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Utah State University

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AGENDA

MEETING OF THE
UTAH STATE BOARD OF REGENTS
TO BE HELD AT
TAGGART STUDENT CENTER
UTAH STATE UNIVERSITY
LOGAN, UTAH
AUGUST 28, 2009

Utah State Board of Regents
Office of the Commissioner of Higher Education
Board of Regents Building, The Gateway
60 South 400 West
Salt Lake City, Utah 84101-1284
August 19, 2009

MEMORANDUM

TO: State Board of Regents

FROM: William A. Sederburg

SUBJECT: Utah State University–Master of Science in Aerospace Engineering–Action Item

Issue

Utah State University (USU) requests approval to offer a Master of Science Degree in Aerospace Engineering, effective Fall Semester 2009. This program was approved by the USU institutional Board of Trustees on May 15, 2009 and approved by the Regents’ Program Review Committee on July 7, 2009.

Background

The Department of Mechanical and Aerospace Engineering (MAE) at Utah State University seeks to offer a new Master of Science (MS) graduate degree program in Aerospace Engineering to complement the current MS, Master of Engineering (ME), and PhD programs in Mechanical Engineering. The new MS program will require at least 30 credit hours beyond the bachelor’s degree and will comply with all Graduate School requirements. The present MS Mechanical Engineering degree has an aerospace specialization option. The coursework available through the existing specialization, and the aerospace expertise that currently exists in the department, are such that the proposed creation of a stand-alone degree is an administrative, structural change requiring no new courses or state resources.

In 2007, the Economic Development Corporation of Utah described Utah as one of the top ten states in the nation in the concentration of aerospace employment. Over the decade from 2006 to 2016, the Bureau of Labor Statistics projects a 10 percent growth in employment for aerospace engineers. Increases in defense aerospace projects and new technologies to be used on commercial aircraft should spur demand for aerospace engineers. Given the large concentration of aerospace industries in Utah, graduates with an MS in Aerospace Engineering should have little difficulty finding a position in Utah.

Two types of students will benefit from the proposed MS in Aerospace Engineering: full-time, traditional graduate students and part-time, working professionals. The full-time students are generally preparing for an entry-level position.
Policy Issues

Other Utah System of Higher Education institutions have reviewed this proposal, have given input, and are supportive of Utah State University offering this degree.

Commissioner’s Recommendation

The Commissioner recommends the Regents approve the Utah State University request to offer a Master of Science Degree in Aerospace Engineering, effective Fall Semester, 2009.

William A. Sederburg, Commissioner

WAS/GW
Attachment
Academic, Career and Technical Education and Student Success Committee
Action Item

Master of Science in Aerospace Engineering

Utah State University

Prepared for
William A. Sederburg
By
Gary Wixom

August 19, 2009
SECTION I: The Request

Utah State University (USU) requests approval to offer the Master of Science degree in Aerospace Engineering effective Fall Semester 2009. The proposed Degree has completed all stages of the campus review process and was approved by the Utah State University Board of Trustees on May 15, 2009.

Section II: Program Description

Complete Program Description

The Department of Mechanical and Aerospace Engineering (MAE) at USU seeks to offer a new Master of Science (MS) graduate degree program in Aerospace Engineering to complement the current MS, ME, and PhD programs in Mechanical Engineering. The present MS Mechanical Engineering degree has an aerospace specialization option. The coursework available through the existing specialization, and the aerospace expertise that currently exists in the department, is such that the proposed creation of a stand-alone degree is an administrative, structural change requiring no new courses or state resources. The proposed MS Aerospace Engineering degree provides the opportunity for its graduates to be more focused on the needs of the aerospace industry or for additional postgraduate studies within aerospace. Over time, it is anticipated that new courses will be developed to enhance the program and strengthen its relevance to changes in the aerospace discipline. These courses will be proposed, reviewed, and integrated into the program using established college and institutional practices.

The new MS program will require at least 30 credit hours beyond the bachelor's degree. The MS Degree will have three options, which are described below.

