New Mexico State University
Approval Form for New Graduate Degrees

Date: October 30, 2008

Originating Department or Program:
Mechanical & Aerospace Engineering

Contact Person: Thomas Burton, Dept. Head

Proposed Degree: MS in Aerospace Engineering

Proposed date to admit new students: Fall 2009

Approvals:		Signature	Date
Department Chair(s)	Thomas Burton	Thomas D Burton	10/1/08
Academic Dean (s)	Steven Castillo		10/1/08
Associate Dean (s) Council	Krist Petersen		29 Sep 08
Graduate Dean	Linda Lacey	L. Lacey	10/1/08
Faculty Senate	Joseph Pfeifer		10/2/08
Registrar	Michael Zimmerman		10/10/08
Executive Vice President and Provost	Robert Moulton		
President of NMSU	Waded Cruzado		Oct. 22, 2008
Board of Regents	Robert Gallagher		
New Mexico Council of Graduate Deans			
Academic Council for Higher Education			
NM Higher Education Dept.			
NM State Board of Finance			

New Graduate Program Approval Request

New Degree: M.S. in Aerospace Engineering

Submitted by
Department of Mechanical and Aerospace Engineering
College of Engineering
New Mexico State University

Thomas D. Burton
Department Head, Mechanical and Aerospace Engineering

November 1, 2008

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November 2008

PROPOSAL FOR MASTER OF SCIENCE IN AEROSPACE ENGINEERING

BACKGROUND INFORMATION AND SUMMARY

The undergraduate degree program in Aerospace Engineering (AE) began enrolling students in Fall 2006 with 20 students choosing this major. Fall 2008's entering freshman class has 38 AE majors, bringing the total of AE majors to 75. We anticipate the first BSAE graduate in December 2008.

In her letter of support for the proposed program, Patricia Hynes, director of the New Mexico Space Grant Consortium, gives a pertinent and succinct description of its value.

"The State of New Mexico has a long, successful history of space-based research and education. Assuring New Mexicans a role in the future benefits related to space commercialization requires that we prepare the workforce using all the resources of our public institutions. With the passing of the gross receipts tax and recruitment of Virgin Galactic and the XPrize Cup as anchor tenants, Spaceport America is poised to bring a new level of economic development to New Mexico. The potential for economic benefits to accrue to New Mexico will depend in part on whether our faculty and students are given opportunities to learn to compete in the emerging industries coming to New Mexico. A graduate degree program in Aerospace Engineering will continue to prepare the workforce for the challenges facing New Mexico as the state recruits new companies to do business at Spaceport America." (Attachment 2)

Approved in 2003, the AE program offered its first courses in the 2006/2007 academic year. One of the three AE undergraduate sections taught at NMSU in AY 2006/2007 was taken by students at New Mexico Institute of Mining and Technology (NMT) via distance education. In AY 2007/2008 NMSU offered seven undergraduate AE sections, two via distance education (DE): one DE course originated at NMT and the other DE course originated at NMSU. Joint AE course offerings with NMT will continue.

Financial support from the state of New Mexico has supported the development of NMSU's AE program. Allocations of $275,000 in FY 2005, $152,000 in FY 2006, and $399,000 in FY 2007 have enabled a major renovation of the NMSU subsonic wind tunnel (approximately $450,000), as well as other facility improvement and acquisition.

Recent recurring funding from the state of New Mexico ($336,800 in FY 2008 and $423,500 in FY 2009), along with the allocation in summer 2007 of two faculty positions by NMSU (I & G funds), has funded five tenure-track faculty positions in aerospace engineering. Following a national search in AY 2007/2008, two new aerospace engineering faculty have been hired and will start in Fall 2008. Another national search is being conducted in AY 2008/2009, with the goal to hire three additional faculty effective Fall 2009.

In May 2007 an external review panel of five distinguished academicians and one national laboratory (Sandia) manager convened at NMSU to assess the emerging aerospace engineering program. The complete panel report is contained in Attachment 1. The external panel was unanimous in its finding that developing and offering graduate degree programs in aerospace engineering is essential. The panel response to the question "Should NMSU AE develop MS and PhD programs in aerospace engineering?" is stated below:

> ***"Panel position:*** The graduate program is absolutely essential for 4 reasons:
>
> a) to recruit outstanding faculty who will be nationally competitive in attracting research funding and outstanding graduate students,
> b) to attract an increasing number of outstanding (national and international) graduate students,
> c) to provide unique educational opportunities for engineers in New Mexico industries and government laboratories,
> d) to provide visibility for the State of New Mexico in the national and international aerospace community, and complement its current vibrant efforts in developing an in-state aerospace industry."

Economic development in New Mexico supports the need and feasibility of initiating an AE graduate program at NMSU. The state is committed to the creation of Spaceport America in nearby Upham; Dona Ana and Otera counties have voted further financial support to the project. Aerospace businesses are locating in the area and state, opening opportunities for those skilled in aerospace fields.

Letters of support (included as Attachment 2) echo the need for a graduate program based on expanding aerospace involvement in New Mexico, the need for a competitive international workforce, and the anticipated decrease in AE engineers as a significant portion of engineers reach retirement within the next half-decade.

A. PURPOSE OF PROGRAM

1.Primary Purposes

The primary purposes in establishing the MS degree in Aerospace Engineering are the following:

- to provide potential MS students with opportunities in an area of high academic interest and relevance, presently unavailable in New Mexico;
- to develop aerospace research programs that will lead to creation of new knowledge and to innovation in aerospace technology;
- to enhance the academic reputation of NMSU engineering through the scholarly work associated with the MS program and its graduates;
- to support economic development in New Mexico in aerospace and related endeavors through expansion of aerospace enterprises currently in New Mexico, and through attraction of new aerospace enterprises into New Mexico;
- to contribute to the replacement of aging faculty in academia and aging professionals in the aerospace industry.

2. Consistency with Role and Scope of NMSU

The development of a MS program in Aerospace Engineering is consistent with the land grant role and mission of New Mexico State University and is consistent with the strategic plans of NMSU and of the NMSU College of Engineering. A Hispanic-serving and Research-Extensive university, the NMSU mission states, "New Mexico State University is the state's land-grant university, serving the educational needs of New Mexico's diverse population through comprehensive programs of education, research, extension education, and public service."

The NMSU Vision for the University as a whole is: "By 2020, New Mexico State University will be a premier university as evidenced by demonstrated and quantifiable excellence [underlining ours] in teaching, research and service relative to its peer institutions." Several goals of the NMSU strategic plan, *Living the Vision*, are applicable to our proposed graduate program, as follows:

- enroll a competitive proportion of degree-seeking graduate students;
- attract and tenure faculty with terminal degrees similar to peer institutions;
- develop and support five nationally and internationally recognized interdisciplinary research clusters through external funding;
- increase technology transferred from university research and creative activity to New Mexico businesses.

The stated vision and the goals to be pursued to realize these visions (for example, "demonstrated and quantifiable excellence…") will require that NMSU enhance its reputation for academic scholarship and

graduate education. In engineering, such demonstration of national stature will be enhanced significantly by the MS program in Aerospace Engineering. A goal of the MSAE program will be to produce quality graduates for research labs and industry and, through the research component of the graduate program, to enhance the quality, quantity, and national competitiveness of the research scholarship coming out of the NMSU College of Engineering. The pursuit of this goal is important to fulfillment of NMSU's Mission and Vision.

As expressed in its strategic plan, a primary goal of the College of Engineering at NMSU is, by 2015, to rank among the top 25 engineering programs at public institutions, as evidenced by nationally accepted measures of excellence in teaching, research and service. Moving toward this goal will require significant improvements in research in the College of Engineering, as follows: 1) MS enrollments and number of MS graduates will need to increase; 2) academic reputation for scholarship will need to be enhanced through increased journal publication; and 3) external funding, especially from competitive federal programs, will need to be increased. MSAE program will be developed, and new AE faculty hired, according to these priorities.

3. Institutional Priority for the Proposed Program

The following decisions made by the leadership of New Mexico State University are cited as evidence of institutional commitment to aerospace engineering:

- The 2003 approval by the NMSU Board of Regents of the undergraduate degree in aerospace engineering is evidence that the university considers aerospace engineering to be a priority.
- During the past five years NMSU has sought funding from the State of New Mexico for initiation of the aerospace engineering program. These efforts have led to the following appropriations by the Legislature: FY 2005: $275,000 non-recurring; FY 2006: $152,000 recurring; FY 2007: $247,000 non-recurring; FY 2008: additional $184,800 recurring (when combined with the $152,000 recurring from FY 2006, the result is $336,800 recurring funding in FY 2008 and beyond); FY 2009: additional $86,700 recurring, for a total of $423,500 recurring in FY 2009 and beyond.* The NMSU legislative requests for the 2007, 2008, 2009 and 2010 fiscal year appropriations were legislative priorities of the university. The declaration of aerospace engineering as an NMSU legislative priority for four consecutive years is evidence that NMSU considers development of the aerospace engineering programs to be of high priority at NMSU. The development of MS and PhD programs in aerospace engineering has been central to the NMSU legislative proposals that have resulted in the aforementioned state appropriations.

  Additional state funding will be requested during the 2009legislative session for FY 2010 This funding will be used for financial salary support for one additional faculty position, support staff, graduate/teaching assistants, laboratory and other infrastructure needs. Funds are also needed for related personnel expenses and equipment.

  *The total state aerospace engineering appropriation for FY2009 is $616,800; $193,300 goes to New Mexico Tech for its undergraduate aerospace engineering minor.

- In August 2007 the NMSU administration allocated two new tenure track faculty positions to the aerospace engineering program. These were the only new positions allocated to the College of Engineering from I&G funds. This allocation is evidence that aerospace engineering is an NMSU priority program.
- The university has established "21st Century Aerospace" as one of five research clusters in the university. The research clusters have been identified as priority areas for both research opportunity and relevance to NMSU's land grant mission. The specification of aerospace as a research cluster is evidence of the importance attached by NMSU to aerospace research, and the MS in aerospace engineering is consistent with and will support this research priority.
- The NMSU Physical Sciences Lab (PSL) has a long history of involvement in aerospace and related activities, including the high altitude balloon program, the unmanned aerial vehicle (UAV)

program, and sensing and communication programs for satellites. PSL has traditionally been oriented toward engineering services rather than academic research. In November 2005, the university announced a change of leadership and mission at PSL: in the future PSL is to develop closer ties to the academic units at NMSU, mainly the College of Engineering, and is to orient its work to have a greater scholarly component. Because PSL has always been an aerospace-oriented enterprise, the recent changes at PSL are evidence of recognition of the importance of scholarly work in the aerospace arena, and this recognition is consistent with deployment of the PhD in aerospace engineering.

The aforementioned evidence of NMSU's support for aerospace engineering, in particular the research component of aerospace engineering, demonstrates that the MS in aerospace engineering is an institutional priority for NMSU.

4. Curriculum for the Proposed Program

The admission requirements, degree program options, thesis requirements, written and oral examinations and defenses, and numbers of hours of required graduate course work will be the same for the aerospace engineering graduate programs as for the existing graduate programs in mechanical engineering. Admission standards, degree requirements, and courses of twenty-six MAE or AE graduate programs in the U.S. were analyzed (Attachment 7). NMSU graduate programs are in line with the general trend represented.

A full description of the program characteristics appears in section F: Quality of Program.

B. JUSTIFICATION FOR THE PROGRAM

1. Need

Economic

New Mexico's economy has traditionally included a significant interaction with aerospace (and related) industry, in both the public and private sectors. This history includes operations at White Sands Missile Range, the NASA White Sands Test Facility, the Holloman Air Force Base High Speed Test Track, the Air Force Research Lab in Albuquerque, the Physical Sciences Lab (PSL) at NMSU, Sandia National Lab, and Los Alamos National Lab. Large aerospace firms such as Boeing (El Paso), General Dynamics (LC), Lockheed Martin (LC), Northrop Grumman (Albuquerque), and Honeywell (LC and Albuquerque) have operated facilities in or near New Mexico for years.

Nationally, the Aerospace Industry is economically strong. According to a report by the American Institute of Aeronautics and Astronautics (AIAA):

- In 2004, despite overall trade deficits, aerospace had a $31 billion trade surplus;
- Sales increased by 8% (in 2004);
- Aerospace made up one quarter of manufacturing growth for 2004;
- In 2006, the aerospace manufacturing trade surplus reached $52 billion, the nation's largest sector trade surplus (AIA); aerospace is the only large US industry that is a net exporter.[1]

The manufacture of aircraft and spacecraft (and the parts thereof) is the fourth highest commodity exported from New Mexico. Despite an overall downturn in employment, Eclipse Aviation in Albuquerque has been adding to its workforce, hopes to add 700 workers by the end of 2008. Among small NM manufacturers anticipating employment growth are Aerospace Composite Structures, Northrop Grumman, Aeromechanical Industries and Raytheon. (New Mexico Economy[2])

Aerospace presence in New Mexico has recently seen a dramatic expansion of private aerospace development. Fueled by commitment to a spaceport in Upham, the state is offering financial incentives to attract further growth in aerospace business (New Mexico Economic Development Department3). This incentive includes tax deduction for research and development.

Locally-created aviation companies have more than doubled their employment and increased their revenue by 50% in the past few years. These include HYTEC, Inc., Sandia Aerospace, TMC Design Corporation, and Eclipse Aviation in Albuquerque, which has grown from a few dozen to approximately 1,500 employees during the past seven years.

Aerospace companies such as Aero Mechanical Industries, Harris, and the Rocket Racing League are adding to the significant aerospace presence in New Mexico. The Spaceport at Upham and the X Prize Cup demonstrate interest and potential for significant new development in the private space tourism and commercial space businesses. The level of established, developing, and potentially new aerospace related ventures in New Mexico is impressive, yet there is no graduate aerospace engineering program in the state.

Aerospace engineers are essential to this industrial strength. To date, companies have had to recruit AE trained employees from graduates of non-New Mexico universities, and conversely, New Mexico students wishing to pursue a career in aerospace engineering have taken their skill and education dollars out of New Mexico.

Letters of support (Attachment 2) from national/international companies operating in New Mexico highlight industry need for aerospace engineers, pinpointing distinct reasons: general health of industry; industry growth in New Mexico; need to maintain competitive level globally; and need to replace an aging workforce. Furthermore, they emphasize that the high technical level of AE typically requires graduate level training.

Los Alamos has a broad array of programs that would utilize students with training in aerospace engineering, and values the innovations produced by university research programs that depend on MS and PhD students.

Northrup Grumman cites the need for aerospace engineers with advanced degrees, in relation to NASA's renewed focus on manned space programs. Another observation they offer: the aerospace industry is strong, but foreign competition and the aging workforce in the U.S. make it imperative that a technically advanced workforce be maintained in the future.

