Senior Capstone Design Experiences at the University of Tennessee: NASA and DOE Student Programs
Viatcheslav I. Naumov\textsuperscript{1}, [David K. Irick\textsuperscript{2}, Lawrence A. Taylor\textsuperscript{3}, Masood Parang\textsuperscript{4}]

Abstract – An effective way to introduce engineering students to aerospace and mechanical engineering issues is to implement exciting NASA, DOE, ASME, and other student programs into the senior year capstone design experience. The University of Tennessee’s implementation of DOE’s Advanced Vehicle Technology Competitions as capstone design projects began with the Methanol Marathon in 1988 and has continued through various alternative fuel and hybrid electric vehicle competitions; the current competition is Challenge X. Later, two new projects, named “Microgravity” and “Lunar Rover Vehicle” were included as capstone design options. Both require participation, on a competitive basis, in two corresponding NASA programs: “The Reduced Gravity Student Flight Opportunities Program” and “The Great Moonbuggy Race.” Years of experience have demonstrated that these programs are very suitable in offering senior students unique opportunities to improve their analytical abilities, develop design skills, gain experience in working in multi-disciplinary teams and solve cutting edge engineering problems.

Keywords: Student programs, Design, Analysis, Fabrication, Competition.

INTRODUCTION AND BACKGROUND
An effective way to introduce engineering students to aerospace and mechanical engineering issues is to implement exciting NASA, DOE, ASME, SAE, and other student programs into the senior-year capstone-design experience, many of which correspond well with the goals of the senior capstone design activity. Examples include the “Reduced Gravity Program” \cite{1}, “Solar Splash Program” \cite{2}, “Formula SAE Project” \cite{3}, “Moonbuggy Program” \cite{4}, Flying Educational Experiments on NASA Vehicles \cite{5}, Hydro Power Contest \cite{6} and Challenge X \cite{7}. A variety of US universities takes part in these programs both within and outside of the framework of senior capstone design projects. The information about specific university projects can be found in the above mentioned reference sites. Historically the Mechanical, Aerospace and Biomedical Engineering (MABE) Department began

\textsuperscript{1} V.I. Naumov, Visiting Professor, University of Tennessee Department of Mechanical, Aerospace and Biomedical Engineering, 214 Perkins Hall, Knoxville, TN, 37996, vnaoumov@utk.edu

\textsuperscript{2} D.K. Irick, Research Assistant Professor, University of Tennessee Department of Mechanical, Aerospace and Biomedical Engineering, 414 Dougherty Engineering Building, Knoxville, TN, 37996, dki@utk.edu

\textsuperscript{3} L.A. Taylor, Professor, University of Tennessee, Department of Earth & Planetary Sciences, 402 Geological Sciences Building, Knoxville, TN, 37996, lataylor@utk.edu

\textsuperscript{4} M. Parang, Associate Dean for Student Affairs, University of Tennessee, College of Engineering, 101 Perkins Hall, Knoxville, TN, 37996, mparang@utk.edu

2006 ASEE Southeast Section Conference
incorporating competition based projects into the capstone design experience with Advanced Vehicle Technology Competitions sponsored by the DOE. These competitions began with the Methanol Marathon in 1988 and have continued through various alternative fuel and hybrid electric vehicle competitions; the current competition is “Challenge X.” Later, the MABE Department launched two additional projects outside of the capstone design experience as special topics courses that could be used as technical electives to satisfy degree requirements. These were the “Reduced -Gravity Student -Flight Opportunities Program”, organized and sponsored by NASA Johnson Space Center [1], and the “Moonbuggy Program”, organized and supported by Marshall Flight Space Center [4]. These projects have been successfully incorporated into capstone design options beginning in 2002.