MS Degree (Plan A) Requirements: The MS (Plan A) degree is based on research and requires 30 credit hours including a formal thesis. The degree is designed to prepare graduates for entering a PhD program or performing research in industry or government labs. The degree consists of core courses (5000-, 6000-, and 7000-level) in Aerospace Engineering, advanced mathematics, technical electives, and a thesis-quality research project.

1. Five courses selected from the Aerospace Engineering Core are required. Note: The following two classes (or their equivalent) are required unless previously completed.
   a. MAE 5500 Aerodynamics
   b. MAE 5560 Dynamics of Space Flight
2. One math class from the MAE-approved list is required.
3. Two technical electives selected from 5000-, 6000-, or 7000-level courses approved by the student’s supervisory committee.
4. At least six credits of thesis research (MAE 6970) are required.
5. No more than 15 semester credits of 5000-level course work may be used for a graduate degree.

MS Degree (Plan B) Requirements: The MS (Plan B) degree requires 30 credit hours including a formal design project. The program is designed to prepare graduates for employment requiring advanced design in industry. It consists of core courses (5000-, 6000- and 7000-level) in Aerospace Engineering, advanced mathematics, technical electives, and a design project.

1. Six courses selected from the Aerospace Engineering Core are required. Note: The following two classes (or their equivalent) are required unless previously completed
a. MAE 5500 Aerodynamics
b. MAE 5560 Dynamics of Space Flight
2. One math class from the MAE-approved list (including ECE 6030 and 6010) is required.
3. Two technical electives selected from 5000-, 6000-, or 7000-level courses approved by student’s committee.
4. Three credits of a design project (MAE 6950) are required.
5. No more than 15 semester credits of 5000-level course work may be used for a graduate degree.

**MS Degree (Plan C) Requirements:** The MS (Plan C) degree requires 33 credit hours of course work. The program is designed to prepare graduates for employment requiring an advanced degree. It consists of core courses (5000-, 6000-, and 7000-level) in Aerospace Engineering, advanced mathematics and technical electives.

1. Seven courses selected from the Aerospace Engineering Core are required. Note: The following two classes (or their equivalent) are required unless previously completed.
   a. MAE 5500 Aerodynamics
   b. MAE 5560 Dynamics of Space Flight
2. One math class from the MAE-approved list (including ECE 6030 and 6010) is required.
3. Three technical electives selected from 5000-, 6000-, or 7000-level courses approved by student’s committee.
4. No more than 15 semester credits of 5000-level course work may be used for a graduate degree.

**Purpose of the Degree**
The new degree program will provide graduate students with the opportunity to receive a comprehensive degree directed towards academic and research skills that are critical to the aerospace industry. Students completing this degree program will possess skills sought by industry and research organizations requiring a master’s degree for advanced design, research, and technical management in aerospace. The MS in Aerospace will support the strong Utah-based aerospace industry represented by companies such as ATK, Northrop Grumman Corporation, The Boeing Company, Hill Air Force Base, and USU’s Space Dynamics Laboratory, as well as other prominent national aerospace companies and research laboratories. Graduates from this program are also expected to be qualified as applicants to doctoral programs. This new degree will also enhance the depth and breadth of the Department’s graduate program.

**Institutional Readiness**
The new degree program will be administered by the MAE Department, which has in place the administrative infrastructure necessary to manage the program. A committee oversees graduate programs and a full-time staff member is assigned to the graduate program. Presently, the MAE department supports an MS in Mechanical Engineering with specialization in Aerospace Engineering. The MS in Aerospace Engineering will place more emphasis on core aerospace engineering coursework, but will not require additional institutional resources or the development of new courses. In a very real sense, the level of effort and cost to administer this degree program will be the same as that already being accomplished for the Mechanical Engineering MS degree. In the near term, the present student body will opt for either the mechanical engineering degree or the aerospace engineering degree. Thus, no new courses are required to accommodate this degree.
Because of USU’s proximity to numerous aerospace companies and the increasing demand for aerospace engineering degrees, it is anticipated that MAE’s graduate enrollment will increase because of this degree. This growth is needed to support its threefold increase in sponsored research over the past five years.