Sandia National Laboratories' letter of support mentions the value of 'partnership' between industry and academia "to fill gaps in our capabilities, perform joint research and development projects that have a national impact, create a pool of future employees, educate on-roll employees, and build a constituency within the state and nationally." SNL also notes the present lack of aerospace educational opportunity as aerospace takes a growing role in the state's economy, and believes the proposed graduate program would be beneficial to this situation.

Boeing notes the need for aerospace engineering programs in response to "burgeoning New Mexico aerospace industry." According to their letter, "aerospace engineering tends to be a highly technical discipline, in which graduate education is often an essential element of the practitioner's capability."

Perhaps the single factor most influencing the potential employment of AE graduates is the anticipated rapid decline in workforce skill as baby boomer engineers reach retirement age. Various studies place this attrition rate at more than a quarter of the workforce (Aerospace Commission[4]). This situation has drawn the attention of NASA, the National Science Board, AIAA and the Aerospace Industries Association (AIA). AIA rates the workforce profile as the top issue for 2007, stating:

"America's skilled aviation workforce is continuing to age and new workers with the necessary capabilities are not entering the workforce in sufficient numbers. Efforts must be taken to address these issues, *including providing adequate federal funds to support relevant advanced degree research at our nation's universities* [italics added]."

"Vanishing Act," published in Aviation Week and Space Technology in February 2007 (Anselmo[5]), presents a comprehensive picture of the situation in the America's aerospace engineering workforce. The publishers contracted two professional studies on the situation which produced an alarming outlook combining the workforce

reductions of the 1990s with the approaching retirement eligibility for 1-in four U.S. aerospace workers. The data presented show that in 1998 the percentage of aerospace workers older than 45 years was 38%. This percentage was considered high in 1998. But by 2005, the percentage of over 45-year old aerospace workers had increased to 55%. These data show that the aging workforce issue is a serious national issue in the aerospace industry.

The article quotes Clay Jones, president/CEO of Rockwell Collins, as saying, "We need to go out and basically generate a new workforce of knowledge workers to replace those experienced people who are going out the door." Jones predicts that though presently Rockwell Collins employs only 5% of its workforce from outside the U.S., that practice will have to increase to meet need.

These figures of impending retirements are repeated by the Aerospace Industries Association who has given Aerospace Workforce Renewal priority as an Election/Legislative issue for the past several years. Their issue statement for 2008 cites the shortage of trained technical graduates as reaching a national crisis level affecting every sector of industry.

Current Funded Research
The Mechanical and Aerospace Engineering Department has established a research presence in Aerospace Engineering which includes projects funded by the Air Force, Army, NASA, and Sandia National Laboratories. At present, faculty are working on one to four year projects (plus one major collaborative project that will go for five to ten years) that range in funding from $29,000 to $415,000. A detailed listing of these research grants appears in Section E (Projected Costs of Program).

Educational
Student response to the new AE program (even before it has been fully implemented) demonstrates the high level of interest in this engineering field. We anticipate an annual average of 25 BSAE graduates by the time a graduate program is in place. A significant percentage of these students would be interested in continuing their engineering education.

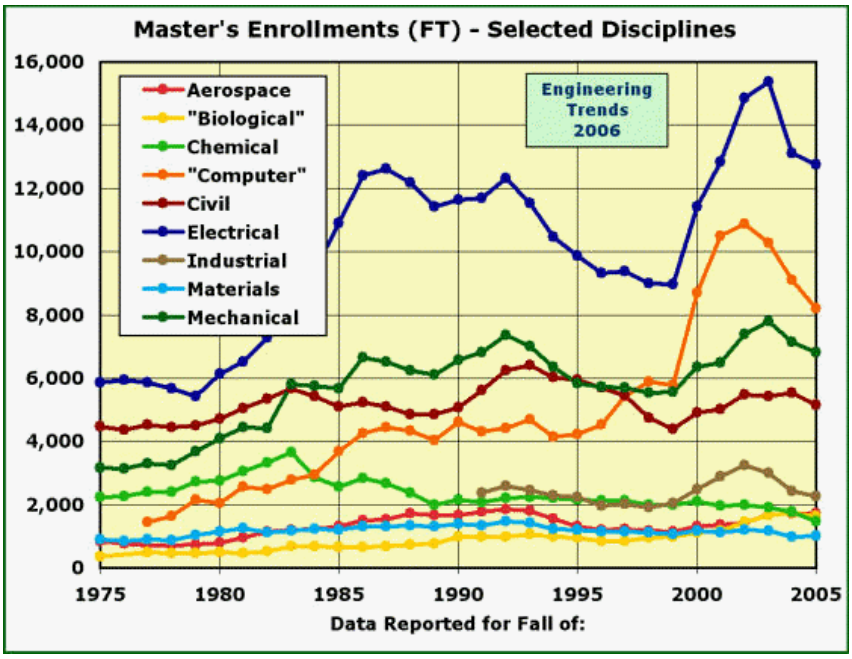
While entry level engineering requires only a bachelor's degree, advancement hinges on higher levels of education and training. Master's degree requirement is increasing as engineering industry has begun to outsource basic (bachelor's level) engineering tasks. Doctoral degrees continue to be essential for high level research, as well as for academic teaching and research positions.

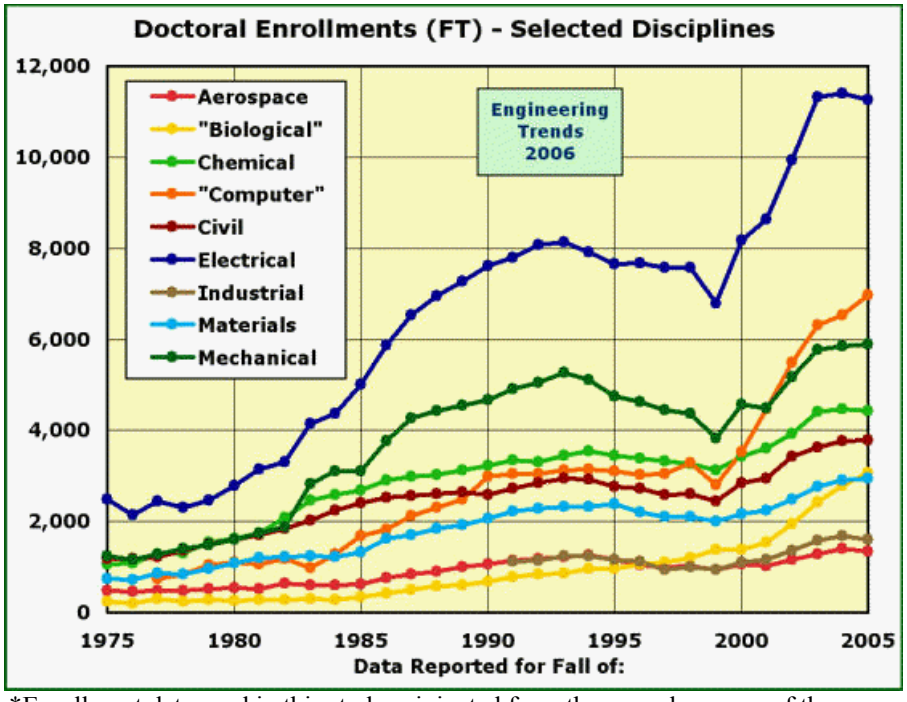
According to the Bureau of Labor Statistics, "Graduate training is essential for engineering faculty positions and many research and development programs but is not required for the majority of entry level jobs. Many engineers obtain graduate degrees…..to learn new technology and broaden their education. "[6]

The BLS reports that 49% of aerospace engineers are employed in the key industry of aerospace product and parts manufacturing. The agency upgraded the employment outlook for AE in 2008 (not factoring in retirement figures). "Aerospace engineers are expected to have a 10% growth in employment over the projection decade…..Increases in the number and scope of military aerospace projects will likely generate new jobs…..new technologies should spur demand."

The availability of aerospace engineers is obviously related to the number of students obtaining degrees; the number of aerospace engineers (as representative of the engineering profession as a whole) declined in the past three decades, though an upward trend is currently reported. According to findings of the Aerospace Commission, as reported by AIA in 2006, "by 12th grade, U.S. high school students' math and science performance ranks near the bottom internationally. A shortage of math and science teachers compounds the problem as do fewer engineering and science students earning degrees – from undergraduate to doctorate – at U.S. colleges and universities…40% of the students now earning engineering and science doctorates are foreign and often return to their native countries or cannot work on sensitive defense programs." [7,1]

Engineering Trends[8] provides quarterly data about engineering education in the U.S. According to their reports of 2006, only aerospace[9] engineering is increasing in master's enrollment, exhibiting a long-term growth. On the doctoral level, AE enrollments declined slightly in 2005. The increase in AE master's enrollment should be reflected in PhD enrollments after a lag of a few years. Below are graphs produced by Engineering Trends.





*Enrollment data used in this study originated from the annual surveys of the engineering Workforce Commission of the American Association of Engineering Societies. …..For further information about their surveys and the availability of survey data see the EWC Web site (www.aaes.org).

These workforce factors are also documented by a University of Michigan compilation [9] which found that the entire aerospace enterprise in the US contributes over 15% to the gross domestic product, and recent three year return on investment (ROI) in the Aerospace sector (10%) exceeds the ROI's of "glamour" industries such as computers,

biotechnology, semiconductors, software, pharmaceuticals, and communication technologies. The Michigan study cites the changing nature of the aerospace industry, including several factors relevant to the new aerospace program at NMSU:

- the aerospace workforce is rapidly aging, and aerospace engineering programs must adjust to provide education for a new generation of aerospace engineers;
- there will be increased demand for suitably designed MS programs, and the MSAE will become the aerospace engineering degree of choice, as routine tasks are outsourced globally;
- new research areas are emerging, including aerospace related to homeland defense, new space launch systems, and highly distributed air transportation systems; successful aerospace programs will respond to the changing climate.

The creation of MSAE and PhD AE programs will have several important consequences:

- hiring a highly competent and respected aerospace faculty will promote a nationally competitive research program;
- research capability and contributions will enhance economic development and will be attractive to aerospace companies considering the establishment of facilities in New Mexico;
- graduate and research programs will form the foundation for recruitment of top students who would otherwise pursue advanced degrees out of state.

2.Duplication

The table below shows the graduate degree programs in engineering that are available in the state of New Mexico. Programs for aerospace engineering master's and doctoral degrees are not currently available in the state. Thus, degree program duplication is not an issue, and items (a) – (c) and (e) – (g) of Section 2 of the "Requirements…." document are not relevant to this application.

Table 1. Graduate Engineering Degrees Offered in New Mexico Institutions

Institution	Masters Degrees	Ph.D. Degrees
New Mexico State University	**Master of Science:** Chemical Civil Electrical Environmental Industrial Mechanical Computer Science	**Engineering* with Specialization/Concentration in:** Chemical Civil Electrical Industrial Mechanical Computer Science

University of New Mexico	**Master of Science:** Chemical Civil Computer Engineering Computer Science Electrical Mechanical Nuclear **Master of Engineering :** Hazardous Waste Engineering Manufacturing Engineering	Chemical Civil Computer Engineering Computer Science Electrical Mechanical Nuclear Optical Science and Engineering Nanoscience & Microsystems
New Mexico Tech	**Master of Science**: Electrical Mechanics Environmental Materials Mineral Petroleum **Master of Engineering:** Engineering Management	Materials Petroleum

*the NMSU degree is a "PhD in Engineering" with the major field (for example, Mechanical Engineering), identified as a specialty.

(d) Access to WICHE regional programs

NM students have access to degree programs offered through WICHE's Western Regional Graduate Program. The University of Colorado at Boulder is the only participating university with a graduate program awarding MS, ME and PhD degrees in Aerospace Engineering Sciences. The number of New Mexico residents who have participated in AE graduate programs via WICHE is minimal. Only one New Mexico student attended the CU aero program last year.

3. Inter-Institutional Collaboration and Cooperation

In January 2008 a draft of this proposal for the aerospace MS and PhD degree programs at NMSU was sent to the other universities in New Mexico for their examination (New Mexico Tech, University of New Mexico, Eastern New Mexico University, Western New Mexico University, and New Mexico Highlands University). By March 7, 2008 NMSU had received preliminary approvals (to proceed with the proposal) from four of the five universities to which the draft had been sent. On March 17, 2008 NMSU's MAE department head met in Socorro with representatives from the fifth university, New Mexico Tech, to discuss the proposal. At that meeting New Mexico Tech gave verbal preliminary approval to the NMSU proposal, followed in June with written support.

The primary suggestion to NMSU from both UNM and NMT was to ensure that the new AE graduate degree programs include a collaboration among the three research universities in the offering of aerospace relevant graduate courses that would be available via distance education to graduate students at all three universities. There is recognition among the three universities of the interdependence of the engineering programs in providing the fullest range of offerings to students. The graduate programs proposed by NMSU are traditional AE programs focused on aerodynamics, flight dynamics, orbital mechanics, structures, controls, propulsion, and aerospace systems. The NMSU graduate programs will concentrate efforts and resources on these core areas, and will turn to other NMSU

departments and to UNM and NMT for complementary courses for interested students. The mechanisms are already in place for distance learning collaboration among the universities.

While neither UNM nor NMT offers degrees (undergraduate or graduate) in aerospace engineering, they offer aerospace-relevant courses not available at NMSU. For example, UNM can provide instruction in the general areas of space based sensing, space operations and communication systems; materials and manufacturing; and space weather (see UNM letter in Attachment 3a for a complete listing of possible shared courses). NMT can provide graduate instruction in materials science, energetic materials, and applications. The aerospace and aerospace-relevant courses available at the graduate level from the combined universities will provide new opportunities for graduate students at NMSU, UNM, and NMT.

We at NMSU anticipate discussion of specific course collaborations with UNM and NMT to take place during the 2008-2009 academic year, with joint course offerings as early as the Fall of 2009.

NMSU/NMT collaboration (undergraduate): A track record between NMSU and New Mexico Tech already exists in the collaborative offering of courses at the undergraduate level. NMT has established an aerospace minor within the existing NMT Mechanical Engineering BS program. The current NMSU/NMT collaborative plan is for each university to offer, via distance education, one or more undergraduate courses per year in aerospace engineering, available to undergraduate students at both universities. During Fall 2006 NMSU taught the course Aerodynamics I via distance education (live two way TV); the course was taken by both NMSU and NMT students. In the Fall of 2007 NMT's Orbital Mechanics course was taken by NMSU students, and in Spring 2008 NMSU's aerospace structures course was taken by NMT students. The NMSU/NMT collaboration at the undergraduate level is functioning well and will expand in the coming years, with participation by UNM a possibility in the future. (See NMT letter in Attachment 3a for a complete listing of suggested NMT courses, both undergraduate and graduate, that could be available in this collaboration.)