Through participation in these competition based capstone design projects, our students gain valuable experience in

- Problem identification,
- Conceptual and detailed design
- Detailed design
- Procurement and fabrication
- Testing
- Reporting (both oral and written presentations)
- Resource management
- Scheduling
- Evaluation and comparisons with competing designs from other universities
- Essential interaction between engineering students from varied disciplines

An important benefit of these projects for the students has been the unique opportunity to meet and communicate with NASA and DOE specialists and to get involved in the solving of real engineering and scientific problems, understand the impact of engineering solutions in a global/societal context as well as, participate in unique competitions.

**Advanced Vehicle Technology Competitions Program Description**

DOE and General Motors are sponsoring this three-year competition, which began in fall 2004 and will end in spring 2007, as part of the ongoing Advanced Vehicle Technology Competition (AVTC) series. AVTCs provide the student teams an opportunity to re-engineer a production vehicle to improve its fuel economy and reduce its environmental impact. In recent years, these competitions have focused on hybrid electric vehicles. Challenge X is different from other DOE-sponsored AVTCs, in part because it mimics the vehicle development process embraced by all major vehicle manufacturers. Challenge X follows key steps of the process throughout the three-year competition, giving students at the participating schools valuable experience in real-world engineering practices as they design, develop and build a hybrid electric version of the Chevrolet Equinox, based on a production vehicle provided to each school. The selection of universities for participation is based on competitive proposals submitted by student teams in the spring prior to the beginning of the competition cycle. Throughout the academic year, the students must submit technical reports and project updates, culminating with the final technical report which is one of the scored categories in the year-end competition.

The first year of the program focused on modeling, simulation, and testing of the vehicle subsystems. Modeling and simulation of available powertrain components were used to predict the performance of vehicle configuration and to ultimately select the vehicle powertrain and subsystems. Packaging analyses were performed using CAD models of the vehicle supplied by GM, and models of candidate powertrain component either supplied or developed by the students. Environmental impact evaluations were performed on a well-to-wheels basis using models developed by DOE. Cost analyses were also performed in parallel with the model and simulation activities to arrive at the powertrain architecture to be developed in the following year.

The second year of the program is building on the work done by the students who participated during the first year. The students are designing the subsystems and interfaces to incorporate the powertrain defined in the first year into the production vehicle platform. The students will continue to refine the models developed in the first year to continue the use of simulation in design activities and vehicle performance predictions. The student designs will be installed into the vehicle to produce a working “mule” vehicle to demonstrate and test their powertrain prior to and during the competition held in June at GM’s desert proving grounds. The competition consists of events to test the vehicle’s performance, such as on-road fuel economy and emissions, acceleration, handling, and trailer towing.
capability. The students are also tested in events such as technical presentations, consumer oriented presentations, and various technology focused presentations for awards given by participating sponsors.

The third year of the program will focus on refining the vehicle’s utility and performance, emphasizing consumer acceptability and marketing qualities. Considerable development and testing will take place in year three to arrive at a production-like quality vehicle for the third year competition.

**Reduced Gravity Student Flight Opportunities Program Description**

The Reduced Gravity Student Flight Opportunities Program provides a unique academic experience for undergraduate students to successfully propose, design, fabricate, fly, and evaluate a reduced - gravity experiment of their choice. This overall experience includes scientific research, hands-on experimental design, test operations, and educational/public outreach activities. The Reduced Gravity Program usually begins in October and has the following milestones:

(a) In early October, a Letter of Intent (LOI) is submitted that marks the first level of communication between the student teams and the program coordinator;

(b) Toward the end of October, a proposal for participation in the competition is submitted. It contains various parts including theoretical background of the proposed research, test objectives, test descriptions, apparatus and equipment descriptions, structural design, electrical and hazard analyses, and description of the data acquisition system;

(c) In early December, the teams receive decision letters of acceptance/rejection and feedback about their proposal;

(d) During January and February, flight physicals are conducted and submitted;

(e) From January through March, the students submit a test - equipment data package that must include detailed test apparatus and equipment description, calculations, plan of experiment, and any additional specific information that may be required;

(f) During March through July, the flight is scheduled and the experimental package is flown;

(g) During August and September, a post - flight final report is written and submitted.