Faculty
Eight faculty members in MAE have appropriate backgrounds and research interests in aerospace engineering to support the program. In the past, these faculty members have supported a degree specialization in aerospace under the MS program in mechanical engineering. The faculty looks forward to having a stronger focus in their area of specialization

- Warren Phillips (PhD Mechanical Engineering)
- Christine Hailey (PhD Mechanical Engineering)
- David Geller (PhD Space Physics and Astronomy)
- Stephen Whitmore (PhD Aerospace Engineering)
- Wenbin Yu (PhD Aerospace Engineering)
- Dhiru Kubair (PhD Aerospace Engineering)
- Steve Folkman (PhD Mechanical Engineering)
- Rees Fullmer (PhD Mechanical Engineering)

Staff
Additional staff lines will not be required. The current resources within the Department of Mechanical and Aerospace Engineering will be able to accommodate this new program. It is planned that undergraduate assistants will be hired using non E&G funds to handle routine functions to offset the increased workload of the staff.

Library and Information Resources
Two major library resources needed for the new program are the IEEE Xplore database and a series of journals produced by the American Institute of Aeronautics and Astronautics. The Merrill-Cazier library presently subscribes to these resources. See attached letter from the Merrill-Cazier Library.

Admission Requirements
Applicants with a bachelor’s degree in Aerospace Engineering or Mechanical Engineering from an ABET-accredited program can apply. For unrestricted admission to the program, students are required to have a minimum 3.0 GPA and successfully pass the GRE exam. The subject GRE is not required. Additional coursework in aerospace engineering fundamentals may be required in individual cases. All graduate students are expected to have a working knowledge of a computer programming language.

Student Advisement
The mechanics of admission to the programs and fulfilling program requirements are handled by a full-time staff graduate advisor. As students are admitted to the program, they are assigned a temporary faculty advisor who guides them on which courses to take the first semester. During the first semester, students select a graduate committee and a major professor who advise them throughout the remainder of their program.

Justification for the Number of Credits
The number of credits required for this program is the same as the currently offered Master of Science in Mechanical Engineering and meets Regents guidelines.

**External Review and Accreditation**

As with the current MS program in Mechanical Engineering, and consistent with practice throughout the United States, no accreditation will be sought.

**Projected Enrollment**

<table>
<thead>
<tr>
<th>Year</th>
<th>Student FTE</th>
<th>Student Headcount</th>
<th># of Faculty</th>
<th>Mean FTE-to-Faculty Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>22.8</td>
<td>24</td>
<td>8</td>
<td>2.8:1</td>
</tr>
<tr>
<td>4</td>
<td>24.1</td>
<td>26</td>
<td>8</td>
<td>3.1:1</td>
</tr>
<tr>
<td>3</td>
<td>26.1</td>
<td>29</td>
<td>8</td>
<td>3.6:1</td>
</tr>
<tr>
<td>4</td>
<td>28.0</td>
<td>32</td>
<td>8</td>
<td>4.2:1</td>
</tr>
<tr>
<td>5</td>
<td>29.8</td>
<td>35</td>
<td>8</td>
<td>4.8:1</td>
</tr>
</tbody>
</table>

Note: Estimates take into consideration the present economy and recent enrollment data. The projected 46% increase in student enrollment will be divided into 47% full-time on campus students and 53% part-time working professional students.

**Section III: Need**

**Program Need**

There are no other institutions within the Utah System of Higher Education (USHE) that offer a Master’s of Science Degree in Aerospace Engineering. According to the U.S. Department of Labor, Bureau of Labor Statistics, aerospace engineers are expected to have a 10% growth in employment during the decade of 2006 to 2016. Utah is one of the top ten states in the nation in the concentration of aerospace employment (Utah Aerospace Industry Profile, 2007, Economic Development Corporation of Utah). Furthermore, a number of reports indicate that the aerospace sector needs qualified young Americans to replace an aging generation of Cold War scientists and engineers. The MS in Aerospace Engineering will meet the needs of Utah’s aerospace and defense industries, as well as the national need for skilled aerospace engineers. USU is in close proximity with a number of small to large aerospace companies (Logan, Brigham City and Ogden areas).