Sources Cited:

(1) Aerospace Industries Association, www.aia-aerospace.org Accessed: March 2007

(2) The New Mexico Economy: Recent Developments and Outlook, September 2007 edd.state.nm.us/images/uploaded/NMeconomy.pdf Accessed: 2/21/2008

(3) New Mexico Economic Development Department edd.state.nm.us/ Accessed February 2008

(4) Aerospace Commission, Final Report: Commission on the Future of the United States Aerospace Industry, November 2002, www.trade.gov/td/aerospace/aerospacecommission/AerospaceCommissionFinalReport Accessed: May 2008

(5) Joseph C. Anselmo, "Vanishing Act," Aviation Week & Space Technology February 5, 2007.

(6) Bureau of Labor Statistics, www.bls.gov Accessed: April 2008

(7) NASA Workforce Development Workshop, "Partnering Strategies for Educating and Motivating the Next Generation of Aerospace Scientists and Engineers," Washington DC, June 1 2006.

(8) Engineering Trends, Report 0806D, Houghton, Michigan, August 2006 www.engtrends.com/IEEE/08606D.phd Accessed May 2008

C. CLIENTELE AND PROJECTED ENROLLMENT

1.Clientele

(a). We anticipate interest in our AE graduate program from:

- recent BS graduates who wish to increase their level of education and training to make themselves more attractive for higher than entry level employment positions;
- recent BS graduates who are interested in pursuing an academic career;
- working engineers who wish to continue their professional education on a part or full time basis.

(b) Admission qualifications

Admission to the Aerospace Engineering graduate program(s) will follow the same admission process as all NMSU graduate programs.

Admission is a two step process: NMSU graduate school admission; department admission.

Students seeking admission to graduate student status at NMSU must hold a minimum of a bachelor's degree or an advanced degree from an accredited institution. The program or preparation should be substantially equivalent in the distribution of academic subject matter to the requirements for a comparable degree at NMSU. Candidates for advanced degrees are required to demonstrate proficiency in written and spoken English.

Admission to the Graduate School is not a guarantee that the student will ultimately be accepted as a master's candidate, since the latter depends upon meeting the individual requirements of the degree-granting departments, as well as the requirements of the Graduate School. In addition, doctoral candidates are not fully admitted until they have passed the qualifying examination and have satisfied all departmental qualifications.

No student will be officially admitted into a graduate program at NMSU until a "Certificate for Admission" has been issued by the Graduate School. Although the Graduate School considers this certificate valid for a period of one year, departments may require re-application if the student does not enroll in the semester noted in the certificate.

Department Admission: Students are eligible for regular admission to graduate study in the Mechanical and Aerospace Engineering Department if the following conditions are met:

- Candidate for the Master's degree must have taken the Graduate Record Exam (GRE) with results reported directly to NMSU and/or the MAE Department.
- Candidate for the Master's degree must hold a bachelor's degree from an ABET accredited school or, if foreign, from an ABET equivalent school.
- Candidate must have a grade point average (GPA) of 3.0 (based on a scale of 4.0) in the last 60 hours of undergraduate study.

Doctoral Degree Program:

- Candidate must hold a Master's degree from an accredited school.
- Candidate must have a grade point average of 3.3 (based on a 4.0 scale).

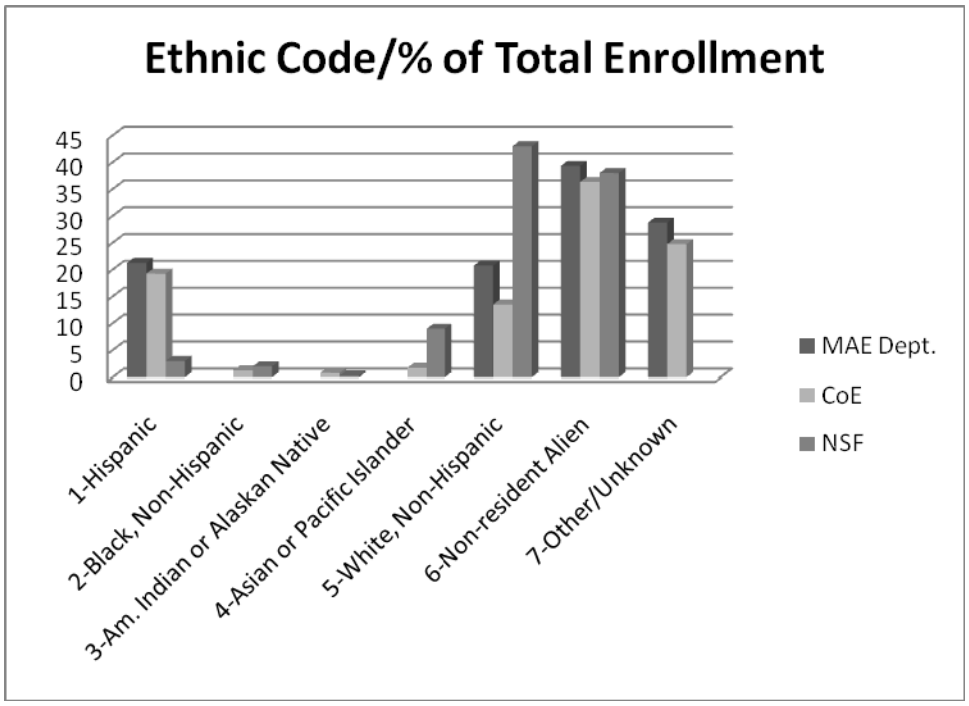
The application materials of students not meeting the above requirements will be evaluated by the Mechanical and Aerospace Engineering Screening Committee. The student may be allowed to enroll with provisional status while completing courses in which the applicant has been deemed deficient.

The standards and process for admission into the aerospace engineering PhD program will be straightforward to implement, because they will be the same as in the mechanical engineering program, for which the supporting infrastructure already exists.

(c). Equitable (ethnic) representation –consistent with state goals; assure access and success of underrepresented

Data illustrating student representation re gender and ethnicity are provided by the College of Engineering for each semester. Comparing these statistics to a national base demonstrates that the MAE department is in line with the College of Engineering and NMSU for ethnic representation. The graph below illustrates this diversity.

NMSU, designated as a Hispanic-serving institution, is favorably noted for its inclusion and commitment to the Hispanic population that makes up a dominant percentage of the state's population. The university is highly ranked by professional Hispanic entities. We will rely on this reputation as represented in pertinent recruitment venues to assure access to Hispanic and all other minorities.



Data for the above graph were obtained from the NMSU College of Engineering (2006-present); and the National Science Foundation (report for 1995-2004)[10]

The 2008 U.S. News and World Report's annual evaluation of graduate school programs ranks NMSU engineering 69th overall, as the 5th highest in the nation for granting engineering degrees to Hispanics, and 6th for Native American students. These two minorities combined make up the majority of New Mexico's population. Enrollment of Hispanics in engineering reflects the makeup of the state.

In terms of minority recruitment, efforts will initially focus on attracting women students from the department's graduating class into the graduate program.

Sources Cited:

(9) Wei Shyy, "University of Michigan Aerospace Engineering Status Report," July 2005. (Materials presented at a workshop attended by Thomas Burton, MAE department head.

(10) Susan T. Hill and Maurya Green, National Science Foundation, Division of Science Resources Statistics, 2006, "Science and Engineering Degrees by Race/Ethnicity of Recipients: 1995-2006." www.nsf.gov/statistics/nsf7308/>> Accessed: 3/13/2008

2. Projected Enrollment and Student Credit Hours Generated

Table 2. Projected Enrollment and Credit Hour Generation for MS in Aerospace Engineering

Projected Student Enrollments for MS in Aerospace Engineering					
Enrollment Year	**Year 1 2009-2010**	**Year 2 2010-2011**	**Year 3 2011-1012**	**Year 4 2012-2013**	**Year 5 2013-2014**
New Students, Part-Time	2	2	2	2	2
New Students, Full-Time	6	6	6	6	6
Returning Students	0	8	10	12	14
Total Head Count	8	16	18	20	22
Graduates	0	6	6	6	7
Approximate Credit Hour Generation					
Enrollment Year	**Year 1 2009-2010**	**Year 2 2010-2011**	**Year 3 2011-1012**	**Year 4 2012-2013**	**Year 5 2013-2014**
Total Head Count	8	16	18	20	22
Number of Student Credit Hours Generated	108+12= 120	216+24= 240	216+36= 252	216+48= 264	216+60= 276
Formula Funding Generated Based On Level 3 ($1293 per graduate Student credit hour)	155,160	310,320	325,836	341,352	356,868
Based on 6 students admittedly annually for full time study Years 1-5 and 2 additional students admitted on part-time status starting in the first year. Calculations assume all full-time students take 18 credits/year and all part-time students take 6 credits/year. Numbers based on the expectation of approximately 1.0 MS graduates/faculty/year.					

Table 3. Projected Enrollment and Credit Hour Generation for PhD in Aerospace Engineering

Projected Student Enrollments for PhD in Aerospace Engineering					
Enrollment Year	**Year 1 2009-2010**	**Year 2 2010-2011**	**Year 3 2011-1012**	**Year 4 2012-2013**	**Year 5 2013-2014**
New Students, Part-Time	0	0	1	1	1
New Students, Full-Time	3	3	3	3	3
Returning Students	0	3	6	7	8
Total Head Count	3	6	10	11	12
Graduates	0	0	3	3	3
Approximate Credit Hour Generation					
Enrollment Year	**Year 1 2009-2010**	**Year 2 2010-2011**	**Year 3 2011-1012**	**Year 4 2012-2013**	**Year 5 2013-2014**
Total Head Count	3	6	10	11	12
Number of Student Credit Hours Generated	54	108	168	174	180
Formula Funding Generated Based On Level 3 ($1293 per graduate Student credit hour)	69,822	139,644	217,224	224,982	232,740
Based on goal of 0.5 PhD graduates/year/AE faculty in steady state. Assumes 3 years beyond MS for PhD, based on 3 new full-time students admitted annually, based on 1 part-time student admitted annually, starting in year 3.					

D. INSTITUTIONAL READINESS

1. Teaching faculty

Financial commitments from the state and from the university will allow five new aerospace engineering faculty positions to be filled by Fall 2009. The first two AE faculty have been hired effective Fall 2008. National searches for three additional faculty who will start in Fall 2009 will be conducted in AY 2008/2009. These five faculty positions will be supported by recurring funding allocated by the state of New Mexico ($423,500 in FY 2009 and beyond), and by the two faculty positions that were allocated to aerospace engineering in 2007 by the NMSU administration. This leaves one remaining position to be obtained from the state, the university, or an external endowment to reach the planned "fully staffed" level of six tenure track aerospace faculty. Current Mechanical Engineering faculty members who have aerospace backgrounds and/or interests are participating in the undergraduate aerospace program, and will also do so on the graduate level. These include Professors Burton, Butcher, Ma, Sevostianov, Shashikanth, and Wei. *(Faculty resumes are included as Attachment 5.)* Graduate teaching duties will be handled by the six aerospace faculty members, augmented as appropriate by the ME faculty. In addition, graduate courses offered at NMT and UNM via distance education will complement those taught by NMSU faculty.

The overall teaching loads of the six AE faculty must be reasonable (average of 3 or 4 courses per year per faculty), and are summarized here. At the undergraduate level we will offer 14 sections of required AE courses per year. Approximately two of these sections will originate from NMT and approximately two sections per year will be taught by ME faculty. This leaves 10 undergraduate sections per year to be taught by the AE faculty. At the graduate level we will eventually offer approximately 10 AE courses per year, with approximately two courses per year taught by NMT, UNM, or NMSU ME faculty, leaving about eight graduate courses per year to be taught by NMSU AE faculty. The total NMSU AE course load will average three courses per year per faculty. This is a desirable steady state teaching load for the AE faculty during the first five years of the program. This load will allow sufficient time to initiate funded research programs, to recruit and advise graduate students, and to develop new courses required for the graduate program.

In summary, six tenure track AE faculty will be sufficient to cover both undergraduate and graduate courses, to advise graduate students, and to conduct scholarly research in aerospace engineering.

2. Sufficient library and other academic supports

Attachment 6, which also appeared in the January 2008 draft of this document, lists Aerospace Periodicals currently subscribed to by NMSU, as well as the NMSU MAE list of needed periodicals to which NMSU is not currently subscribed. This list was prepared by NMSU MAE and considered only research journals (periodicals). We did not consider monographs or research databases.

The NMSU library has reviewed the January 2008 draft of this proposal. We received the Library Resource Analysis for our proposed program from the NMSU Library in late May. The report is in-depth and too lengthy to include in the main part of this document; it is included in Attachment 3a. Library reviewers used the libraries of the University of Arizona and the University of Colorado at Boulder as comparison bases for establishing recommendations for the NMSU AE graduate program. Based on this analysis, the Library recommended initial startup costs and ongoing yearly expenses for the monographs, periodicals, and research databases that would be needed in order to develop library aerospace resources comparable to those at the University of Arizona and Colorado-Boulder.

The Library report concludes that the current collections are not sufficient to support the proposed AE program and that additional funding is needed for resource enhancements. The collection is judged by the Library to be in need of development in all areas, including monographs, periodicals, and research databases. The Library states that its current materials budget cannot support the new resources required. The Library estimates needed start up funding of $30,837 and needed ongoing (yearly) funding of $41,417 in order to procure its recommended aerospace assets (see table below for Library recommendation summary).

Library Budget Recommendations for Aerospace Engineering Graduate Program Resources		
	Recommended Start Up Costs	**Recommended Ongoing Costs (yearly)**
Monographs	$10,000	$3,090
Periodicals	$13,337	$15,000
Research Databases	$7,500	$23,327
TOTALS	**$30,837**	**$41,417**

Based on a preliminary analysis of the Library recommendation, we agree that there are critical needs in monographs, periodicals, and research databases; the Library has done a thorough analysis and their results are useful and informative, for which we thank them. It is our position, however, that two periodicals identified by the Library are prohibitively expensive (approximately $9,600 per year for the two) and that two of the research databases recommended for ongoing (yearly) purchase are also prohibitively expensive (about $18,500 per year for the two). While these periodicals and databases are intrinsically valuable, we do not view them, from a cost/return standpoint, as critical to the successful library support of the aerospace program during its first five years. Accordingly, it is our position that a startup (first year) cost of approximately $22,000 and an ongoing (yearly) cost of approximately $14,000 will provide adequate resources during the initial five years of the program. The AE program is willing to assume this level of startup cost using existing state recurring funds. For the ongoing (yearly) costs we would plan to put a yearly library budget into our FY 2010 legislative recurring funding request for aerospace engineering.