During the flight week, the selected team normally undergoes physiological training in classroom and hypobaric chambers, completes construction of the experimental equipment, passes test-readiness review and technical inspection, loads equipment onto the aircraft, flies two - consecutive days with their experiment package, and collects data. Each team is assigned two consecutive flight days, with one flight scheduled per day. Each flight lasts an average of 60 to 80 minutes and has approximately 30 reduced-gravity parabolic maneuvers over the Gulf of Mexico. The trajectory flown on each parabolic maneuver will provide approximately 25 seconds of near - zero gravity conditions for each team's experiment (Fig. 1). At the end of the reduced gravity maneuvers, teams/experiments are also subjected to approximately 30 seconds of lunar-g (1/6-g) and approximately 40 seconds of Martian-g (1/3-g) environments. Ground crew-membership is unrestricted, and may include students (high school, undergraduate, graduate), faculty members, and professional consultants. The proposed experiments can cover a wide range of research in mechanical and aerospace engineering, electrical engineering, material science, biomedical engineering, biomedicine, and many other fields. The same test facility may be used for a maximum of 3 years if needed to complete the proposed research. A significant aspect of the Reduced Gravity Program is the outreach component, which is designed to engage the team members in outreach activities in their own university, community, and region.

**NASA Moonbuggy Program Description**

The NASA Moonbuggy Program addresses the design, fabrication, assembly, and testing of a human powered vehicle inspired by the Lunar Rover, or moonbuggy. Students are required to design a vehicle that solves engineering problems similar to problems faced by the original Apollo moonbuggy team. Each moonbuggy is human powered and carries two students, one female and one male, over a half-mile simulated lunar terrain course, including “craters”, rocks, “lava” ridges, inclines, and “lunar” soil (Fig. 2). There are several requirements that are included in the design of the moonbuggy vehicle. They include:

(a) Vehicle should be human powered; energy storage devices (e.g., springs, flywheels, etc.) are not allowed;

(b) The unassembled vehicle must fit (or be collapsible to fit) in a volume with maximum dimensions of 4’ x 4’ x 4’;

(c) The assembled vehicle must be able to be lifted and carried 20 feet by the two passengers without any aid;
(d) The maximum width of the assembled vehicle should be not more than 4 feet, including wheels;
(e) Vehicles, or parts of vehicles, not constructed by the entering team are not acceptable; and
(f) Vehicles that have been previously entered into the competition should contain major modifications designed to improve performance (i.e., no repeat running of the exact same buggy).

Figure 1 The diagram of a typical reduced gravity maneuver

Figure 2 Course map at NASA Marshall Space Flight Center (MSFC). Many of the obstacles along the “lunar track” and the layout of the course were designed in the early 90’s by Frank Six of MSFC and Prof. Larry Taylor of The University of Tennessee.

In comparison with the Reduced - Gravity Program, the NASA Moonbuggy Program has only two milestones: the list of moonbuggy team-members are submitted in February, and the list of teams participating in the Great Moonbuggy Race and Technical competition is finalized in early April.

Motivation
The motivation to incorporate the outlined programs into senior capstone design courses was based on the following factors:

1. General consensus that more and varied design experiences should be incorporated into the engineering curriculum [8], [9].
2. The projects completely cover all steps of the design process – from the brainstorming phase to the evaluation of hardware, competition, and analysis of the results.
3. The projects provide practical application of engineering fundamentals to real engineering and scientific problems.
4. The projects cover the expected outcomes for a capstone design course specified by ABET Inc. accreditation.
5. The experience can improve students’ understanding of mechanical and aerospace engineering issues.
6. The projects can be completed over a period of two semesters.