**Labor Market Demand**

In 2007, the Economic Development Corporation of Utah listed the top 25 aerospace industries in Utah. The industries ranged in size from large employers such as Hill Air Force Base, ATK Space Systems, to medium sized employers such as Moog Aircraft Group, Parker-Hannifin Corporation, Boeing Company, to small employers such as Groen Brothers. Utah State University is home to the Space Dynamics Laboratory, another employer of aerospace engineers. Increases in defense aerospace projects and new technologies to be used on commercial aircraft should spur demand for aerospace engineers. Given the large concentration of aerospace industries in Utah, graduates with an MS in aerospace should have little difficulty finding a position in Utah. The MS degree will prepare future employees who are well suited to conduct research, lead advanced design teams, and move into technical managerial positions.

Nationally, the labor market demand for aerospace engineers should be strong, fueled in part, by the impending retirement of the Cold War scientists and engineers. In 2007, an article by Alicia Chang of the
Associated Press reported that the average age of an aerospace worker was 45 in 2005. In 2008, roughly one out of four will be eligible to retire. Large aerospace companies such as Boeing, Raytheon, Northrop Grumman and Lockheed Martin Corporation are developing innovative recruiting strategies, outreach programs for elementary, and secondary schools in anticipation of the growing need to attract American citizens with engineering degrees to their companies. Other evidence of a strong labor market demand for aerospace engineers comes from former NASA Administrator Michael Griffin. During a press conference in 2005, he stated, “twenty-five percent of NASA’s workforce reaches retirement age in the next five years and it will not be different in our contractor community.”

**Student Demand**
Two types of student needs will be met by the proposed MS in Aerospace Engineering: full-time, traditional graduate students and part-time, working professionals, both interested in pursuing an advanced degree. Presently the MAE department supports an MS in Mechanical Engineering with specialization in aerospace. The MS in Aerospace Engineering will provide graduate students with an option that is more focused on aerospace engineering. For the traditional student, an MS aerospace degree will make him/her more competitive in the aerospace industry. For the working professionals, career advancement is presumably the primary motivation.

When the MS in Aerospace Engineering program is approved, it is anticipated that there will be a decrease in the number of students pursuing an MS in mechanical engineering. However, because of the market demand described above and especially in the Utah aerospace sector, a 46% increase in aerospace student enrollment is projected over the next five years.

**Similar Programs**
Presently within the USHE there are no other institutions offering an MS degree in Aerospace Engineering. Within the intermountain region, Arizona State University, University of Arizona, and the University of Colorado at Boulder and at Colorado Springs offer MS and PhD programs in Aerospace Engineering. There are no Aerospace Engineering programs in Wyoming, Nevada or Idaho.

**Collaborations with and Impact on Other USHE Institutions**
There should be no impact on other USHE institutions.

**Benefits**
The MS in Aerospace Engineering will directly impact the goals of the USHE to prepare a workforce and develop advanced aerospace technologies that will directly impact Utah’s economy. This proposed degree will make USU graduates more competitive for aerospace engineering positions within Utah as well as elsewhere in the aerospace industry. By having more engineers educated and trained for their needs, the Utah aerospace companies are presumably going to be more competitive in competing for new contracts and developing new aerospace technologies.

**Consistency with Institutional Mission**
The mission of USU is to be one of the nation’s premier student-centered land-grant and space-grant universities by fostering the principle that academics come first, by cultivating diversity of thought and culture, and by serving the public through learning, discovery, and engagement.
The proposed MS Aerospace Engineering enhances the University’s reputation as a space grant institution through both its graduates and research productivity. It supports the University Mission Statement in the following ways:

1. The department becomes more student-centered by providing a program to meet the needs of the students.
2. The master’s program will improve academics in aerospace engineering by fostering research in the forefront of the field, consistent with the USU mission to be one of the nation’s premier space-grant universities.

The master’s program will serve the public by application of the research produced. It will also serve the growing aerospace industry in Utah with a better-prepared workforce.

Section IV: Program and Student Assessment

Program Assessment
The major goal for the program is to graduate MS students with expertise in aerospace engineering and who are prepared to meet the needs of industry and academia by equipping them with modern skills and tools of aerospace engineering. Attainment of this goal will be measured by the placement rate of graduates within industrial, research laboratories, and doctoral programs.