3.Physical facilities adequate for the 1st 5 years

The facilities that are currently available to the Mechanical and Aerospace Engineering Department are adequate to allow the department to accomplish its program objectives. The department facilities, laboratories and offices are dispersed in several locations both on campus and off campus as follows:

- Jett Hall (West and North Wings)-- Faculty offices, laboratories and classrooms
- Jett Hall Annex -- Fluids Laboratory, Combustion Laboratory, and Student Projects Machine Shop
- Wind Tunnel Facility (recently renovated, located 1.5 miles from Jett Hall)

Jett Hall is home to most of the instructional laboratories, classrooms, and faculty offices. There are currently 6-7 unoccupied offices which can accommodate the projected six AE faculty members.

The only possible lack of space that may be experienced by the end of the initial five years is office space for graduate students. Presently, five rooms are used to house graduate students, with a total capacity of 37 work spaces; twenty-two spaces are being used now. Another 10 graduate students can be housed in a room temporarily being used by staff from the College of Education. As the graduate AE enrollment grows, with attendant desired growth in the ME graduate student body, provision will have to be made for additional graduate student office space.

Classrooms

The classrooms used by Mechanical and Aerospace Engineering students are primarily located in Jett Hall which is home to the Mechanical and Aerospace Engineering Department. The quality of the classrooms is average to good. Seating is typical of most classrooms at NMSU, ranging from 20 to 60 seats per classroom. Exit interview results indicate that students are generally satisfied with quality of the classrooms.

There are nine classrooms used for traditional lecture classes. There is one seminar room used for senior and graduate seminar classes, and for research seminars. There is one large computer instructional classroom with 52 computer stations and two projection systems, one on each side of the classroom.

Four of the classrooms (Rooms 105, 103, 203, and 604) in Jett Hall are equipped with computer projectors. In addition, three college-wide classrooms have been equipped with projectors (Engineering Complex I, Rooms 210 A and B, and Goddard Hall 100).

The number of classrooms exceeds the current need of the MAE program, and our classrooms are used routinely by other colleges on campus.

Laboratories

Summarized in the table below are the departmental laboratories used for instruction. Some of these laboratories are dedicated to instruction (noted by an "I" in the right hand column), while others are used for both research and instruction (noted by "I/R" in the right hand column).

Table 4. MEA Department Laboratories

	Lab Name	Location Size (sq.ft.)	Use
1	CAD/CAM Lab	JH 604/1593	I
2	Design Lab	JH 601/900	I
3	Fluids Lab	JH 18/1161	I
4	Heat Transfer Lab	JH 18/1161	I
5	Mechanics Lab	JH 16/706	I/R
6	Instrumentation Lab	JH 602/1108	I
7	Water Channel	JH1/2669	I/R
8	Wind Tunnel labs	Remote/~5000	I/R
9	Composites Lab	JH 607/496	I/R
10	Mechatronics Lab	JH 503	I/R
11	Robotics Lab	JH 608/633	I/R
12	Lego Lab	JH 13/817	I
13	PC Lab (19 stations)	JH 21/683	I/R
14	PC Lab (21 stations)	JH 22/683	I/R
15	PC Lab (7 stations)	JH 504/250	I/R

The aforementioned laboratories are adequately equipped to meet our instructional and research needs.

4.Equipment and technological resources

Computing and Information Infrastructure

The department has four modern computer facilities with approximately 100 workstations available to students. These computer laboratories are adequate for the number of students that need to use those machines for their courses. These facilities are briefly described below.

- Jett Hall room 21 houses nineteen (19) 3.6 GHz Dell Pentium D workstations. This facility is available to all students 24 hours/7 days per week.
- Jett Hall room 22 houses (21) 2.4 GHz Dell Pentium 4 workstations. This is a new PC lab that came on line in the spring of 2008.
- Jett Hall room 504 houses seven (7) Dell 2.4GHz Quad Core workstations. This facility is available to all students 24 hours/7 days per week.
- Jett Hall room 604 houses fifty-two (52) Dell 3.0 GHz Core 2 Duo workstations. This facility serves as a computer teaching classroom by day and as a general use student computing lab during non-class hours. All 52 computers were upgraded in the summer of 2007.

These Microsoft Windows XP based systems have several engineering software programs installed on them including Pro/Engineer Wildfire and Pro/Mechanica, Unigraphics NX5, Hypermesh FEA Suite, MSC Adams and Nastran, and three EES Thermodynamics calculators.

All of the workstations are also equipped with Microsoft Office 2007 suite of software, including Word, Excel, Powerpoint, Project, and Visio, as well as Mathcad 13, Matlab 2006a, and SigmaPlot, for report writing, analysis of data, statistical analysis, plotting, and preparation of presentations.

The computers and the software are used in several ME classes including: ME 159, ME 222, ME 260, ME 329, ME 460, ME 518, ME 533, and ME 580.

The Department upgraded the networks in Jett Hall in 1998 from thin-net Ethernet to category V wiring and fast Ethernet. The new network operates at 100 megabits/s and has reduced the amount of network downtime almost to zero. All faculty offices and graduate student offices are wired with category 5 networking.

The four computer labs and the server room were all upgraded to gigabit networking in 2005, providing extremely high speed communications between our computer labs and servers, and all campus WebCT, e-mail, and other IT campus infrastructures.

With the support from aerospace engineering and faculty start-up funding, a powerful Linux cluster was built in 2007 for research requiring large-scale parallel computation. This cluster has 1 headnode with 4 Dell 2.4 GHz dual-core processors and 40 compute nodes with 2 Dell 2.4 GHz dual-core processors each, 2 GB RAM memory perprocessor, and 3 TB external Raid drive for data storage. In early 2008, Army High Performance Computing Research Center (AHPCRC) installed a 16-node Linux cluster with 2 quad-core processors and 16GB RAM for each nodes for AHPCRC supported research which involves MAE department and two other engineering departments.

The College of Engineering is currently centralizing and consolidating all engineering departments into one active directory computer domain to allow for a seamless computer environment for students. This will allow students to "roam" from one department's computers to another department's computers within the College of Engineering and always have their personalized profile (My Documents, Desktop, etc.). MAE Department is integrated into this consolidation; college-wide, only one department has not completed its integration.

5.Other operating resources (such as clerical support) adequate to initiate the program

The current Mechanical Engineering support staff consists of one computer engineer, one machinist, two administrative office staff (one grade 10 and one grade 8), and a part-time writing specialist. This level of staff support is not adequate to support the increase in faculty, students, laboratory maintenance, and administrative load that will accompany the AE graduate and undergraduate programs. Two additional staff will be needed as follows:

- a departmental administrative assistant, with accompanying reorganization of the office staff duties;

- a laboratory/instrumentation technician to support teaching and research lab maintenance and development of the aerospace engineering teaching lab that will support both undergraduate and graduate instruction..

It is anticipated that these staff will be hired in early 2009 and that the state recurring funding will partially support their salaries.

E. PROJECTED COSTS OF PROGRAM

1. New Costs for Program Start-Up

Major costs associated with the start-up of the undergraduate AE program will facilitate program activities on the graduate level also. The budget items listed below are directly attributed to the undergraduate program, regardless of the establishment of the graduate program.

- Additional faculty
- Additional support staff
- Additional facilities, equipment and technological resources
  New teaching lab equipment, to include the following:
  Small wind tunnel and instrumentation @ ~$50k
  Instrumentation for large wind tunnel @ ~$50k
  5 PCs @ $3k + Flight Simulation software @ ~$5k = ~$20k

- New graduate assistantships to support undergraduate AE lab and senior design
  2 TAs for UG Aero Fluids Lab
  2 TAs for UG Aero Design Lab

Additional start up funds will be necessary to provide an appropriate level of library resources for the AE graduate program. An analysis of needs and resources developed by the NMSU library is summarized on page 16. Overall budget estimates, including revenue, expenses and tuition generated, is presented in Attachment 4.

2. State Support

The State has provided and/or committed funding for the NMSU Aerospace Program since FY 2005. This includes both non-recurring and recurring funds. Non-recurring funds have been used for renovation of the wind tunnel facility which is one of the few and best of its kind in the world, and is invaluable for teaching and research.

State Funding	Description
FY 2005	$275,000 non-recurring
FY 2006	$152,000 recurring
FY 2007	$152,000 recurring from FY 2006 + $247,000 non-recurring
FY 2008	$152,000 recurring from FY 2006 + additional $184,800 recurring = $336,800 recurring
FY 2009	$336,800 residual recurring + $86,7000 additional recurring = $423,500 recurring.

NMSU has also committed financial support for two faculty positions from I & G funds. These positions have been filled with the first two AE faculty effective Fall 2008.

3. Other Support

a (research grants and contracts)
Current mechanical engineering faculty have had several externally funded research grants focused on aerospace research. These research projects are providing funding for students, faculty, and infrastructure, and they are evidence of emerging credibility in aerospace research. The funded research programs from 2006 on are summarized below.

- AFOSR grant (Allen[PI], Shashikanth, Ma, ….) – "Development of Scaled Hummingbird Models for Studying the Dynamics of Hovering and Low Speed Forward Flight" - $415,00 over 3 years
- PSL UAV earmark through HAFB (Ma[PI], Burton [co-PI]): utilize UAVs as teaching tools for aerospace education - $400,000 over 4 years for ME/AE
- AF - STTR grant (Allen [PI], Shashikanth), "Flapping Wing Aerodynamics and Control for Maneuverable Hovering Micro Air Vehicles," $100,000, Phases I and II.

- AFRL (Kirtland) grant (Ma [PI]), "On-orbit identification of inertia properties of spacecraft using robotics technology," $37,000, one year.
- ARO grant (Ma[PI]), "Experimental Verification of a Systematic Method for Identifying Contact-Dynamics Model parameters," $29,000, one year.
- NASA grant (Sevostianov [co-PI]), "Novel Nanoparticle-Filled Matrices for Thermal Stress reduction in Polymer Matrix Composites: Multi-Scale Modeling and Experimental Validation," $57,000, three years.
- Sandia National Labs (Hills [PI]), **"**Model Validation Methodology," $100,000, one year
- Sandia National Labs (Wei [PI]), **"**Reduced-Order Modeling of Shear Layers," $80,000, two years (SURP program)
- US Army: AHPCRC (Stanford is lead, with NMSU, UTEP, Morgan State; total $5 - $10 million per year for 5 – 10 years; NMSU share ~ $750K/year; NMSU MAE share ~ $175K/year) MAE PIs = Shashikanth and Wei; "Fluid – Structure Interaction."
- NASA EPSCoR Grant, October 2007 (Burton, Butcher, Sevostianov + NMT; NMSU share = $404K over three years) – "Structural Health Monitoring and Self-Healing of Aerospace Structures"
- ARO grant (Ma [PI**],** May 2008,"Model Reduction for Contact Dynamic Simulations of Flexible Multibody Systems**,"** $210,000, three years.

b (funding already in place for AE bachelor's program, and anticipated revenue from undergraduate program)

The financial position for initiation of the program, and the first five years of its operation, are sound. A summary of the overall revenues, expenses and formula funding generated is presented as Attachment 4.

Table 5. Projected Enrollment and Credit Hour Generation for BS in Aerospace Engineering

Projected Student Enrollments for BS in Aerospace Engineering					
Enrollment Year	Year 1 2009-2010	Year 2 2010-2011	Year 3 2011-1012	Year 4 2012-2013	Year 5 2013-2014
Freshmen	40	40	40	40	40
Junior	25	45	45	45	45
Senior	25	25	45	45	45
Total Head Count/Jr & Sr	50	70	90	90	90
Graduates	25	25	45	45	45
Approximate Credit Hour Generation for undergraduate AE program					
Enrollment Year	Year 1 2009-2010	Year 2 2010-2011	Year 3 2011-1012	Year 4 2012-2013	Year 5 2013-2014
Total Head Count	50	70	90	90	90
Number of Student Credit Hours Generated (LD=lower division UD=upper division)	40 LD 375 UD	40 LD 525 UD	40 LD 675 UD	40 LD 675 UD	40 LD 675 UD
Formula Funding Generated Based On Level 2 SCH generation LD=$279 UD=$489	40@279 + 375@489 = 195,263	40@279 + 525@489 = 286,613	40@279 + 675@489 = 341,963	40@279 + 675@489 = 341,963	40@279 + 675@489 = 341,963
Assumes ▪ 40 new entering freshmen per year. ▪ attrition to 25 students in junior and senior years ▪ additional 20 students added to junior year from joint AE program with Universidad Autonoma de Chihuahua (as per agreement) starting in 2010-2011 academic year. ▪ each freshman takes 1 credit/year of AE courses ▪ each junior and senior takes an average of 7.5 credits/year at 300/400 level.					

F. QUALITY OF PROGRAM

Graduate Program Plan

General Issues and Planning Principles:
The budgetary and staffing requirements for the aerospace program are based on the following primary considerations:

- the requirement to achieve ABET accreditation of the undergraduate program;
- the need for a critical mass of graduate course offerings (approximately ten courses per year) to ensure a viable graduate program;
- the development of adequate laboratory facilities for the instructional and research components of the program;
- technician, graduate teaching assistant, and office staff to support the program; and
- adequate resources to support salaries and startup funds for the six new faculty positions deemed necessary to implement a nationally competitive program and attain accreditation.

The most critical aspect of program implementation will be hiring the six new faculty who will form the backbone of the program. Two faculty have been hired to start in Fall 2008. A national search will be conducted in AY 2008/2009 to hire three additional faculty who would start in Fall 2009. We plan to increase the aerospace faculty to the recommended level of six by the end of the first five years.

As previously noted, graduate programs in aerospace engineering at the MS and PhD levels are necessary

- to enable development of a nationally competitive research program,
- to enable the hiring of nationally competitive aerospace engineering faculty, and
- to produce research innovations and capabilities that will enhance economic development and collaborations with aerospace-related entities in the state of New Mexico.

A viable graduate program requires an adequate research faculty and graduate students sufficient to constitute critical masses for the research enterprise. Especially important is the development of a graduate program that produces graduates who can compete with those from nationally prominent AE graduate programs. The main constraints that must be taken into account in development of the graduate programs are the relatively small faculty (six planned) and the necessary commitment of these faculty members to both undergraduate and graduate programs.

State funded programs must comply with standards given in 5 NMAC 3.12 [now 5.3.12 NMAC]

(a1) Curriculum – Program Structure
MS and PhD Programs in Aerospace Engineering: General Requirements

The admission requirements, degree program options, thesis requirements, written and oral examinations and defenses, and numbers of hours of required graduate course work will be the same for the aerospace engineering graduate programs as for the existing graduate programs in mechanical engineering. These MS and PhD requirements are summarized below.

