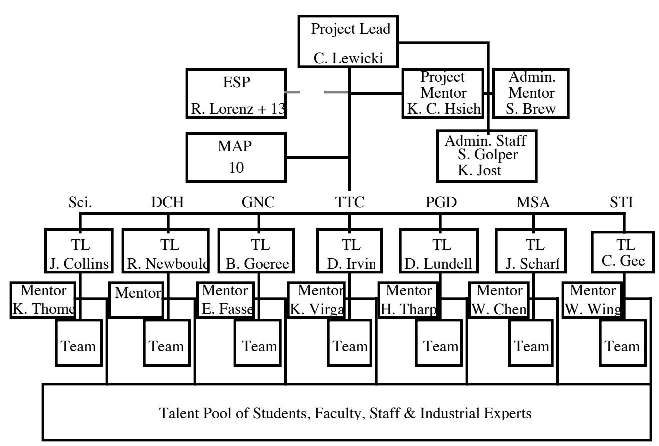

Figure 6. Organization chart of the Student Satellite Project at the University of Arizona as of end of 1997. The structure will evolve as SSP enters into different phases with different requirements.

Table 2. The Evaluation & Selection Panel (ESP).

[LPL = Lunar & Planetary Lab; AME = Aerospace & Mechanical Engineering; ECE = Electrical & Computer Engineering; MMT = Multi-Mirror Telescope. All these are working units of the University of Arizona.]

Name	Current Position	Expertise
Ralph Lorenz (Chair)	Res. Assoc. LPL	Nine years of experience on small satellites at Univ. of Surrey, Univ. of Kent, & ESA.
Jill Bechtold	Assoc. Prof., Astronomy	Active in space-based astronomy. Member of NASA selection panels.
Bob Brown	Prof., LPL	Planetary surface science. Mars missions.
Chuan F. (Tony) Chen	Prof., AME	Fluid dynamics & complexity
Don Huffman	Regents Prof., Physics	Optical properties of matter. Nobel nominee for his work on C_{60}.
Don Hunten	Regents Prof., LPL	Senior member of space physics & planetary aeronomy communities. Member of National Academy of Sciences and various national panels.
Matthew Jones	Asst. Prof., AME	Radiative heat transfer
Ron Jost	Chief Engineer, IRIDIUM Project, Motorola	System engineering, integration and testing. DoD & NASA programs since 1969.
Bill Kerwin	Prof. Emeritus, ECE	Analog & digital circuits
Pitu Mirchandani	Head, System & Industrial Eng.	Complex systems
James Palmer	Assoc. Res. Prof., Optical Sci.	Spacecraft solar-cell engineering.
Ed Pierce	Adj. Assoc. Prof., ECE; Senior Engineer, Hughes	Microwave specialist. 34 yrs. with Hughes from design to project management.
John Reagan	Head, ECE	Space radiometry & remote sensing.
Rich Van Riper	Chief Engineering Fellow, Honeywell Satellite Systems	Attitude control & guidance, data handling systems. 35 yrs. in space engineering.
Richard Schotland	Prof., Atmospheric Sciences	Space-borne LIDAR experiments.
Bobby Ulich	Vice-Pres., Kaman Aerospace Res. Prof., Astronomy Chief Engineer, MMT	Electro-optics development. First space-borne adoptive optics.

Table 3. Team mentors

Team	Mentor/Title	Department
Science	Kurt Thome, Asst. Prof.	Optical Sciences
Data & Command Handling	Vacant	
Tracking, Telemetry & Command	Kathleen Virga, Asst. Prof.	Electrical & Computer Eng.
Guidance & Navigation Control	Ernie Fasse, Asst. Prof.	Aerospace & Mechanical Eng.
Power Generation & Distribution	Hal Tharp, Assoc. Prof.	Electrical & Computer Eng.
Mechanical Structure & Analysis	Wayne Chen, Asst. Prof.	Aerospace & Mechanical Eng.
Strategic Technology Initiative	Bill Wing, Prof.	Physics and Optical Sciences

The organization of SSP will evolve as different needs arise. For example, at the Conceptual Design Review, the ESP rightly pointed out the need for a System Team to ensure the interface requirements between the subsystems are clearly defined and carefully monitored. This recommendation will be heeded as SSP moves into its Preliminary Design Phase. Obviously, still later, other teams will be formed to meet the new needs; e. g., an Integration Team to perform the task of integration and testing prior to delivery. The evolution will continue as the tasks progress.