Expected Standards of Performance
The standard of performance for all students is a grade of C or better in all classes required for the degree and to maintain an overall program GPA of 3.0 or higher in order to graduate with an MS degree. In addition, all Plan A thesis or Plan B report students must satisfactorily pass a defense of their MS thesis or project report.

These standards are already well established in the Graduate School as well as for the existing Mechanical Engineering MS degree program.

Section V: Finance

Budget: Salaries, wages, and benefits represent the expenses associated with teaching the courses for the new MS Aerospace program. Since these courses are already being taught, the revenue to pay for these expenses is simply a reallocation within current department funds. Thus, the difference, revenue – expenses, is zero. The teaching expenses are based on eight faculty members with an approximately 50% teaching role assignment, and with a 50/50 split between mechanical engineering courses and aerospace engineering courses. The expenses are thus approximately 25% of the current salaries, wages, and benefits for these faculty members. Note that any additional expenses associated with research will be externally funded.
### Table 2. Projected Aerospace MS Program Revenue and Expenses

<table>
<thead>
<tr>
<th></th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
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<td><strong>Students</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projected FTE Enrollment</td>
<td>22.8</td>
<td>24.1</td>
<td>26.1</td>
<td>28.0</td>
<td>29.8</td>
</tr>
<tr>
<td>Cost Per FTE</td>
<td>1,770</td>
<td>1,912</td>
<td>2,065</td>
<td>2,230</td>
<td>2,408</td>
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<tr>
<td>Student/Faculty Ratio</td>
<td>2.8:1</td>
<td>3.0:1</td>
<td>3.3:1</td>
<td>3.5:1</td>
<td>3.7:1</td>
</tr>
<tr>
<td>Projected Headcount</td>
<td>24</td>
<td>26</td>
<td>29</td>
<td>32</td>
<td>35</td>
</tr>
<tr>
<td><strong>Projected Tuition</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Gross Tuition</td>
<td>40,361</td>
<td>45,979</td>
<td>53,890</td>
<td>62,439</td>
<td>71,648</td>
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<tr>
<td>Tuition to Program</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>5 Year Budget Projection</strong></td>
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<td></td>
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<tr>
<td>Expenses</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salaries &amp; Wages</td>
<td>189,157</td>
<td>194,832</td>
<td>200,677</td>
<td>206,697</td>
<td>212,898</td>
</tr>
<tr>
<td>Benefits</td>
<td>86,067</td>
<td>89,623</td>
<td>93,315</td>
<td>96,114</td>
<td>98,998</td>
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<td>275,224</td>
<td>284,455</td>
<td>293,992</td>
<td>302,812</td>
<td>311,896</td>
</tr>
<tr>
<td>Current Expense</td>
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<td>0</td>
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<td>Travel</td>
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<td>0</td>
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<tr>
<td>Capital</td>
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<td>0</td>
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<td>0</td>
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<td>Library Expense</td>
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<td>0</td>
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<tr>
<td>Total Expense</td>
<td>275,224</td>
<td>284,455</td>
<td>293,992</td>
<td>302,812</td>
<td>311,896</td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legislative Appropriation</td>
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<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Reallocation</td>
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<td>311,896</td>
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<tr>
<td>Tuition to Program</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fees</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total Revenue</td>
<td>275,224</td>
<td>284,455</td>
<td>293,992</td>
<td>302,812</td>
<td>311,896</td>
</tr>
<tr>
<td><strong>Difference</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Revenue-Expense</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Comments for Table 2: FTE = 9 credits. Tuition increase is estimated at 8%. Salary and Wages increase is estimated at 3%. Benefit increase follows the Sponsored Programs rates. MAE 5540: Propulsion Systems has a course fee of $25.

**Funding Sources**

The proposed MS in Aerospace Engineering builds on the aerospace specialization in place within MAE’s graduate program. Three faculty members (Geller, Kubair, and Yu) with doctoral degrees in aerospace were hired to strengthen this specialization area using funding from Senate Bill 61, the Governor’s Initiative for Engineering and Computer Science. Additional funding is not required.

**Reallocation**

No budget transfers or reallocations will be requested or needed to offer a quality program as explained in the next section.