PROJECTS’ ACCOMPLISHMENTS, AND ENGINEERING/SCIENTIFIC RESULTS

Challenge X
The University of Tennessee has been involved with hybrid electric vehicles since 1992. After several successful competitions involving alternative fueled vehicles, the UTK involvement in hybrids began with the 1993 Hybrid Electric Vehicle Challenge and continues with the current Challenge X competition. The U.S. DOE has, since 1989, organized an annual intercollegiate automotive design competition focused on the use of alternative fuels (including hybrid electric drives). These competitions involve several industrial sponsors and culminate with the student teams meeting at the vehicle manufacturer’s test facility for comprehensive testing and design reviews.
Several vehicles have been built by the students and have competed successfully in the competitions over the years, placing first overall several times and demonstrating best in class in fuel economy and emissions. Additionally, the students have won several awards for their work on the vehicles such as National Instruments’ Most Innovative use of Virtual Instruments and Visteon’s Most Innovative Use of Electronics awards. Two of the vehicles are shown below in Figure 3.

![FutureCar and FutureTruck](image)

Figure 3 FutureCar, 1998-99 capstone design project and FutureTruck, 2002-2004 capstone design project

**Reduced - Gravity Project**

During 2002/03, 2003/04, and 2005/06 academic years, three Reduced - Gravity Projects where initiated:

“Making A Mixing Measurement Of Two Phase Flow - MAMMOTH” was started in 2000 by a group of volunteer students and was completed in 2003 as a senior capstone design project. The objectives of this experiment were to simulate film boiling in reduced - gravity conditions using air injected into a liquid flow in a vertical pipe.

“Heat Exchange Research and Condensation Evaluation by Utilizing a Liquid/fog Experimental Set up - HERCULES” was started as a senior capstone - design project in 2002 and completed in 2005. The objectives of this project were to investigate the peculiarities of forced - flow condensation in reduced - gravity using saturated air/water mixture flow.

“Simulation for Confirmation of the Onset Correlation of Liquid Potassium Entrainment – SCOPE” started in 2004. The objectives were to simulate liquid droplet entrainment in vapor flow and to investigate the entrainment interaction between air and water in an annular - flow regime at reduced - gravity conditions.

HERCULES is a typical example of these projects. It began as a senior capstone - design course, and then was extended through two additional academic years in two different senior capstone - design classes. After an initial intensive brain - storming phase and careful discussion of various ideas, two separate projects were proposed by the design teams. These projects were selected based on their technical significance, their relevance to the engineering problems faced in the space environment and in according with the goals of NASA.

After selection of the problems, proposal preparation began. The proposals were submitted to NASA Reduced Gravity Student Flight Opportunities Program at the end of October. In spite of the fact that the project selection results were not yet known, the teams immediately began to work on the detailed schematics of the test apparatus and a data acquisition system, designing the test apparatus, and establishing communicating with vendors to purchase the needed equipment. By the end of the fall semester the main analyses were completed, the major portion of the equipment was purchased, and important parts of the test apparatus (e.g., frame, water tank, test section), were designed and fabricated. By the beginning of March, the test apparatus was completely assembled (Fig.4, 5) and had undergone ground tests to adjust fluid - flow parameters. The flight tests were performed in the middle of March in Houston (Fig. 6,7), and data analysis, writing of the senior capstone - design final report, and final presentation were completed during the remainder of the spring semester.
This project produced interesting qualitative results. The experiments on condensation confirmed expectations about air/liquid annular, slug, and bubble-flow patterns under reduced gravity. The temperature change measurements were collected for various phases of the flow (Fig. 8). These data demonstrated that less condensate is expected to form under microgravity condition than under normal gravity. The detailed description of the test apparatus, experimental performance, and scientific results were presented and published in the proceedings of 42nd and 43rd AIAA Aerospace Science Meeting and Exhibit [10, 11].