MS in ME or AE (2 options)

Thesis option: 30 beyond BS (6 credits of thesis + 24 credits of formal coursework)

- Student must have either a refereed conference proceeding accepted or a refereed journal article in review by graduation. The MS thesis can be a reformatted version of this paper.

Coursework only option: 30 credits formal coursework

- All students take a final oral examination

For the MSAE (MSME) degree eighteen credits must be in graduate (500 level) AE/ME courses.

PhD in ME or AE

- 48 hours of formal coursework beyond BS; 18 of these hours must support the student's research area.
- 24 hours of research credit.
- Written qualifying examination early in the PhD program (3 subject areas).
- A comprehensive oral and written exam, including a subject matter exam and a research proposal, taken when coursework is substantially complete.
- Final doctoral thesis defense
- PhD students must have one refereed journal paper accepted and a second one accepted or in review by graduation. The PhD dissertation can be a compiled and reformatted version of these published or accepted journal papers.

Background: Characteristics of typical AE graduate programs in combined MAE departments.

Admission standards, degree requirements, and curricula of twenty-six MAE/AEgraduate programs were analyzed. NMSU graduate programs are in line with the general trend represented. A table comparing a selection of these (other) programs is presented as Attachment 7.

The course offerings in the MAE departments are usually divided into five broad areas as follows:

1. Aerodynamics and Fluid Mechanics
2. Heat Transfer and Thermodynamics
3. Solid Mechanics, Materials and Structures
4. Dynamics and Controls
5. Systems, operations, missions and supporting subjects

Usually the requirements in Mathematics are higher in MAE departments than in ME departments. The list of engineering courses varies depending on the research interests of the student . However, there are several core courses that are offered almost everywhere; most of these courses are common for AE and ME graduate students.

After analysis of the aforementioned graduate programs and discussion with Aerospace Committee members, the following courses have been identified for consideration:

- **Basic:** Continuum Mechanics, Aerodynamics (low and high speed), Aeroelasticity, Structural Dynamics, Turbulence, CFD, Experimental Methods in Aerodynamics, Propulsion, Control Systems, Flight Dynamics, Spacecraft Dynamics and Controls, Orbital Mechanics.
- **Also recommended:** Unsteady Aerodynamics, Combustion, Smart Materials, Thermal Stress Analysis, Optimization in ASE, Dynamic Stability of Elastic Systems, Fracture Mechanics, System Analysis, Hydrodynamic Stability.

(a2) Curriculum – Planned Aerospace Engineering Graduate Courses and Schedule of Offerings

The graduate courses in the NMSU MAE Department available to AE graduate students will be of two types: 1) existing mechanical engineering graduate courses relevant to aerospace, and 2) the new aerospace engineering courses described here. Many ME graduate courses are suitable for AE graduate students and vice versa. Thus, the addition of the AE graduate courses will strengthen the ME graduate program.

Current mechanical engineering courses that would be suitable for both mechanical and aerospace engineering graduate students are listed below. These are fundamental courses of relevance to both ME and AE degree programs.

Engineering Math

ME 570 – Engineering Analysis I
ME 580 – Engineering Analysis II

Dynamics and Controls

ME 511 - Advanced Dynamics
ME 512 – Advanced Vibrations
ME 527 – Control Systems

Fluids and Thermal Science

ME 503 – Thermodynamics
ME 530 – Intermediate Fluid Dynamics
ME 533 – CFD
ME 540 – Heat Transfer

Structural Mechanics

ME 502 – Elasticity
ME 514 – Composite Materials
ME 518 – Finite Elements

In addition to these basic ME courses which are appropriate for AE students, the following more specialized ME courses may also be appropriate for ME students depending on the student interest area: ME 5xx (Non-destructive Evaluation, currently taught as a special topics course), ME 526 (Robotics), and ME 5xx (Nonlinear Dynamics, special topics course).

The planned Aerospace Engineering graduate courses appear below. This course list will evolve as AE faculty are hired, according to the specialties of the faculty and focus of incoming graduate students.

General

AE xxx – Aerospace Systems and Missions
AE xxx – Modeling and Simulation of Aerospace Systems

Aero-Fluids

AE xxx – Advanced Fluids with Heat Transfer
AE xxx – Aerodynamics Laboratory and Flow Diagnostics
AE xxx – Ideal Fluid Aerodynamics
AE xxx – Supersonic Flow
AE xxx – Propulsion
AE xxx – Boundary Layers and Hydrodynamic Stability

Dynamics and Control

AE xxx – Structural Dynamics (joint with ME 512, Vibrations)
AE xxx – Aircraft Flight Dynamics and Control
AE xxx – Spacecraft Dynamics and Control
AE xxx – Nonlinear and Optimal Control
AE xxx – Orbital Mechanics

Structural Mechanics

AE xxx – Aeroelasticity
AE xxx – Fracture Mechanics and Fatigue

The preceding plan would add twelve new graduate courses associated with the Aerospace Engineering program. Some of these AE graduate courses would be offered yearly and some would be offered every other year, as is now done with the ME graduate courses. A preliminary schedule of planned offerings of both ME and AE graduate courses is shown in Table 6. The details of this plan will evolve.

Based on the aforementioned plan, sample course work for students with emphasis areas in dynamics/controls or in aerodynamics are shown below for a three semester thesis program having 24 hours of graded course work:

Dynamics/Controls Emphasis	Aerodynamics Emphasis
ME 570 – Engineering Math I	ME 570 – Engineering Math I
ME 511 – Advanced Dynamics	ME 511 – Ideal Fluid Aerodynamics
AE xxx – Advanced Fluids & Heat Transfer	AE xxx – Dynamics
AE xxx – Structural Dynamics (joint w/ ME512)	ME 533 – Comp. Fluid Dynamics (CFD)
ME 527 – Controls	AE xxx – Aero Lab & Flow Diagnostics
AE xxx – Aircraft Flight Dynamics and Control	AE xxx – Boundary Layers & Hydrodynamic Stability
AE xxx – Aeroelasticity	AE xxx – Aeroelasticity
AE xxx – Aero Systems & Missions or	AE xxx – Supersonic Flow
AE xxx – Modeling & Sim. of Aero Systems	

Table 6	**Summary AE and AE relevant ME courses - Preliminary Schedule**												
August 1st, 2008													
	F09	S10	F10	S11	F11	S12	F12	S13	F13	S14	F14	S15	
AE Courses (unnumbered)													
Systems/Missions					x				x				
Mod/Sim Aero Systems			x				x				x		
Adv. Fluids w/ Heat Transfer	x		x		x		x		x		x		
Aero Lab & Flow Diagnostics		x				x				x			
Boundary Ls & Hydro Stability		x				x				x			
Supersonic Flow				x				x				x	
Propulsion				x				x				x	
Ideal Fluid Aerodynamics	x		x		x		x		x		x		

	F09	S10	F10	S11	F11	S12	F12	S13	F13	S14	F14	S15	
Structural Dynamics		x		x		x		x		x		x	
Aircraft Flight Dynamics/Control		x				x				x			
Spacecraft Dynamics/Control				x				x				x	
Nonlinear & Optimal Control					x				x				
Orbital Mechanics	x			x			x			x			
Aeroelasticity			x		x		x		x		x		
Fracture Mechanics & Fatigue		x				x				x			
AE Relevant ME courses													
ME 502 Elasticity I	x		x		x		x		x		x		
ME 503 Thermodynamics	x		x		x		x		x		x		
ME 511 Dynamics	x		x		x		x		x		x		
ME 512 Vibrations		x		x		x		x		x		x	
ME 514 Composite Materials		x				x				x			
ME 518 Finite Elements		x		x		x		x		x		x	
ME 527 Controls		x		x		x		x		x		x	
ME 530 Int. Fluid Mechanics	x		x		x		x		x		x		
ME 533 CFD		x		x		x		x		x		x	
ME 570 Engineering Math I	x		x		x		x		x		x		
ME 580 Engineering Math II		x		x		x		x		x		x	
ME 526 Robotics													
ME 540 Heat Transfer		x		x		x		x		x		x	
ME 5xx Non-destruct. Eval.													

b. Faculty - The most critical aspect of program implementation will be hiring the six new faculty members who will form the backbone of the program. Two faculty have been hired to start in Fall 2008. A national search will be conducted in AY 2008/2009 to hire an additional 3 faculty to begin in Fall 2009.

c. Admission standards for NMSU's graduate school and the Mechanical and Aerospace Engineering Department are in line with other regional and national AE programs. Refer to table in Attachment 7.

d. Current technologies available to graduate students in the MEA graduate programs:

- Fully networked (fast Ethernet to desktop) offices for graduate students
- State-of-the-art engineering analysis software and parallel computing cluster for CFD..
- Research labs (e.g., non-destructive testing and evaluation, combustion, composites, robotics, controls, VAVs)
- Subsonic Rough Wall Boundary Layer Wind Tunnel
- Water Channel

e. Practical experience: Requirements included in MS and Ph.D programs guarantee that "real life" experience is integrated in the curriculum. Candidates are mentored by faculty in thesis and dissertation research, in accordance with research interest and funded research grants.

Collaboration and interaction with various industries and agencies in the state provide on-site experience, either as summer internships (especially for MS candidates) or research related activities.

f. Academic support services: Fellowship, research assistantship and teaching assistantship support are available to qualified graduate students. Awards are made on a competitive basis.

Graduate assistantships in the MEA Department, designed in the nature of an internship, are learning experiences facilitating completion of degree requirements. They are an opportunity for students to acquire practical and professional experience related to their degree program, and to prepare for a professional career.

The graduate school provides information on numerous sources of support for graduate engineering students, including aid specifically directed towards minorities and women.

g. Final Integrating experience: Research is the foundation of the MEA Department's graduate program at the MS and PhD levels. Production of a thesis for master's candidates, and dissertation for doctoral candidates is the culmination of graduate study. Focused research under the mentorship of a faculty member in the field of interest is the central core of a candidate's plan of study. Coursework supports intellectual skills and knowledge to draw on during the research stage. The final action is to report on the research activity.

Master's degree candidates, for all options, must give a seminar presentation based on their research, project or, in the case of coursework only option, a topic of interest. They also must go through an oral examination by the graduate committee (chosen by the candidate).

Doctoral candidates are required to give presentations and undergo examinations at a number of stages in their plan of study. The final qualification, the dissertation defense, occurs at least a year after passing the written and oral comprehensive exams.

h. External review or evaluation: An external review panel was convened during June 2005 to meet with our department's aerospace committee and other faculty to and review our plan to implement an aerospace engineering program at NMSU, and to offer advice and suggestions based on their experiences. A second panel composed primarily of AE Department Heads from other institutions met in May 2007 to discuss the proposed AE graduate program. (See Attachment 1 for the report of this panel.)

We also plan to organize an industrial advisory committee based on the model of ME's Industrial Advisory Committee (IAC) which provides an annual review of the program (undergraduate and graduate) and presents the department head with a report on its findings. The committee may make (non-binding) evaluations and recommendations based on its observations and interviews with staff and students. The May **2007 Aerospace Review panel has agreed to serve in the future as an advisory committee.**

The MEA Department will also conduct employer and alumni surveys annually. Findings from these evaluation tools will be applied to the graduate program, depending on relevance and need.

i. Specialized accreditation will not be sought for the AE graduate program. ABET, the accrediting agency for engineering programs, will accredit either the undergraduate or graduate program, not both. All of NMSU's engineering departments participate in the ABET accreditation process for their undergraduate programs. The graduate programs follow university guidelines for graduate education at NMSU.

G. ASSESSMENT OF OPERATIONS AND IMPACT

- **Monitoring of program, students, completion rates**: The same process used for ME will be applied to the AE program. Records for the following are maintained and reviewed on a regular basis:

    - Enrollment, retention and degree completion
    - Candidates' committee meetings and recommendations
    - Individual student records including completion of required courses, cumulative GPA, charted progress towards degree completion
    - Agenda and minutes from the department's graduate committee

Records pertaining to staff, budgets, and planning are also kept and will be used in assessing the operation of the AE graduate program.

- **Evaluations and self-assessment, quality assurance process:** Methods for obtaining evaluations from students, graduates or other appropriate sources will also be modeled on the existing processes used for the ME program.

    - Students on all levels complete a course evaluation at the end of the semester for each course taken.
    - Information is solicited annually through an Alumni survey send to graduates two years and five years after degree completion
    - Records of quantifiable responses from interviews and surveys are maintained and reviewed on a regular basis. Changes based on these evaluations are implemented in the program as appropriate and necessary.

H. ADMINISTRATIVE RESPONSIBILITY FOR THE PROGRAM AND INSTITUTIONAL COMMITMENT

1. Structural Location of Oversight –Administrative Responsibility

The AE graduate program will be administered through the Mechanical and Aerospace Engineering Department, as directed by the department head. The organization of key program elements is described in the following paragraphs.

Initially (first two years) the Mechanical Engineering Graduate Committee and the Mechanical Engineering Graduate Program Director will handle aerospace engineering graduate student admissions, initial advising of incoming graduate students, and related matters. AE graduate student recruiting activities will be organized jointly by the department head and the ME graduate program director. By year three (AY 2011/2012) a separate AE graduate program director will be appointed from among the 5-6 new aerospace faculty. An "aerospace committee," consisting of several AE and experienced ME faculty, will oversee AE curricular matters at both the undergraduate and graduate levels.

Planning for the three-way distance education course offerings among UNM, NMT, and NMSU will be responsibility of the department head, with assistance from the aerospace committee.

Assignment of departmental teaching duties, maintenance of student records, space utilization, and other administrative support functions will be organized for the department as a whole, rather than for ME and AE separately, in order to make best use of the leveraging with the existing ME programs.

1. Statement of Administrative Support -- Institutional Commitment

a. Sufficient Resources

As noted in Section A3, aerospace engineering is an institutional priority for NMSU. The Dean of Engineering, the Provost, and the President of NMSU have strongly supported the development of the AE undergraduate and graduate programs for the past four years. The University has allocated two new faculty positions from I&G funds for aerospace engineering and has accorded legislative priority status to aerospace engineering for three consecutive years. The NMSU Dean of Engineering, the Provost and the President have worked hard with the local legislative delegation to obtain program funding, resulting in the current NMSU AE state funded budget of $423,500 recurring funding. The establishment of graduate programs in AE has been an important goal from the outset.

Combining the two faculty positions allocated by NMSU, existing recurring state funding, additional state recurring funding anticipated in FY 2010, new faculty startup funds to be provided by the NMSU College of Engineering ($30,000 per new faculty) and by the NMSU Vice President for Research (amount to be determined), and student credit hour generated funding, the available resources will be adequate to support the graduate degree programs in aerospace engineering.

b. **Internal Approvals Granted:** NMSU internal reviews were completed and approved prior to the Board of Regents meeting on October 30, 2008.