**Impact on Existing Budget**

A new aerospace MS degree will enhance the MAE graduate program by being able to serve a wider range of qualified student interests at relatively low budget impacts. Students wanting a graduate degree in
aerospace engineering will be able to stay in Utah rather than go out of state to get a graduate aerospace engineering degree.

**Faculty:** This proposed degree will not have an impact on faculty salaries since no new faculty positions are needed to offer the degree. Since the Plan A/B students will be integrated into the research activities much of the increased workload will be absorbed within each professor’s research group. In reality, each professor is constantly managing his/her time to maintain a research program that includes preparing proposals, contract management, student mentoring, teaching courses, publishing research results, and providing University and professional service. Experience has shown that even though the student contact time increases with the number of graduate advisees, the overall workload may not increase but actually decrease because there is more personnel support for developing and maintaining the research productivity. The MAE Faculty feels that the benefits of the projected enrollment offset the time costs to manage the program. Plan C students do not do a project other than those associated with the courses and therefore require little faculty supervision outside of normal interactions associated with each course.

**Staff:** The proposed degree will increase the work load for three MAE staff members: 1) accountant will need to manage several more accounts resulting from an increase in sponsored research activities in aerospace; 2) office manager will interact with more students and faculty which will result in an increased work load; 3) graduate coordinator will be impacted the most by the new degree. These impacts will be caused by increased enrollment especially from the working professionals and more student programs to manage. This increased workload can be offset by adding part time student help to complete routine tasks. These students will be supported with F&A return from sponsored projects and will have no impact on the E&G budget.

**Facilities:** During the past five years, the MAE department has been planning for and working toward increased graduate enrollment and has sufficient office/study space to accommodate the anticipated enrollment increase. Most of the incidental costs associated with graduate students are already covered by the research grants/contracts and F&A return such that the impact on E&G funds is essentially zero.

**Operating Costs:** Larger enrollments result in increased copy service charges and other miscellaneous expenses. MAE has already been using electronic communications more and more to curb paper and copy expenses. This will continue such that these costs will be minimal for this degree program.

In summary, the additional work load imposed by this degree can be offset by hiring 1-2 part time student assistants to handle routine tasks that would normally be done by faculty and staff.
### Appendix A: Program Curriculum

#### All Program Courses

<table>
<thead>
<tr>
<th>MS Degree (Plan A)</th>
<th>Credit Hours</th>
<th>MS Degree (Plan B)</th>
<th>Credit Hours</th>
<th>MS Degree (Plan C)</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Aerospace core courses</td>
<td>15</td>
<td>6 Aerospace core courses</td>
<td>18</td>
<td>7 Aerospace Courses</td>
<td>21</td>
</tr>
<tr>
<td>6 hours of thesis, MAE 6970</td>
<td>6</td>
<td>3 hours of design project</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>21</strong></td>
<td><strong>Sub-total</strong></td>
<td><strong>21</strong></td>
<td><strong>Sub-total</strong></td>
<td><strong>21</strong></td>
</tr>
<tr>
<td>1 math elective</td>
<td>3</td>
<td>1 math elective</td>
<td>3</td>
<td>1 Math elective course</td>
<td>3</td>
</tr>
<tr>
<td>2 technical electives</td>
<td>6</td>
<td>2 technical electives</td>
<td>6</td>
<td>3 technical electives</td>
<td>9</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>9</strong></td>
<td><strong>Sub-total</strong></td>
<td><strong>9</strong></td>
<td><strong>Sub-total</strong></td>
<td><strong>12</strong></td>
</tr>
<tr>
<td><strong>Total Credits</strong></td>
<td><strong>30</strong></td>
<td><strong>Total Credits</strong></td>
<td><strong>30</strong></td>
<td><strong>Total</strong></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>