**NASA Moonbuggy Project**

The University of Tennessee’s participation in the NASA Moonbuggy Program began 9 years ago with a group of volunteer students through the initial efforts of Prof. L.A. Taylor, UT’s director of the Tennessee Space Grant Consortium. In August 2002, this program was offered for the first time as a senior capstone project for ME students. There are two alternative project tasks: a) to improve the existing moonbuggy fabricated in previous academic year(s), or b) design, fabricate and build a new one. Due to the complexity of the designs, both options take two semesters to be completed. Even improving an existing moonbuggy often involves considerable change in the design and requires significant effort and time.

The fabrication of a new moonbuggy or improving the existing design requires a period of intense discussion and brainstorming, which typically takes one month. After discussions, approximately two to three months are spent for calculations (especially stress analysis) and drawings. For example, design and fabrication of a new vehicle requires stress analysis of frame, seats, analysis of the suspension system, the transmission, the shock absorbers, and preparation of more than 100 drawings and sketches. The fabrication process starts normally toward the end of November and finishes in the middle of March. Vehicle assembly often proceeds in parallel with the fabrication process (Fig. 9). At the end of March, students are usually in the process of writing and sending their report to the NASA Moonbuggy Program officers, wherein they describe the moonbuggy design and road tests of the vehicle. The technical competition (Great Moonbuggy Race) takes place at the Marshall Space Flight Center, at the
beginning of April. Here students have the unique opportunity to test their vehicle in the races and compare the advantages and disadvantages of their design with other vehicles entered in the competition from some 20 to 30 other American universities (Figs. 10 and 11). During the remainder of the semester, the students write the senior capstone - design report and prepare a final presentation.

Figure 8 Comparison of the history of temperatures difference of fog and water for reduced gravity and normal gravity condition.

Figure 9. Moonbuggy assembly

Figure 10 UT moonbuggy on the start line at MSFC

Figure 11 UT moonbuggy on course

EDUCATIONAL LESSONS LEARNED

Course organization and leadership

Various pedagogical problems were identified and resolved during the experience with these projects. In general, the organization of the course proved to be effective with regard to the division of responsibilities. A portion of the semester was spent defining each project before the groups were formed and assignments made. However, even with this planning, there was some variation in individual work loads within the groups and within the class as a whole. Some of this variation was due to an incomplete definition of the project, and some of it was due to a variation of initiative among the students.

The experience showed that it would be more reasonable to distribute student activity uniformly during the fall and spring semesters. This would alleviate many of the problems exacerbated by the "time crunch" and by the complexity of the projects. The current offering starts with a two or three (depends on the project) semester - hour credit course in the fall followed by a three or two (depends on the project) semester credit hour course in the spring. It is preferable to have a two - semester class from the point of view of NASA and DOE deadline.
requirements. For example the Reduced Gravity Project has deadlines that exist in both semesters, and the Challenge X program has reporting requirements that span the entire academic year. Similarly for the Moonbuggy project, there is a great need to distribute the extensive work in the machine shop so that the assembly of various parts can proceed smoothly and often simultaneously so that the end of November deadline can be met.

The second problem that needed to be addressed was how to meet the required team nature of the activity. The experience showed that teams of two to four students are optimal in the redesign and improving of the existing (old) moonbuggy vehicle or microgravity test apparatus, and teams of four to six students are optimal for the design and building of new microgravity test apparatus or new moonbuggy vehicle. As a result, in every academic year, between eight and ten seniors students have been involved in the Moonbuggy and Microgravity projects. An important issue is to involve students in both NASA projects on a continuing basis and transfer the experience gained in each previous year to that of the projects for the next year. To provide this opportunity we decided to offer 1 credit hour class for junior students. The junior students are able to work with the seniors while taking the 1-credit hour course and become familiar with the project and are trained for the problems they have to face in their own senior year. So, every year, 3-4 former junior students that took the 1 credit hour class in the previous academic year continue to work on the project as senior students. The Challenge X project has a broader scale, which requires more students (up to 30) to accomplish the project goals. However, the overall project is divided into smaller projects, along the lines of the subsystems of the vehicle, and groups are formed in a manner similar to that described above. Due to the specialized nature of the project, the students are required to enroll in an additional class in the fall semester. This class is Introduction to Hybrid Electric Vehicles, and it provides the students with the background required for the design activities. Underclassmen typically don't have the background required to participate in this project; therefore, project continuity is provided primarily through the instructor and graduate students who participated in the project as seniors.