ATTACHMENT 1: AEROSPACE PANEL REVIEW
May 21, 2007

Attachment 1 – NMSU AE Graduate Degree Proposal

Aerospace Panel Review
New Mexico State University
May 21, 2007

Outside Attendees:

Earl H. Dowell, William Holland Hall Professor, Mechanical Engineering and Materials Science, Duke University and Member, National Academy of Engineering (NAE); formerly Dean of Engineering, Duke University

Christopher D. Hall, Professor and Interim Department Head, Aerospace and Ocean Engineering, Virginia Tech

Basil Hassan, Manager, Aerosciences Department, Engineering Sciences Center, Sandia National Laboratories

D. Joseph Mook, Professor and Chair, Mechanical and Aerospace Engineering, University at Buffalo, State University of New York

Dean T. Mook, N. Waldo Harrison Professor Emeritus, Engineering Science and Mechanics, Virginia Tech

Helen L. Reed, Professor and Department Head, Aerospace Engineering, Texas A&M

Desired Outcomes of Review: The Department Head of Mechanical and Aerospace Engineering at New Mexico State University, Prof. Thomas Burton, asks for a written summary from the Outside Review Panel addressing the following provided questions:

1) ***Question:*** Should NMSU AE develop MS and PhD programs in aerospace engineering?

   Panel position: The graduate program is absolutely essential for 4 reasons:
   e) To recruit outstanding faculty who will be nationally competitive in attracting research funding and outstanding graduate students;
   f) To attract an increasing number of outstanding graduate students from all over;
   g) To provide unique educational opportunities for engineers in New Mexico industries and government laboratories;
   h) To provide visibility for the State of New Mexico in the national and international aerospace community, and complement its current vibrant efforts in developing an in-state aerospace industry.

2) ***Question:*** Are the budget plan, proposed new faculty startup plan, and the number of faculty (6) planned adequate to develop and offer the programs?
   Panel position:
   a) Yes, the plan to hire 6 new faculty is well thought out and represents the bare minimum of the critical mass required to achieve the ambitious goals of this program. It is noted that the ability to create a new aerospace program with only 6 new faculty is a result of highly leveraging existing mechanical engineering faculty and resources.
   b) The details of the start-up plan are in line with what quality US aerospace programs have found to be necessary to be competitive in attracting outstanding candidates. The typical start-up package offered by quality US aerospace programs includes faculty salary summer support, graduate student support, professional support, moving expenses, laboratory and computer equipment, and space, with costs comparable to what is proposed for the NMSU program as presented to this Committee.

3) ***Question:*** What are the Panel's recommendations/suggestions on how best to state the position descriptions for the new AE faculty searches (with specificity as the panel recommends)?
Panel recommendations/suggestions:
    a) We recommend that the positions remain general with respect to area and rank with a focus on hiring the best people who can successfully teach the breadth of classes offered and provide leadership in developing emerging high-quality research programs.
    b) Sell the program by pointing out the unique and tremendous opportunities, such as to be:
        i. on the ground floor of shaping a new program;
        ii. in a state in which aerospace is a cultural and economic force;
        iii. in a state with many cultural and natural attractions and a very pleasant lifestyle;
        iv. working with a forward-thinking administration.

4) ***Question:*** What are the Panel's recommendations/suggestions on the promising research areas in AE (nationally and for NMSU AE program, as the panel is able to identify)?
Panel recommendations/suggestions: Given that this is a brand new program, we believe that the best approach is to build on current strengths and be open to expansion into new areas as opportunities arise.

5) ***Question:*** What are the Panel's evaluation/comments/suggestions on the planned undergraduate AE program?
Panel recommendations/suggestions: The Department Head has provided a very thoughtful and solid plan and the Committee has a few minor suggestions. These might include:
    a) Focusing on the junior and senior years in keeping students on track. Given the limited faculty resources, only offering courses once an academic year in the junior and senior years, with the possibility of offering critical courses in the summer with university support.
    b) Offering structured computer programming.
    c) Taking full advantage of computer simulation methods as an educational tool.
    d) Covering vibrations, aeroelasticity, and intermediate dynamics after they have completed ODE's (ordinary differential equations) and can do closed-form solutions.
    e) Employing senior engineers with industrial experience for capstone classes.
    f) Leveraging the existing emphasis in UAVs (unmanned aerial vehicles) and/or aerospace systems into senior capstone design, and seizing the opportunity to create multidisciplinary teams with students from other departments.
    g) Assembling an Industrial Advisory Board with more mid-career professionals for continuous feedback on desired program outcomes and objectives.

6) ***Question:*** What are the Panel's evaluation/comments/suggestions on AE labs and facilities?
Panel recommendations/suggestions: There is a need for graduate-student office space. At present, all other facilities appear to be adequate and up-to-date. However, as the program grows, undoubtedly additional investments in existing and expanded facilities and support staff will be required.

7) ***Question:*** What are the Panel's other evaluations/comments/suggestions?
Panel recommendations/suggestions: Additional issues to consider might be
    a) Department Head joining the Aerospace Department Chairs' Association.
    b) Mentoring junior faculty to have them successfully achieve tenure and promotion.
    c) Balancing space and aeronautics.
    d) Offering distance education classes (a market study is needed) to both supplement the program for NMSU students as well as reach out to the community.

Prepared by: Helen L. Reed, helen.reed@tamu.edu, (979) 458-2158, Texas A&M University

ATTACHMENT 2: LETTERS OF SUPPORT

NEW MEXICO SPACE GRANT

New Mexico State University
College of Engineering
MSC SG
P.O. Box 30001
Las Cruces, NM 88003-8001
(505) 646-6414
Fax: (505) 646-7791
nmsgc@nmsu.edu
http://spacegrant.nmsu.edu
3050 Knox Street

May 15, 2008

Dr. Tom Burton, Department Head
Mechanical Engineering and Aerospace Engineering Department
New Mexico State University
Las Cruces, NM 88003-0001

Dr. Burton,

It is my pleasure to provide this letter of support for the New Mexico State University Aerospace Engineering Program. The undergraduate program, only three years old, has 70 majors and is expecting its first graduates in Spring-2009. A graduate program must be made available for these students.

The State of New Mexico has a long, successful history in space-based research and education. Assuring New Mexicans a role in the future benefits related to space commercialization requires that we prepare the workforce using all the resources of our public institutions. With the passing of the gross receipts tax and recruitment of Virgin Galactic and the XPRIZE Cup as anchor tenants, Spaceport America is poised to bring a new level of economic development to New Mexico. The potential for economic benefits to accrue to New Mexico will depend in part on whether our faculty and students are given opportunities to learn to compete in the emerging industries coming to New Mexico. A graduate degree program in Aerospace Engineering will continue to prepare the workforce for the challenges facing New Mexico as the state recruits new companies to do business at Spaceport America.

New Mexico Space Grant Consortium has provided financial support to the Aerospace Engineering program since its inception. We support development of Aerospace Engineering courses. We support faculty and student research. We support students to design and fly microgravity experiments as part of NASA's Reduced Gravity Flight Opportunity Program. Dr. Burton also received a NASA EPSCoR grant in the amount of $741,144 to promote aerospace engineering research, for which I am the principal investigator.

I congratulate you on the development of your successful undergraduate program and support the development of a graduate program. I believe this program is vital to the development of our state and our Nation's diverse workforce.

Respectfully,

Patricia Hynes
Director

NASA

New Mexico State University
New Mexico Institute of Mining and Technology
University of New Mexico
Doña Ana Branch College
San Juan College
Physical Science Lab
White Sands Test Facility
White Sands Complex
X PRIZE Foundation
N.M. Spaceport Authority

Y:\Recommendations\2008\Burton.doc

W-4, MS A114
P..O..Box 1663
Los Alamos, New Mexico 87545
April 5, 2007

Dr. Tom Burton, Dept. Head
Mechanical Engineering
MSC 3450, PO Box 30001
New Mexico State University
Las Cruces, NM 88003-3450

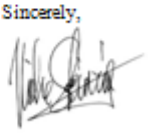
Dr. Burton,

I've heard about the fledgling Aerospace Engineering program at NMSU, which will take advantage of the existing mechanical engineering infrastructure. I think the synergy provided by the combined program will benefit both the college of engineering and the students, and will fuel the aerospace industry that is growing here in New Mexico. Employers like Los Alamos National Laboratory also have a broad array of programs that would utilize students with training in subjects typically taught in aerospace programs, such as propulsion, hydrodynamic stability, gas dynamics, space vehicle dynamics, and advanced structural dynamics. So, I wish you success in obtaining the necessary recurring funding from the legislature to make this a fully accredited program.

In addition to the undergraduate program now offered, I believe it is important to begin planning for advanced degree programs (MS and PhD) in aerospace. There are obvious reasons for doing this; the need for advanced degrees to support the industry, and the hope that innovation will be maintained in this country by university research programs that require MS and PhD level students. A less obvious reason is to strengthen the undergraduate program. Graduate programs generate research projects, which provide the physical results that a college points to when it is recruiting undergraduate students. These potential students get to see first hand what is being done at the school they are evaluating, which in my experience is often the impetus for a final choice. The research programs also provide a better hands-on environment for the teaching of undergraduate students, and the graduates of these programs have a better understanding of real world projects than students that are not exposed to such things.

I support the development of the aerospace engineering program at NMSU, and think that a successful undergraduate program, which is well on the way, will also require a successful graduate level program. Good luck in attracting the first few graduate students that will pave the way for this development. I look forward to collaborating on some joint research projects with you and some of these students.

Sincerely,



Michael Steinzig, PhD, PE
W4 Systems Engineer

cc: M.R. Miller, W4 Group Leader
Steve Renfro, Weapons Division Deputy

Vice President
International Business Development
President
Northrop Grumman International Inc.

NORTHROP GRUMMAN

Northrop Grumman Corporation
Integrated Systems

One Northrop Grumman Ave
El Segundo, California 90245-2804
Telephone: 310-331-5746

10 April 2007

The purpose of this letter is to express my support for the development of MS and PhD degree programs in Aerospace Engineering at New Mexico State University. The recent development and offering of the undergraduate aerospace engineering program at NMSU is a very good first step. This is the only aerospace engineering degree program in New Mexico, and the undergraduate Aerospace Engineering program will provide excellent opportunities for New Mexico's college students and will enhance workforce development in New Mexico to support the state's burgeoning aerospace industry.

The United States government through NASA has embarked on a series of programs that will replace the Space Shuttle and return focus on a manned space programs in the near term. Additionally, the United States Air Force is faced with modernizing many of its aging airframes. This renewed focus on Aerospace will require aerospace engineers with advanced degrees. Most aerospace companies desire a mix of engineers with graduate degrees to enhance their competitive position. The aerospace industry nationally is strong, but foreign competition and the aging aerospace workforce in the US make it imperative that a technically advanced workforce be maintained into the future. The graduate Aerospace Engineering program planned at NMSU appears to be competitive with the good programs around the country in terms of level of course work and research possibilities.

In addition to the undergraduate program now offered, however, I believe that graduate degree programs (MS and PhD) are also needed I support the development of the MS and PhD aerospace engineering programs and think the graduates of this program will provide value to the state of New Mexico and to the United States in the coming decades.

Carl O. Johnson

Sandia National Laboratories

Operated for the U.S. Department of Energy's National Nuclear Security Administration by Sandia Corporation

P.O. Box 5800
Albuquerque, NM 87185-0457

P.O. Box 969
Livermore, CA 94551-0969

Dr. J. Stephen Rottler
Vice President
Weapons Engineering & Product Realization

Phone: (505) 844-3882
Fax: (505) 844-8512
Internet: jsrott@sandia.gov

May 1, 2007

Dr. Thomas D. Burton
Mechanical and Aerospace Engineering
P. O. Box 30001 / MSC 3450
New Mexico State University
Las Cruces, NM 88003-8001

Tom

Dear ~~Dr. Burton~~:

I am writing this letter to endorse the development and implementation of Master and Doctoral degree programs in Aerospace Engineering at New Mexico State University (NMSU). Though aerospace activities are a growing element of our state's economy, no university in New Mexico offers graduate degrees in Aerospace Engineering. This forces New Mexico students to leave the state after receiving their Bachelor degree, creating a risk that they will not return to employment in the state upon completion of their academic career.

Sandia National Laboratories employs staff at all degree levels, but we typically seek technical staff that have completed at least one graduate degree in engineering or science. We believe graduate degrees provide the training required and are an excellent indicator of preparedness to work on the challenging problems we are called upon to address. Further, as you know, we seek strategic partnerships with universities to fill gaps in our capabilities, perform joint research and development projects that have national impact, create a pool of future employees, educate on-roll employees, and build a constituency within the state and nationally. We are pleased to count NMSU among the small number of universities with whom we have such relationships, and believe that development of the proposed degree program will be of value to our relationship.

A high quality graduate degree program in Aerospace Engineering at NMSU would be of benefit to the State of New Mexico, as well as Sandia National Laboratories and other employers in the state, and I am supportive of your effort to establish such a degree program.

Sincerely,

Steve R

Copy to:
Steven P. Castillo, NMSU

ATTACHMENT 3a: RESPONSE TO PROPOSAL
Distributed January 2008 & June 2008
To New Mexico Universities

University of New Mexico

New Mexico Institute of Technology

Eastern New Mexico University

Western New Mexico University

New Mexico Highlands University

GRADUATE STUDIES

Office of the Dean
MSC03 2180
1 University of New Mexico
107 Humanities Building
Albuquerque, NM 87131-0001

3 March 2008

Dr. Thomas Burton, Chair
Department of Mechanical & Aerospace Engineering
P.O. Box 30001/ MSC 3450
New Mexico State University
Las Cruces, NM 88003-8001

Dear Prof. Burton:

Let me begin by acknowledging that in addition to being the Acting Dean of Graduate Studies at UNM, I am a faculty member in the School of Engineering at UNM and also serve as Associate Dean of Engineering for Academic Affairs. As such, I have been involved in the conversations within the School of Engineering regarding the proposal from NMSU for a Masters and PhD program in Aerospace Engineering. In responding to this proposal, I will try to only wear my Graduate Studies hat; the Dean of Engineering is preparing a separate response.