The SSP could not get to its present state relying on enthusiasm and voluntarism alone. Expenses for student support (especially in the summer), student travel to the Annual Conference of the American Institute of Aeronautics and Astronautics and Utah State University Small Satellite conference in the neighboring state of Utah, communications, and some computer and clerical supplies had to be paid. Again, SSP has been fortunate to have received a total of $52,703, including the first prize awards at the Student Showcase on campus, as listed in Table 4.

Table 4. Funding received as of November 1997

Source of Funding	Amount	Remarks
Department of Physics	$5,000.	Summer student stipends; office supplies; and partial support for student travel to AIAA in Utah.
Prizes from Student Showcase	$500.	SSP won first place in engineering undergraduate and first place in engineering graduate.
Department of Atmospheric Sciences	$5,000.	Summer student stipends
WAESO (Western Alliance to Expand Student Opportunities)	$3,386.	Two Undergraduate Grants $1100 Materials & Supplies $286 Admin. Fee $2000 Student Stipends
Space Grant	$38,187.	$6785 5 undergraduate students $25402 1 graduate fellowship $6000 Cash and 486 computer $68 Joel Rademacher's airfare to informational meeting at UA $1000 Partial travel to AIAA in Utah

In addition to the generously contributed funds, SSP also received contributions in kind. These include the use of services and spaces in different departments. For example, the Department of Physics provided the crucial service of establishing a SSP website that made publicity and out-reach possible within one month of SSP's inception and the use of a lab space as the SSP Headquarters. The Aerospace & Mechanical Engineering Department also provided the use of two teaching labs for the MSA and the GNC teams, and the use of the Department's machine shop facilities.

WHAT IS SO SPECIAL?

The SSP at the University of Arizona is indeed very special in what has already been described above and in the additional features to be described below.

Student-run. After the announcement of the result of evaluation and selection on 28 April 1997, the original 17 proposing teams re-grouped into 7 teams, as shown in Figure 6. Each team elected its own Team Leader. Except the DCH Team, all teams found their respective Team Mentors. With or without its Team Mentor, each team met weekly to carry out self-assigned tasks towards its defined goal. The Team Leaders, fully aware of its own team's progress and problems, met weekly with the Project Coordinator, C. A. Lewicki., to ensure the smooth progress of the project by mutual assistance and coordination. All meeting agenda and minutes were distributed through the electronic mailing network and archived electronically in a central location accessible to all. The timely completion of the Conceptual Design Review is a proof of the strength of the students, because most of the work in preparation for the Review was done during the summer months of 1997, when most of the mentors and advisors, including the Project Mentor, were away from the campus!

Abundant talents. The smooth progress of SSP up to now has to be attributed to the highly motivated students coming from all disciplines that are necessary for the complexity of the project. These students demonstrated their ability to obtain necessary technical knowledge and to work together in harmony. In addition, we have right on campus all the experts in space science and technology. A group of experts on and off campus offered themselves to meet SSP's needs on a day-to-day and issue-by-issue basis form the Mission Advisory Pool (MAP), as shown in Table 5. A wide variety of expertise of the members of MAP can be seen in Table 5. Not to be forgotten is the pool of talents that are not yet involved, but potentially available. This is represented as the base of Figure 6.

