

**Minority Universities Systems Engineering (MUSE) Program at the
University of Texas at El Paso**

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Introduction

In 1995, The University of Texas at El Paso (UTEP) responded to the suggestion of NASA Jet Propulsion Laboratory (NASA JPL) to form a consortium comprised of California State University at Los Angeles (CSULA), North Carolina Agricultural and Technical University (NCAT), and UTEP from which developed the Minority Universities Systems Engineering (MUSE) Program. The mission of this consortium is to develop a unique position for minority universities in providing the nation's future system architects and engineers as well as enhance JPL's system design capability. The goals of this collaboration include the development of a system engineering curriculum which includes hands-on project engineering and design experiences.

UTEP is in a unique position to take full advantage of this program since UTEP has been named a Model Institution for Excellence (MIE) by the National Science Foundation. The purpose of MIE is to produce leaders in Science, Math, and Engineering. Furthermore, UTEP has also been selected as the site for two new centers including the Pan American Center for Earth and Environmental Sciences (PACES) directed by Dr. Scott Starks and the FAST Center for Structural Integrity of Aerospace Systems directed by Dr. Roberto Osegueda. The UTEP MUSE Program operates under the auspices of the PACES Center.

Needs Addressed by the Program

Academic departments within universities are extremely capable of creating curricula. However, curricula is often lacking in connectivity. Senior-level capstone design courses help tie together courses within a single discipline, but do little to provide connection between courses in various departments. As technology has grown increasingly sophisticated, it has become clear that real-world problems require teams of engineers and scientists from every discipline. The coordination of this effort, systems engineering, is rarely taught as a discipline in and of itself. It requires the focus of a project. All this contributes to a general lack of understanding of what a practicing engineer does. Students often graduate and have little grasp of the communication and teamwork skills that engineers must have to do their jobs effectively. Additionally, students are often unaware of the numerous career opportunities which abound in industries such as aerospace,

Objectives of the Program:

As a result of this project, two major objectives will have been accomplished:
Academic and Professional Development of our students:

Provide students access to career opportunities in the aerospace industry, and government research and development laboratories.

Provide students with first-hand knowledge of the engineer's workplace and overcome the problems associated with the leap that must be made from coop/summer internship programs to the first job.

Stimulate students to pursue graduate study.

Development of a system engineering curriculum:

Incorporation of systems engineering concepts in all engineering disciplines.

Regular offering of an interdisciplinary systems engineering course sequence,

Activities Associated with the Program

Fall, 1995

Student recruitment represented the first activity of the project. An informational meeting was held at UTEP in mid-November to provide students an opportunity to obtain information related to the year's activities and to meet the UTEP faculty who will be involved. Kim Leschly, a systems engineer at JPL, attended the meeting. Selection of the students was made by a committee and based on completion of an application and academic record.

Spring, 1996

Students attended videotaped lectures provided by JPL. The topics of these lectures pertained to Satellite Subsystems and included: Systems Engineering Overview, Thermal Control Design, Communications Systems Design, Aerospace Mechanisms, and Power. At the completion of the spring semester 3 undergraduate and 1 graduate student were chosen to work at JPL during the summer.

Summer, 1996

Design Activity at JPL

Three UTEP undergraduate students and one UTEP graduate student spent nine weeks at JPL where they participated in the program designed by JPL in order to become acquainted with the System Engineering Tools and Project Engineering Tools available in the JPL Project Design Center. During this session they met and worked with students from CSULA and NCAT. This opportunity provided an ideal setting for building teamwork skills and to lay the foundation for these geographically-distanced students to continue their collaborative efforts when they return to their respective schools. These students participated in all aspects of the design of the satellite which they named Urania. Their final presentation was a formal design review which included a presentation of the Satellite Implementation Plan. The Review Board was comprised of a number of JPL experts in satellite design.