Overall, I find the proposal to initiate MS and PhD programs at NMSU in the area of aerospace engineering to be sound. However, I have one suggestion for strengthening the proposal. There are courses offered within the School of Engineering at UNM that complement those proposed for the NMSU program. I think it is important to be clear in your proposal that UNM will partner with NMSU in offering these complementary courses to students in the proposed program via distance education. In addition, UNM occasionally has graduate students who express an interest in taking courses in areas that NMSU is proposing. Although UNM doesn't currently offer degrees in aerospace engineering, these students are studying and pursuing research in related areas and find courses in this area valuable. Although courses covering these topics are readily available nationally via distance education, some students would prefer to take these courses more locally. I feel that the NMSU proposal will be strengthened if it is clear that UNM graduate students will have access to the proposed NMSU courses via distance education, and that NMSU students will have access to UNM courses as well.

As you know, in the current funding climate in New Mexico, higher education decision makers at the state level are looking to the higher education institutions in the state to be as collaborative as possible. I think that the NMSU Aerospace proposal will be strengthened by making collaborations with UNM and NMT clearer and stronger. As a member of the New Mexico

Council of Graduate Deans, one of the bodies that makes recommendations regarding new graduate degree proposals, I know that the first question that comes up in considering a new degree proposal is whether any of the other NM schools are participating in the program. When there is a clear way in which collaborations are taking place, this greatly strengthens the proposal in the view of the Graduate Deans.

I look forward to seeing this proposal again when it makes its way to the Council of Graduate Deans for consideration.

Sincerely,

Charles B. Fleddermann
Acting Dean, Graduate Studies

The University of New Mexico

To: Charles Fleddermann, Associate Dean
From: Juan C. Heinrich, Chair, ME Department
Re: Response to NMSU
Date: March 7, 2008

I have finished compiling the SOE response to the proposed New Mexico State University graduate degree programs in Aerospace Engineering.

Please forward the attached document to NMSU on behalf of the University of New Mexico School of Engineering.

Comments on the NMSU proposal for new graduate degrees on Aerospace Engineering

The proposed graduate program in Aerospace Engineering by NMSU is timely and fills a gap in the State of New Mexico graduate education program. Of particular note to us here at UNM, provision is made and should continue to be made, to offer courses in this degree program through distance learning to students at UNM and New Mexico Tech. All three research universities can both contribute to and benefit from a variety of aerospace engineering-themed courses and could each use this access to fashion unique curricula of great benefit to New Mexico students. Distinct, but coupled degrees can be offered by NMSU, NMT and UNM by allowing students to take courses from any of the three institutions towards fulfillment of the respective degree requirements.

A key rationale for this is based on the fact that Aerospace is an extremely broad discipline, with each of the main New Mexico institutions having the capability to address several of the wide spectrum of disciplines that are expected to comprise Aerospace Engineering in the 21st Century. Making the curricular resources of the three institutions accessible to each other will provide a sound basis for each University to place their own emphasis on Aerospace Engineering and provide a greater range of options to students.

Pages 18 and 19 of the plan submitted by NMSU show the proposed set of courses, some already in place and others that will be developed, that will constitute the core of the NMSU program. This is a sound and well thought out program that fits well in the category of a traditional aeronautics program. However, except for the proposed future course "Space flight dynamics and control", and the potential to introduce a space component in the proposed future courses entitled "Aerospace systems and missions" and "Modeling and simulation of aerospace systems," the curriculum does not yet address space. Until those course are developed, UNM would be happy to offer NMSU students access to UNM courses currently available that cover several topics relevant to interest to the space portion of Aerospace Engineering. This includes course offerings in the development of large autonomous space based sensor systems, the coordination of multiple satellites or swarms of robots for surveillance, operations and communications. In addition, courses covering the mechanical and structural properties of nanocomposites, metallic alloys, superplastic forming and precision manufacturing, and courses in the area of space and space nuclear energy systems are available. In software, complex systems control algorithms and special topics courses in the areas of reconfigurable computing for space applications covering Field Programmable Gate Arrays (FPGA) and radiation hardened electronics for space applications are available. UNM courses also cover areas of computer engineering, control systems, signal processing, optical and microwave systems that are integral components to any space based telecommunication system. Finally, UNM has an internationally recognized effort in the area of plasma science with applications to space weather and communications. All of these areas are of primary relevance to Space research and engineering, are not yet offered at NMSU, and could benefit NMSU students.
To summarize, the proposed NMSU Aerospace Engineering degree program should strive to make its courses available by distance education technologies, and could supplement its course

offerings in the space engineering component by allowing courses taught at UNM and NMT to be accepted towards a degree in the program.

-----Original Message-----
From: Tom Burton [mailto:tdburton@nmsu.edu]
Sent: Monday, March 03, 2008 4:13 PM
To: 'Charles Fleddermann'
Subject: RE: Aero Grad degree proposal

Dr. Fledderman,

Thank you for the comments on our proposal for graduate degrees in Aerospace Engineering. In revising the document, I plan to implement your suggestions to be specific in stating that NMSU (UNM/NMT) graduate aero-related courses could be available to students at UNM (or NMSU/NMT) via distance education.

Thanks you,
Tom Burton

From: Tom Burton [mailto:tdburton@nmsu.edu]
Sent: Sunday, May 11, 2008 2:24 PM
To: 'pgerity@admin.nmt.edu'; 'vromero@nmt.edu'; 'djohnson@nmt.edu'; 'sayavur@nmt.edu'
Subject: NMSU aero MS & PhD

Dear Drs. Gerity, Romero, Johnson, and Bakhtiarov,

During my March 17, 2008 visit to NMT to discuss NMSU's proposal for graduate degrees in aerospace engineering, there was general agreement that NMT would support the NMSU proposal. NMT recommended that NMSU should make it clear in the proposal that the three universities (NMT, UNM, and NMSU) would collaborate in the offering of aerospace-related graduate courses (via distance education) that could be taken by students at all three schools. I have attached a revision of the relevant section of the proposal for your examination (in this document, please note the sentence "NMT can provide graduate instruction in ….."; there are probably technical areas in addition to those listed in which NMT could offer graduate aerospace related courses; if you identify such areas, I will add them). I am now finalizing the proposal so that during the period June – September 2008 it can be considered by the various NMSU committees that have to approve it. Then it will be submitted to the New Mexico Graduate Deans Council as early as possible in the Fall. I would appreciate receiving from NMT a short statement of support for the proposal (an email would be fine) so that we can attach it to the final draft; we have so far received such statements from the other NM universities.

I look forward to working with NMT in developing a plan for the joint graduate course offerings.

Regards,

Tom Burton, NMSU

575-646-3501

UNM_NMT_collaboration2.doc
30K View as HTML Open as a Google document Download

Reply Reply to all Forward Invi

New Mexico Tech
DEPARTMENT OF MECHANICAL ENGINEERING

To: Thomas Burton, Department Head
Mechanical and Aerospace Engineering
College of Engineering
New Mexico State University

Date: May 28, 2008

Re: Proposal for Graduate Programs in Aerospace Engineering

Dear Dr. Burton:

I have reviewed the proposal presented for a graduate program in Aerospace Engineering at New Mexico State University. Your proposal has merit but should be modified before it is presented for further consideration by NMSU entities. My suggestions for this revision are:

The Section 3 of the Proposal must state the following:

3. Inter-Institutional Collaboration and Cooperation

Although there are no other graduate programs in aerospace engineering in New Mexico, we are engaged in the following established and planned collaborations in aerospace education:

NMSU/NMT collaboration (undergraduate): A functioning collaboration exists between NMSU and New Mexico Tech to team-teach courses in the emerging undergraduate aerospace engineering program. NMT has established a minor degree in aerospace engineering within the existing NMT Mechanical Engineering BS program. The current NMSU/NMT collaborative plan is for each university to offer, via distance education, one or more undergraduate courses per year in aerospace engineering, available to undergraduate students at both universities. During the 2006/2007 academic year NMSU taught the course Aerodynamics I via distance education (live two-way TV); the course was taken by both NMSU and NMT students.

In the Fall of 2007 NMT's Orbital Mechanics course was available to NMSU students, and NMSU's Flight Dynamics course was available to NMT students. The NMSU/NMT collaboration at the undergraduate level is functioning well and will be expanded to include graduate courses. The Mechanical Engineering, The Materials and Metallurgical Engineering, and The Physics Departments at NMT will provide the following courses on regular basis available to NMSU students:

- AE 311, Aerodynamics I, 3 cr, 3 cl hrs
- AE 313, Orbital Mechanics & Space Environment, 3 cr, 3 cl hrs

Mechanical Engineering Department • 122 Weir Hall • 801 Leroy Place • Socorro, New Mexico 87801-4750
e-mail: mecheng@nmt.edu • *phone:* (505) 835-5693 • *fax:* (505) 835-5209 • www.nmt.edu/~mecheng/
New Mexico Institute of Mining and Technology is an Equal Opportunity Institution

- AE 412, Aerospace Systems, 3 cr, 3 cl hrs
- AE 414, Aerospace Structures, 3 cr, 3 cl hrs
- AE 415, Aerodynamics II, 3 cr, 3 cl hrs
- AE 416, Aircraft Flight Dynamics and Controls, 3 cr, 3 cl hrs
- AE 417, Aerospace Propulsion, 3 cr, 3 cl hrs
- AE 418, Structural Dynamics in Aerospace Engineering, 3 cr, 3 cl hrs
- MATE 445, Introduction to Composite Materials, 3 cr, 3 cl
- MATE 530, Design and Analysis of Experiments, 3 cr, 3 cl
- MATE 548, Advanced Composite Materials, 3 cr, 3 cl
- MATE 560, Failure Analysis, 3 cr, 3 cl
- MATE 570, Corrosion Phenomenon, 3 cr, 3 cl
- MENG 519, Adaptive Structures, 3 cr, 3 cl hrs
- MENG 523, Engineering Mechanics of Cellular Structures, 3 cr, 3 cl hrs
- MENG 556 Compressible Fluid Flow, 3 cr, 3 cl hrs
- MENG 582, Nondestructive Evaluation and Structural Health Monitoring, 3 cr, 3 cl hrs
- MENG 583, Engineering Mechanics of Composite Structures, 3 cr, 3 cl hrs
- PHYS 565, Astronomical Techniques, 3 cr, 3 cl hrs
- PHYS 566, Advanced Radio Astronomy, 3 cr, 3 cl hrs
- Some new courses will be developed and offered on demand.

The above suggestions are coordinated with two other departments (Physics and Materials Engineering) at New Mexico Tech.

Sincerely,

S. Bakhtiyarov

Sayavur Bakhtiyarov, PhD, DSc

Chair, Associate Professor

New Mexico Tech
DEPARTMENT OF MECHANICAL ENGINEERING

To: Thomas Burton, Department Head
Mechanical and Aerospace Engineering
College of Engineering
New Mexico State University

From: Sayavur Bakhtiyarov, Department Head
Mechanical Engineering Department
New Mexico Institute of Mining and Technology

Date: June 2, 2008

Re: Proposal for Graduate Programs in Aerospace Engineering (June 2008 draft revision)

I have reviewed the revised proposal presented for a graduate program in Aerospace Engineering at New Mexico State University. My response:

√ Your proposal has merit and should be submitted for consideration by the NMSU Board of Regents and the New Mexico Higher Education Department

__ Your proposal has merit but should be modified before it is presented for further consideration. My suggestions for this revision are:

Mechanical Engineering Department • 122 Weir Hall • 801 Leroy Place • Socorro, New Mexico 87801-4750
e-mail: mecheng@nmt.edu • *phone:* (505) 835-5693 • *fax:* (505) 835-5209 • www.nmt.edu/~mecheng/

To: Thomas Burton, Department Head
Mechanical and Aerospace Engineering
College of Engineering
New Mexico State University

From: Dr. Phillip Shelley, Dean, Graduate School, ENMU

Date: Feburary 12, 2008

Re: Proposal for Graduate Programs in Aerospace Engineering

I have reviewed the proposal presented for a graduate program in Aerospace Engineering at New Mexico State University. My response:

_X_ Your proposal has merit and should be submitted for consideration by the next level for NMSU approval
__ Your proposal has merit but should be modified before it is presented for further consideration by NMSU entities. My suggestions for this revision are:

Note: This is not area in which we have great institutional expertise and therefore the proposal was read only by the Dean and only for the academic soundness of the curriculum and for institutional resources to support the program.

Faye Vowell <vowellf@wnmu.edu> to Ms show details Feb 29 (4 days ago)
Western has no issues with this draft proposal.

Faye Vowell
Provost and Vice President for Academic Affairs
Western New Mexico University
vowellf@wnmu.edu
538-6317

-----Original Message-----
From: Ms Helen B. Stork [mailto:hbstork@nmsu.edu]
Sent: Monday, February 11, 2008 2:20 PM
- Show quoted text -

Reply Reply to all Forward Invite

To: Thomas Burton, Department Head
Mechanical and Aerospace Engineering
College of Engineering
New Mexico State University

From: Linda La Grange, Dean Graduate Studies and Research, NMHU

Date:

Re: Proposal for Graduate Programs in Aerospace Engineering

I have reviewed the proposal presented for a graduate program in Aerospace Engineering at New Mexico State University. My response:

_X_ Your proposal has merit and should be submitted for consideration by the next level for NMSU approval
__ Your proposal has merit but should be modified before it is presented for further consideration by NMSU entities. My suggestions for this revision are:

ATTACHMENT 3b: RESPONSE TO PROPOSAL
Distributed January 2008
To NMSU Departments

College of Engineering, Dean Steven Castillo

Graduate School, Dean Linda Lacey

Student Success, VP & Dean Carmen Gonzalez

Student Success, Kitty Berver

NMSU Libraries, Dean Elizabeth Titus

Dr. Castillo,

Dr. Burton reported that the department heads gave approval to the proposal for a graduate program in Aerospace Engineering at their meeting on Monday, December 17. Dr. Peterson had responded previously.

Could you please submit formal approval to Dr. DeLeon, as described below in my e-mail of October 15.

Thank you for your assistance,

Happy Holidays,

Helen Stork

From: Steve Castillo [mailto:scastill@ad.nmsu.edu]
Sent: Monday, October 15, 2007 3:33 PM
To: Helen Stork
Cc: Thomas Burton; Krist Petersen
Subject: Re: Proposals for graduate programs in Aerospace Engineering

Helen,

Please send the draft to Dr. Petersen for his review. He needs to do a cursory check to ensure it meets with academic requirements. I would also like to have the support from the Department Heads in the COE. Rather than wait for the next DH meeting, I suggest sending the proposal to the DH's and asking for comments, suggestions or opposition. After the DH's and Dr. Petersen have expressed their support, I will go ahead and write a letter of support for the proposal. It should then move to ADAC for the second step in the formal university approval process. However, I do encourage Dr. Burton to send a draft to Dr. DeLeon in advance of the approval by my office and submission to ADAC in order to solicit some informal feedback from the Provost's office to minimize unforeseen difficulties later on.