Table 5. Mission Advisory Pool (MAP)

Name	Current Position	Expertise
Steve Bell	Senior Staff Eng., LPL	Space-borne electronics
Bill Bickel	Prof., Physics	Particle accelerator for detector calibration and radiation effects on space-borne instruments
Lyle Broadfoot	Senior Res. Scientist, LPL	Space-borne EUV imagers. PI on numerous space missions.
Matt Cheselka	Res. Specialist, Steward Obs.	
Elliot Chu	Asst. Prof., Physics	Particle detection & digital electronics
Charles Curtis	Res. Assoc. Prof., Physics	Space-borne particle detectors. Co-I on numerous space missions.
Roger Davies	Assoc. Prof., Atmospheric Sci.	Cloud physics from space
Eustace Dereniak	Prof. Optical Sci.	IR detector & imagers.
C. Y. Fan	Prof. Emeritus, Physics	Space physics since 1950's
Uwe Fink	Prof., LPL	Stellar photometry
Sy Goodman	Prof., Managem. & Info. Systems	Management
Larry Head	Asst. Prof., Sys. & Industrial. Eng.	Complex systems.
Keith Hege	Assoc. Astronomer, Steward Obs.	Opto-electronics
Ben Herman	Head, Atmospheric Science	Remote sensing via GPS
Jeff Jacobs	Assoc. Prof., AME	Fluid dynamics
Philip Krider	Prof., Atmospheric Science	Lightning & sprites
Larry Lebofsky	Sr. Res. Sci., LPL	Solar system small bodies
Alfred McEwen	Assoc. Res. Sci., LPL	Remote sensing surfaces
Kumar Ramahalli	Prof., AME	Space-borne new materials
Bill Sandel	Sr. Res. Sci., LPL	Space-borne EUV imaging
K. R. Sridhar	Assoc. Prof., AME	Spacecraft engineering
Tom Vincent	Prof., AME	Control & guidance.

Broadly based interest & support. Aside from the initial support received from the University in the form of faculty and staff volunteers and contributions of funds, services and facilities, SSP has already received the attention it needs from the industry and local community. Already mentioned is the dedicated service of experts from industries such as, Motorola, Honeywell, Hughes, and Kaman to the ESP. Not mentioned in the listing of members in the MAP (Table 5) are six staff engineers from SatCON, covering mechanical components, as well as electronics, power, guidance and control aspects of a spacecraft. Other industrial partners have also offered advisory help. Talks of possible material support coming from industries are already in the planning. Another important sector has also shown interest in supporting SSP. This is the local community of Tucson. On 4 June 1997, K. C. Hsieh gave a presentation to the Greater Tucson Economic Council, a body of community leaders and financial magnates interested in improving the economic lot of the City of Tucson and its surroundings. The reaction was enthusiastic. Ways to attract industrial and financial support for SSP are being planned under the leadership of D. Finley and R. Walkup, both of the Greater Tucson Economic Council.

WHAT CAN WE EXPECT FROM SSP?

The overwhelming response from the students, faculty, staff, industries, and community to SSP has its base on at least five potential benefits SSP could offer. These are:

1. A hands-on experience through teamwork in the design, fabrication, testing, and operation of a complex system with a well-defined objective
2. A needed channel for many students to gain self-confidence and employable skills
3. An example of intercollegiate, inter-departmental, and interdisciplinary collaboration
4. An avenue to enhance beneficial interactions among university, industry and community
5. A test-bed for innovative ideas in a wide variety of areas

Each of these benefits is delineated below.

1. A hands-on experience through teamwork in the design, fabrication, testing, and operation of a complex system with a well-defined objective

There is no substitute for experience. Bad experience may teach us caution and good experience courage; but no experience teaches us nothing.

Complexity and specialization are inseparable. As individual and societal goals become harder to achieve, more complex systems and devices are sought. The more complex the system or device becomes, the more specialized skills and techniques in a wide variety of fields are needed. The whole process of making a complex system work, from conceptual design to fully operational, demands closely coordinated large-scale teamwork. Such teamwork requires people skills as much as technical skills. The development of a complex system also demands time -- a duration longer than the average dwell time of its participants. Such a disparity in time-scale brings on the challenge for patience and dedication to the continuity of a larger self. A modern university is to provide its students the opportunity to face these challenges and to develop these skills.