The third and major problem is that of team leader, which has been addressed with the appointment of project leaders. For the current version of these projects, the project leaders have the typical responsibilities of both principal engineer and project engineer. The project leader is responsible for moderating meetings, scheduling the outside-class meetings, and tracking the design and procurement schedules. The project leaders also have responsibility for identifying and resolving subsystem integration issues.

An interpersonal communication problem has been identified, but this problem is rooted in personalities, egos, and the makeup of the groups and the team as a whole. As with the leadership and scheduling problem already mentioned, this problem was exacerbated by the short time frame of the course (only one semester). This is not an easy problem to solve but can be alleviated by early and frequent intervention on the instructors' part.

Another significant problem to resolve was to organize an effective outreach activity. The university and community outreach activity is a very important part of these projects. Typically, one or more students are assigned the responsibility for organization of the presentations of projects in the university, high schools, and middle schools, where school children could be exposed to the project activity. They are also responsible to facilitate the presentation of the projects in exhibitions, and communicate with the media. As an example, approximately ten presentations were carried out in middle and high schools. The moonbuggy vehicles and the microgravity test apparatus were exhibited in the 2002 and 2003 UTK Exhibition of Undergraduate Research and Creative Achievement. The moonbuggy vehicles, FutureTruck, Challenge X vehicle, and the microgravity test apparatus are exhibited during Engineering Day, Homecoming weekend, and other on-campus events. Moonbuggy vehicles and Microgravity test apparatus were also exhibited in 2002 and 2003 in the Discover–E Event organized for Girl Scouts. Various articles about these projects have been published in the University of Tennessee newspaper (Daily Beacon), in the city newspaper (Knoxville News Sentinel) and in U.S. News & World Report Journal, as well as UT alumni newsletters. The projects have also received local television coverage in science and technology programming.

**Projects evaluation**

In order to check the effectiveness of the above-described senior capstone - design projects, the student were asked to assess these design courses. Students were asked to evaluate ABET Inc. educational outcomes (see Table 1). The grades assigned were 1(not at all); 2 (somewhat); 3 (moderate); 4 (well); and 5 (very well). The results of the evaluation are presented in Fig. 12 and 13. The students - also - rated all - other departmental senior capstone - design classes. It was found that the 58% of the ABET outcomes in the Moonbuggy design class were evaluated.
more favorably, compared with the average departmental design classes (3.74 from 1-5 scale). The number was even higher for the Microgravity design class, where more than 78% of the outcomes were judged better than the average departmental outcomes

Table 1

<table>
<thead>
<tr>
<th>(a)</th>
<th>Apply knowledge of math, science and engineering</th>
</tr>
</thead>
<tbody>
<tr>
<td>(b)</td>
<td>Design and conduct experiments; analyze and interpret data</td>
</tr>
<tr>
<td>(c)</td>
<td>Design a system or component to meet desired needs</td>
</tr>
<tr>
<td>(d)</td>
<td>Function on multi-discipline teams</td>
</tr>
<tr>
<td>(e)</td>
<td>Identify, formulate, and solve engineering problems</td>
</tr>
<tr>
<td>(f)</td>
<td>Understand professional and ethical responsibility</td>
</tr>
<tr>
<td>(g)</td>
<td>Communicate effectively</td>
</tr>
<tr>
<td>(h)</td>
<td>Understand the impact of engineering solutions in a global/societal context</td>
</tr>
<tr>
<td>(i)</td>
<td>Recognize the need for lifelong learning</td>
</tr>
<tr>
<td>(j)</td>
<td>Apply training to contemporary issues</td>
</tr>
<tr>
<td>(k)</td>
<td>Use modern engineering tools necessary for engineering practice</td>
</tr>
<tr>
<td>(m)</td>
<td>Apply advanced mathematics</td>
</tr>
<tr>
<td>(n)</td>
<td>Apply statistics and linear algebra</td>
</tr>
<tr>
<td>(o)</td>
<td>Work professionally in both thermal and mechanical systems</td>
</tr>
</tbody>
</table>