#### Existing Aerospace Core Courses
- MAE 5420: Compressible Fluid Flow (3, F)
- MAE 5440: Computational Fluid Dynamics (3, S)
- MAE 5500: Aerodynamics (3, F)
- MAE 5510: Dynamics of Atmospheric Flight (3, S)
- MAE 5520: Elements of Space Flight (3, F)
- MAE 5540: Propulsion Systems (3, S)
- MAE 5560: Dynamics of Space Flight (3, F)
- MAE 5580: Aircraft Design (3, S)
- MAE 6180: Dynamics and Vibrations (3, S)
- MAE 6340: Spacecraft Attitude Control (3, S)
- MAE 6440: Advanced Computational Fluid Dynamics (3, S)
- MAE 6500: Potential Flow (3, F)
- MAE 6510: Aircraft Dynamics and Flight Simulation (3, F)
- MAE 6540: Advanced Astrodynamics (3, F)
- MAE 6550: Advanced Structural Analysis (3, S)
- MAE 6560: Space Navigation (3, S)

#### Existing Mathematics Electives (credit hours)
- MATH 5270: Complex Variables (3, S)
- MATH 5410: Methods of Applied Mathematics (3, F)
- MATH 5420: Partial Differential Equations (3, S)
- MATH 5460: Introduction to Theory and Application of Nonlinear Dynamics Systems (3, S)
- MATH 5760: Stochastic Processes (3, F)
- MATH 6270: Complex Variables (3, S)
- MATH 6410: Ordinary Differential Equations I (3, F)
- MATH 6420: Partial Differential Equations I (3, S)
- MATH 6440: Ordinary Differential Equations II (3, S)
- MATH 6450: Partial Differential Equations II (3, S)
- MATH 6470: Advanced Asymptotic Methods (3, S)
- MATH 6610: Numerical Analysis (3, F)
• MATH 6620: Numerical Analysis (3, S)
• MATH 6640: Optimization (3, S)
• ECE 6010: Stochastic Processes in Electronic Systems (3, F)
• ECE 6030: Mathematical Methods for Signals and Systems (3, F)

New Courses to be Added in the Next Five Years
No new courses are planned. The aerospace courses that have supported the specialization in aerospace within the present mechanical engineering MS curriculum provide sufficient breadth and depth to support the proposed MS in Aerospace Engineering.

Appendix B: Program Schedule
The following sample programs show how each of the three degree options can be completed within 18 months. (Some students may elect to complete an industry internship during the summer term which would add another semester at USU.)

<table>
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<tr>
<th>Fall 1</th>
<th>Spring 1</th>
<th>Summer 1</th>
<th>Fall 2</th>
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<tr>
<td>Master of Science (MS Plan A)</td>
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<td></td>
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<tr>
<td>MAE 5500</td>
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<td>MAE 6510</td>
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<td>MAE 5420*</td>
<td>MAE 6440*</td>
<td>MAE 6540</td>
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<td>MAE 6950</td>
<td>MAE 6510*</td>
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<tr>
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<td>Math 5420</td>
<td>MAE 5520</td>
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<td>MAE 6500*</td>
<td>MAE 5580</td>
<td>MAE 6540</td>
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</tr>
<tr>
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<td>9 hours</td>
<td>3 hours</td>
<td>9 hours</td>
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<td>MAE 6510*</td>
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<tr>
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<td>Math 5270</td>
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<td>MAE 6500</td>
<td>MAE 6180*</td>
<td>MAE 6540</td>
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</tr>
<tr>
<td>MAE 6440</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>9 hours</td>
<td>12 hours</td>
<td>3 hours</td>
<td>9 hours</td>
</tr>
</tbody>
</table>

* Technical Elective

Appendix C: Faculty

Professors:
Warren F. Phillips - PhD University of Michigan, 1970 (aerodynamics and flight mechanics)
Christine Hailey - PhD University of Oklahoma, 1985 (aerodynamics and flight mechanics)

Associate Professors:
Rees Fullmer - PhD University of Utah, 1985 (guidance, navigation and control)
Wenbin Yu - PhD Georgia Institute of Technology, 2002 (aerospace structures)
Steven Folkman - PhD Utah State University, 1990 (aerospace structures)
Assistant Professors:
David Geller - PhD Rice University, 1999 (guidance, navigation and control)
Steven Whitmore - PhD University of California, Los Angeles, 1989 (propulsion)
Dhirendra Kubair - PhD University of Illinois, Urbana-Champaign, 2001 (aerospace structures)