Test-oriented courses, result-driven research projects and departmentally-defined programs are necessary building blocks of a university. They alone, however, do not provide the kind of learning just described. Talents already nested in these building blocks, however, can indeed be organized to provide a "hands-on experience through teamwork in the design, fabrication, testing, and operation of a complex system with a well-defined objective " to the students to gain the experience and the varied skills that are more and more demanded of them upon graduation.

2. A necessary channel for many students to gain self-confidence & employable skills

Realistic self-confidence enables further endeavors, and it grows out of excelling in one's performance along the way. Not all students can excel in classroom-oriented and test-driven learning. Students who excel in test-oriented learning are not necessarily profitably employable. If the university can provide a training ground for professional athletes, who do not always excel in regular classes, there should be room for programs that will enable a larger number of students, who may not necessarily excel in regular classes, to become competent workers in a variety of fields.

As a state university, we serve a large number of students with a wide range of interests and abilities. We must try to provide additional modes of learning to attract and retain a larger cross section of students to become future productive citizens.

3. An example of intercollegiate, inter-departmental, and interdisciplinary collaboration

The knowledge and skills required for SSP thread through departments and colleges, within our university. The breadth of experience to be offered by SSP should surpass all existing interdisciplinary programs. What is learned in the process of making SSP a success can be beneficial to other interdisciplinary programs addressing other complex systems. An example of a more practical, but far more complex system, could be the design, construction and operation of a model water-supply system that could adequately, safely and economically serve a community living in a delicate environment.

While much of the problem-solving along the way utilizes analytic tools and approaches, the entire project offers a holistic view and integrating process of working together towards a common goal. The SSP and similar kinds of projects or programs re-affirm the concept of "UNI" in our "university".

4. An avenue to enhance beneficial interactions among university, industry and community

A holistic view of the university must include the community. From the community, the university draws its life-giving resources in the form of money, goods, employees, and most of all, its students. To the community, the university returns life-enriching truth, beauty and goodness in the form of profound and innovative ideas, useful technology and services, and most of all, responsible and productive graduates.

The University of Arizona is a state institution located in a city that is equipped and working for economic development through "hi-tech" industries, especially in optical- and aerospace-based science and technology. The SSP will intensify the interactions among industry, the community and the university. For example, mutual benefits are expected when the Mechanical Structure & Analysis (MSA) Team of SSP interacts with the Composite Airframe Program at Pima Community College. Another example could be SSP's use of test facilities and expertise at Hughes as SSP trains skilled potential employees. The selection of the instrument and scientific objectives for SSP's first satellite stands as an example of the electro-optics based science and technology linking the University of Arizona with the local industries.

5. A test-bed for innovative ideas in a wide variety of areas

Generating and testing new ideas are intrinsic to the mission of a university. Unlike most of the research projects -- each conducted by a faculty and professional staff plus one or two graduate students -- SSP is conducted by undergraduate and graduate students. In addition to new ideas generated or stimulated by students, rigid rules and regulations can also be made more rational and tolerant to allow testing new ideas under much less external pressure. This is in obvious contrast to the way NASA runs its missions. SSP can truly serve as a test-bed for ideas in a wide variety of disciplines, in a manner NASA could not afford or dare to pursue.

The test-bed is also available to participating industries. As an example, Tucson Electric Power Co.'s newly developed thin-film solar battery is being considered by SSP for its first satellite. SSP offers other industrial partners similar opportunities to test their ideas or components.

CONCLUSION

The Student Satellite Project at the University of Arizona (SSP) has been underway for a year. It is an interdisciplinary project in engineering and science for students. Students participating in SSP are to design, fabricate, test, and deliver a small Earth-orbiting satellite to NASA for a launch by the Hitchhiker Ejection System on the Space Shuttle, and to carry out post-launch operations, data analysis and publications. The duration of the project is estimated at 2 - 3 years from conceptual design to launch and 1 - 2 year from launch to publications. The scientific objectives of the first attempt are to monitor global distribution of lightning, observe sprites and to perform stellar photometry. In addition, a laser communication experiment using the same optical system will be attempted. In the process of accomplishing these goals, SSP will offer predictable benefits to the students, faculty and staff at the University and concerned parties in industry and the local community. This is another example of the use of microsatellites.

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