for the departmental design classes. The average scores for average departmental projects, Moonbuggy project and Microgravity projects were correspondingly 3.74, 3.81, and 4.13 from 1-5 scale. The course assessment for the Challenge X capstone design course was in the average range in 2005 for the first year in quite some time. This was felt to be a result of the absence of a hands-on component due to the focus on modeling and simulation in the first year of the Challenge X competition. This only underscores our experience that these competition based capstone design projects with a hands-on component are most beneficial to, and the best received by, the students.

Figure 12 Moonbuggy course student assessment

Figure 13 Microgravity course student assessment

ACKNOWLEDGMENTS

The authors wish to thank NASA for providing the opportunity for the students’ participation in the NASA Reduced Gravity Student Flight Opportunity Program and the NASA Moonbuggy Program, both with major financial support and encouragement from the Tennessee Space Grant Consortium, and the U.S. Department of Energy, General Motors Corporation, Ford Motor Company, and Daimler-Chrysler Corporation, Honeywell for their continued support of the Advanced Vehicle Technology Competitions.
REFERENCES


BIOGRAPHICAL INFORMATION

Viatcheslav Naumov
Visiting Professor, The University of Tennessee, Department of Mechanical, Aerospace & Biomedical Engineering. BS, MS, and PhD and Dr.Sc. degrees in Aerospace Engineering from The Kazan State Technical University, Russia. Distinguished Scientist of the Russian Republic of Tatarstan. AIAA Member. Teaching interests: Thermodynamics, Propulsion, Heat Transfer, Combustion. Research interests: thermo-chemical non-equilibrium flows, chemical kinetics, thermodynamics, combustion analyses, thermal/fluid systems, numerical simulation of propulsion and power generation systems, microgravity fluid flow and phase change heat transfer.,

David Irick
Research Assistant Professor, The University of Tennessee, Department of Mechanical, Aerospace & Biomedical Engineering. BS, MS, and PhD degrees in Mechanical Engineering from The University of Tennessee. SAE Member, SME Senior Member. Teaching interests: Internal Combustion Engines, Thermodynamics, Engineering Design. Research interests: internal combustion engines, vehicle systems, computer integrated engineering and Manufacturing.

Lawrence Taylor
Distinguished Professor, The University of Tennessee, Department of Earth and Planetary Sciences. Indiana University (B.S., degree in Chemistry and M.S. in Geology from The Indiana University, Ph.D. Lehigh Univ., Geology/Material Science.; Distinguished Prof. Of Planetary Science., Univ. of Tennessee; Director, Planetary Geosciences Institute; UT Director, Tennessee Space Grant Consortium; NASA PI on Lunar, Martian, and Meteorite Sample Studies. Teaching interests: Geochemistry, Petrology. Research interests: geochemistry of planetary specimens, In-Situ Resource Utilization (ISRU) of lunar and martian rocks and solids; flight programs to Moon and Mars; origin of diamonds; space outreach endeavors.

Masood Parang
Associate Dean of Student Affairs, The University of Tennessee College of Engineering. BS, MS and Ph.D degrees from University of Oklahoma. Shell Professor of Mechanical Engineering, Associate Fellow, AIAA. Teaching interests: Fluid Mechanics, Heat Transfer, Thermodynamics, Applied Mathematics. Research interests: vortex stability, application of boundary integral and finite difference methods in heat transfer and phase change problems, two-phase flows, perturbation methods in heat transfer and fluid flow problems, microgravity fluid flow and phase change heat transfer, thermoacoustic convection under normal and microgravity conditions.