Design Activity at UTEP

UTEP was the site of a design activity during the Summer of 1996 in order to verify the approach which ultimately will be used in the development and institutionalization of the desired systems engineering curriculum. Five undergraduate students worked two months at UTEP preparing a detailed satellite communications subsystem design under supervision of Dr. Bryan Usevitch. This particular subsystem was one which UTEP agreed to assume the lead of the development.

Fall, 1996

Activities in the Fall included attendance at the AIAA/USU Conference on Small Satellites. Students presented their work in Poster Sessions at the Conference. Faculty and students from all three participating schools met with Kim Leschly of JPL, and devised a plan for continuing the work on the project. An electronic newsletter was one vehicle chosen to keep members informed of the progress of other groups. Several students at UTEP are continuing the work of the group in their senior design projects.

Rationale

The proposed plan of activities presents a cost-effective approach to assist UTEP in achieving the objectives stated earlier. Specifically, designing a satellite can serve as a unifying theme for bringing together students, faculty, and staff to study concepts from systems engineering. We felt that our students would be keenly interested in the prospects of designing a system that may ultimately be flown in space, and thus the recruitment of students for the proposed project was readily accomplished. Due to the wide range of engineering disciplines that must come together to accomplish such a design, the choice of a satellite project will lead to the desired interaction among departments in UTEP's Colleges of Engineering and Science. This in turn should lead to the development of a model curriculum in systems engineering which will find an audience among students from a wide range of academic majors. The existence of the consortium will enable us to draw upon the expertise present at other schools and will also provide a wider range of student backgrounds upon which we can test the effectiveness of the curriculum to be designed.

The involvement of JPL personnel and the availability of resources at JPL is critical to the success of the project. Through this project, UTEP students will be able to meet and work on a continuing basis with professionals at JPL. This experience is especially important for many UTEP students since the majority of UTEP students come from backgrounds which have prevented them from knowing first-hand what to expect in the engineering workplace. In general, they have little experience in relating to professionals holding graduate degrees other than faculty. Furthermore, the El Paso region is not one which contains large numbers of aerospace employers. The time that UTEP students spent at JPL will give them first-hand knowledge of career opportunities that exist in the aerospace industry.

Evaluation Plan

During 1995, UTEP was awarded a major grant from the National Science Foundation called Model Institution for Excellence (MIE). This major proposal lays the programmatic and systemic reform foundation for UTEP's strategic mission to increase its production of science, engineering and mathematics degrees awarded to underrepresented minority students. A major activity associated with the preparation of this proposal was a self-study in which over 200

faculty and staff participated. The self-study resulted in the development of goals for the numbers of students to be graduated over a five-year horizon.

We like to think that the educational activities associated with the MUSE Program as comprising an important part of the overall minority recruitment and retention efforts of UTEP in line with the goals of the MIE proposal. Programs such as this one are vital to UTEP in its efforts to obtain the desired increases in underrepresented minority student degree production in science, engineering and math. Through this project, UTEP has been able to provide some stipend support for approximately 15 students at the undergraduate level, as well as for one graduate student over the next year.

In terms of collecting evaluation data, UTEP has in place two offices which will support this effort. The Center for Institutional Evaluation Research and Planning (CIERP), along with the Office of Institutional Studies (OIS), will track students who participate in the Satellite Design experience. In particular, we will be interested in determining how many of these students, by virtue of their participation in the program, will ultimately enter graduate school in Electrical, Mechanical or Civil Engineering, as well as Geological Sciences. Another goal of this project will be to stimulate students to enter careers after the bachelor's degree in the aerospace industry. We will track students after graduation to determine the numbers of students that do exactly this.

Systems Engineering Curriculum Initiatives at UTEP

A major goal of the MUSE program has been to strengthen the ability of the participating universities to educate their students in the field of systems engineering. Along these lines, UTEP has adopted a staged strategy for the introduction of systems engineering concepts and courseware in its curricula. A philosophy has been adopted that the courses to which these efforts are to be applied should be regularly scheduled courses, preferably required by major. Additionally, UTEP has selected courses as candidates for the integration of systems engineering principles which have as their goal the design and development of student projects. It is the judgment of the UTEP faculty that group-oriented design and development are the most natural venue for learning systems engineering concepts. The following sections provide a near term plan for its curriculum development activities relating to systems engineering.

Senior Design Project Course Sequence in Electrical and Computer Engineering

The Senior Design Project course sequence is a two-course sequence which is required for all students majoring in electrical and computer engineering. In this course sequence, students work in groups of 3-4 to define, design and build a prototype product. The course sequence was previously modified through the efforts of an IBM Faculty Fellow on loan to UTEP. The course was restructured to introduce students to some concepts of systems engineering: preparation of requirements, specification, and other related documents. Furthermore, students are introduced to several forms of project planning, such as PERT charting. To enhance communication skills, students are required to make numerous written and oral reports. The Department of Electrical and Computer Engineering enrolls the largest number of students of any department within the College of Engineering. The Senior Design Project course sequence has won praise for its success in preparing students for future careers.

During the Fall 1996 semester, UTEP will use the existing Senior Design Project course sequence in the Department of Electrical and Computer Engineering as the setting for its curriculum reform efforts in systems engineering. Systems engineering courseware developed at JPL will be integrated into the lecture portion of the Senior Design Project course sequence. In particular, UTEP will pursue the introduction of systems engineering elements such as design to

cost principles, project trade-offs, and other concepts which have previously not been a part of the Senior Design course sequence. UTEP also plans to pursue the possibility of involving members of JPL's technical staff in the teaching of various systems engineering topics. It is envisioned that this might be accomplished via distance learning and visits to the UTEP campus. By augmenting and enhancing the systems engineering component of this course sequence, the entire class of graduating seniors in electrical and computer engineering will be impacted. This should be on the order of 100 students per year, the bulk of whom are underrepresented minorities.

All majors in the College of Engineering at UTEP offer capstone senior design courses. Once success is shown in terms of infusing systems engineering concepts into the Senior Design Project course sequence in electrical and computer engineering, UTEP will investigate mechanisms for replicating the process with other majors in the College.

Special Topics Course in Mechanical Engineering

UTEP will offer an upper-division special topics elective in the Department of Mechanical and Industrial Engineering during the Spring 1997 Semester. The subject of the courses will be internal combustion engines and a potential project of the course will be development of a propane-powered vehicle. This elective course will be an excellent candidate for integration of systems engineering courseware and instructional materials. Systems engineering concepts such as effective team building, subsystem specification and design and others will be introduced in the course to provide a framework for the diverse student groups who will be responsible for the various vehicle subsystems. It is believed that approximately thirty upper-division engineering majors will receive instruction in systems engineering concepts and processes. Additionally, this course will provide UTEP with a multi-disciplinary setting into which systems engineering instructional materials can be placed.

Other Courses

The concepts of systems engineering will also be taught to engineering students in the Introduction to Engineering course sequence. These courses are multidisciplinary, and required for students planning to pursue an engineering degree at UTEP. An additional course, communication systems engineering, will be offered by UTEP in Fall, 1997. This course will be offered through the Electrical Engineering department, and will focus on systems design as it relates to communications.

Summary

In line with the requirements set forth by the Accreditation Board for Engineering and Technology, and in light of current trends in engineering education, the College of Engineering at UTEP has embarked upon a process that has resulted in the teaching of engineering design across the curricula. Presently, students are given opportunities to participate in engineering design activities at all stages of their development beginning with the freshman year and culminating with senior capstone design classes. Many of these activities are group-oriented. It is the expectation of UTEP that by integrating systems engineering concepts into selected courses such as those presented earlier, students will be able to master systems engineering principles within the context of group-oriented projects. Also, the approach presented above will enable UTEP faculty to evaluate the need for establishing a specific course in system engineering.

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