Regards,

Steve Castillo

FW: MS and PhD in Aerospace Engineering Inbox

Tom Burton show details 2:12 pm (9 minutes ago) Reply

From: Steve Castillo [mailto:scastill@ad.nmsu.edu]
Sent: Thursday, January 24, 2008 4:19 PM
To: Josie De Leon
Cc: Petersen, Krist; Thomas Burton; Steven Castillo
Subject: MS and PhD in Aerospace Engineering

To: Jozi DeLeon, Associate Provost Academic Affairs

From: Steven Castillo

Re: Proposed MS and PHD degrees in Aerospace Engineering

I fully support the proposed MS and PHD degrees in Aerospace Engineering. Both of these degrees are necessary to build a nationally competitive aerospace engineering program at NMSU. The aerospace engineering program is already well underway with 60 undergraduate majors and the competition of major instrumentation and laboratories. Please let me know if you have any questions regarding this memo of support.

Cc: Tom Burton
Krist Petersen

from	"Lacey, Linda" <lacey@ad.nmsu.edu>	hide details Feb 11
to		hbstork@nmsu.edu, Tom Burton <tdburton@nmsu.edu>
cc		scastill@nmsu.edu, jjordan@nmsu.edu, vimalc <vimalc@ad.nmsu.edu>
date		Feb 11, 2008 6:38 PM
subject		Comments on the Aerospace Engineering Proposal
mailed-by		ad.nmsu.edu

Great Proposal!

The Graduate School

New Mexico State University

PO Box 30001 MSC 3 G

Las Cruces, New Mexico 88001-8001

505-646-2736 fax 505-646-7721

505-646-2737

http://gradschool.nmsu.edu/

February 11, 2008

To: Professor Thomas Burton, Department of Mechanical Engineering, MSC 3450

Helen B.Stork, Dept. of Mechanical Engineering

From: Linda Lacey, Dean of the Graduate School

Re: Review of the Proposal to offer a master's and doctoral degree in Aerospace Engineering

First of all, I appreciate your efforts to obtain wide spread feedback on the new degree proposal in aerospace engineering. As mentioned, prior, allowing institutions and administrators to review a draft proposal will help your department gain wide spread approval of the proposal. My comments are provided below.

Comments:

Page 1: Background Information and Summary: thanks for putting this section in the proposal. It demonstrates that NMSU is collaborating with another institution within the state to offer courses to students in aerospace.

Page 4: Justification for the Program: You need to present evidence of need within the state of New Mexico. This could be employer surveys and state level Labor statistics. Have you conducted surveys among potential employers? Have you conducted surveys of your undergraduate students in aerospace engineering? The State Board of Finance in particular will want hard core data.

Page 6: I like your table on duplication of degree programs. At a glance, it clearer shows that no other institution within the state has a graduate aerospace engineering program.

Page 7: Thanks for discussing collaborative efforts in the proposal. Your discussion on the undergraduate degree program demonstrates that collaborative efforts are currently being implemented by your department.

Page 8: Equitable Ethnic representation: You need to provide data on the number of

minority students enrolled in graduate programs within the department at the master's and Ph.D. level. You also need to specifically state strategies to recruit underrepresented students. The Graduate School has been recruiting at American Indian and Hispanic and African American engineering conferences. We sent information requests cards to the department. What is your program doing to recruit underrepresented students?

Page 10: Can a graduate student obtain a Ph.D. degree in three years? What is the average number of years it takes for your current students to obtain a doctoral degree? You may have a student or 2 obtain a doctoral degree in 4 years.

Page 17: I suggest you put the detailed descriptions of requirements in your appendix rather than directing people to the web site. It makes it easy for them to find the information while they are reading the proposal.

Page 17: Ph.D. in ME or AE: you indicate that 18 of 48 hours must support the students' research area and then you indicate right below that the student needs 24 hours of research credit. Can you clarify the difference between the two research credit hours requirements?

Page 20: Faculty: you indicate that this program requires 6 new faculty members. How many faculty positions will President Martin support using NMSU funds? How many slots need to be funded by the state of New Mexico? These questions will be raised by the NM Graduate Dean's Council as well as the State Board of Finance.

Final comment: The appendices should include letters of support from other universities within the state and if possible potential employers. You also need to put copies of the resumes of faculty in the appendix. The research of faculty can help support the new Ph.D. students.

Please let me know if I can be of whether assistance, lacey@nmsu.edu

Dr. Lacey,
Thank you for your support, advice and direction for enhancing what we have now.

(1) Justification for the Program: I have information from various NM sources about AE status and (hoped for) expansion which I intended to reference in the body, then list in Reference section. Do you think it would be better to more directly present this information in the body of the proposal?

We have not done any official surveys but I will discuss the possibility with Dr. Burton.

(2) Equitable Ethnic representation: I know I can get the enrollment figures from the College of Engineering; they were included in information for ABET accreditation process. I will get specific information from CoE also on recruitment practices. A great deal of recruitment is done through the college rather than the department.

(3) Program of study: We will clarify these issues, and include degree requirement information in an appendix.

(4) Faculty: I believe the current funding for faculty is based on state funds supporting 3 positions, and NMSU supporting 2. The sixth position is a future consideration, not necessary in the initial years of the program.

(5) Letters of support, resumes: We have compiled most of that but didn't include it in the draft. We have 6 letters of support from prominent AE industries active in the state, and so far, one response (positive) from a NM university.

To: Thomas Burton, Department Head
Mechanical and Aerospace Engineering
College of Engineering
New Mexico State University

From: Carmen Gonzales, Vice President for Student Success & Dean, College of Extended Learning

Date: February 29, 2008

Re: Proposal for Graduate Programs in Aerospace Engineering

I have reviewed the proposal presented for a graduate program in Aerospace Engineering at New Mexico State University. My response:

X Your proposal has merit and should be submitted for consideration by the next level for NMSU approval
__ Your proposal has merit but should be modified before it is presented for further consideration by NMSU entities. My suggestions for this revision are:

To: Thomas Burton, Department Head
Mechanical and Aerospace Engineering
College of Engineering
New Mexico State University

From: Kitty Berver, Distance Education Director

Date: 2/29/2008

Re: Proposal for Graduate Programs in Aerospace Engineering

I have reviewed the proposal presented for a graduate program in Aerospace Engineering at New Mexico State University. My response:

✓ Your proposal has merit and should be submitted for consideration by the next level for NMSU approval

__ Your proposal has merit but should be modified before it is presented for further consideration by NMSU entities. My suggestions for this revision are:

NMSU Library - New Program Statement
Aerospace Engineering, M.S. & Ph.D.

Susan E. Beck, Collection Development Coordinator
Cindy Pierard, Head, Reference & Research Services Department
Theresa Valko, Engineering Subject Specialist

I. Introduction

This report examines the adequacy of the NMSU Library's collections to support the proposed M.S. and Ph.D. programs in Aerospace Engineering that have been proposed by the Department of Mechanical & Aerospace Engineering in the College of Engineering. The report focuses on three broad areas.

1. Current scope of the collection
2. Start up costs to achieve a doctoral level collection
3. Ongoing costs to support a doctoral level collection

The Library's collection is analyzed as to its current status and future needs by format (books, periodicals, databases, etc.), by content (subject strengths and weaknesses), by depth, and by currency.

II. Current scope of the collection

General Note on Use of Collection Analysis from OCLC®

This report uses the Collection Analysis program from OCLC® to analyze NMSU and its peer collections. The analysis focuses on 16 OCLC® Conspectus subject areas most core to aerospace engineering. The OCLC® Conspectus provides a standardized method to organize and analyze library resources by subject. OCLC® is a nonprofit computer library service and research organization. More than 53,548 libraries in 96 countries and territories around the world use OCLC® services to locate, acquire, catalog, lend and preserve library materials. The 16 core subject areas are:

Aeronautics -- Aerodynamics
Aeronautics -- Aeronautical Meteorology
Aeronautics -- Aircraft
Aeronautics -- Airways, Airports
Aeronautics -- Flying, Special Uses of Airplanes
Aeronautics -- Gliders & Soaring
Aeronautics -- Materials of Construction
Aeronautics -- Motors & Propulsion
Aeronautics -- Navigation & Instruments
Aeronautics, General
Astronautics -- Artificial Satellites
Astronautics -- Astrodynamics
Astronautics -- Rocket Propulsion, Rockets
Astronautics -- Space Travel, General
Astronautics -- Space Vehicle Design & Materials
Astronautics -- Systems & Navigation

A. Current annual funding structure for materials relating to aerospace engineering

The Library has two principal means of funding monographic purchases: firm order funds and approval plans. The Library has one fund, Mechanical Engineering, which specifically supports the acquisition of monographic resources in this area. The Mechanical Engineering firm order fund has been allocated $1,900 for the past several years; however this past year this department's allocation was reduced to $1,375.00 due to subscription cost increases in serials and electronic resources, which includes both databases and electronic journal packages. Approval plan expenditures coded for the 16 Conspectus areas mentioned above totaled $ 817.66 (12 titles) in FY07 and $269.91 (4 titles) in FY08 (to date).

In the area of periodicals, this analysis identified 12 current subscriptions that are related to Aerospace Engineering, and that are currently supported on the Mechanical Engineering departmental serials list. The total cost for these related periodical subscriptions, which includes both print and electronic resources, was $17,449 as of 2008.

Database funding is included in Section D of this report.

N.B. At this point we should note that the Library supports the Aerospace Studies program in the College of Arts and Sciences with a small firm order fund for monograph purchases and subscribes to a few periodicals to support the program. Although similar in name, the Aerospace Studies program provides pre-professional training for future Air Force officers; thus Library resources purchased to support this program do not overlap with resources typically found to support an Aerospace Engineering program.

2007-8 Funding Summary

Monographic Expenditures (includes approval and firm order allocations)	$ 1,294.91
Periodicals Expenditures (titles related to the proposed program)	$17,449.00

B. Size and scope of collection

Age of collections relating to aerospace engineering		
Date Range	**Number of Titles**	**Percentages**
Pre 1900's	2	0.08%
1900-1949	167	6.53%
1950-1959	254	9.93%
1960-1969	592	23.15%
1970-1979	490	19.16%
1980-1989	315	12.32%
1990-1999	480	18.77%
2000-2007	257	10.05%
Total	**2557**	

Collection age and growth

The above chart shows that less than 30% of the Library's collection in aerospace engineering was published within the last 17 years, from 1990 to the present. In fact, a little more than 10% of the collection is less than 10 years old (i.e., published between 2000 and the present). Most of the growth in the aerospace engineering collection occurred during the New Frontier age, between 1960 – 69 and also

in 1970 – 79. This is not surprising based on the high level of interest, generally, in aerospace engineering generated during that 20 year period. That said, the field of aerospace engineering depends on recent, if not cutting edge, developments and technologies and the NMSU Library's current monograph collection in that area is lacking.

Related Collections

The NMSU Library is a Federal Depository Library, receiving ca. 67% of all publications issued to the program by the U.S. Government. The federal documents collection supports aerospace engineering research, especially in technical reports, briefs, and series published by the National Aeronautics & Space Administration (NASA). The NMSU Library collects 63% of the 80+ NASA publications made available through the federal depository library program.

The Library's department of Archives & Special Collections has several collections of interest to aerospace engineering history. The Ernst Steinhoff papers detail the research of an expert in early missile navigation and rocketry who was brought to New Mexico under "Operation Paperclip" to work on U.S. intelligence and military projects at White Sands Missile Range during the latter stages of World War II. The collection includes papers from various scholarly societies interested in space travel research, including the International Astronautical Federation (IAF), the Herman Oberth Society and the German Scientific Society of Air and Space Travel. Steinhoff's abstract drawings and notes on rocketry, including his work on underwater missiles are also included in the collection. The William Merrill Photographs include publicity photographs and press releases concerning aerospace activities including the development of various intercontinental ballistic missiles, satellites, launch and tracking sites, tests and testing facilities for other projects such as the Holloman Air Force Base rocket sled.

The Library has a collection of industry codes and standards that serves some of the needs of the College of Engineering. The entire ASTM International collection of standards is available electronically. Other collections are available in print and individual standards are purchased as needed or requested. Currently, the Library does *not* have any electronic access to the IEEE Standards.

Existing standards

In examining the adequacy of our monograph collection to meet the heavy research demands of a doctoral program, national standards on library collection levels were reviewed. The most recent recommendation [1995] from the Association of College and Research Libraries is a collection level of 25,000 for each doctoral program and 6,000 for each masters program when no higher degree is offered in the field[1]. Having stated this, it is clear that none of the library collections included in this analysis (U. Arizona, U. Colorado-Boulder, New Mexico State University) come close to this standard.

Peer group comparison

A number of institutions support graduate-level programs in aerospace engineering. This analysis reviews library collections at the University of Arizona and University of Colorado-Boulder as both of these institutions offer doctoral and masters-level programs in aerospace engineering. Both programs are included the Department of Mechanical Engineering's Graduate Degree Programs proposal. Although neither parent institution is a designated NMSU peer institution, the graduate programs at the University of Arizona and at the University of Colorado-Boulder possess similar characteristics to that which the Mechanical Engineering department aspires. The same 16 core OCLC® Conspectus categories were used for the peer comparison.

Subtotals in each of the 16 core OCLC® Conspectus categories are presented in **Appendix Group A**. Total collection numbers are presented in the table below.

NMSU Library Holdings	**2,557**
Peer Group Holdings	**Totals**
University of Colorado-Boulder	5,694
University of Arizona	5,431
Average # of titles in peer group	**5,562**

The difference in the size of these collections is immediately apparent. The average number of monographic titles held by our peer group is 5,562—3,000 titles more than the number in the NMSU Library's collection. It is also true that both universities in this peer analysis are much larger and their overall library collections far surpass ours. Another area under analysis is the currency of the collections and the rate of growth. Around 30% of the titles in all of the libraries were published in the last 17 years and between 10-13% in the last decade, though NMSU trails slightly in the percentage of titles from the most recent period (2000-7). In the past two years, the University of Arizona has added 180 titles in the 16 conspectus areas and the University of Colorado-Boulder has added 131 titles in those same areas. During the same period, NMSU added 46 titles. Thus, the University of Arizona has added about 4 times as many titles and the University of Colorado has added 3 times as many.

Monographic Collection Summary

The NMSU Library's monographic collection supports many graduate programs in the sciences and in engineering. When taking the broader subject view, the Library's collection does an adequate job in these areas, though researchers must frequently supplement local holdings with interlibrary loan services. For example, departments in the College of Engineering requested 877 monographs through interlibrary loan in 2007-8. The Library holds related collections of interest to aerospace engineering in its federal government documents collection and archival collections.

When focusing on the sixteen subject areas that are core to this field, both the University of Arizona and the University of Colorado-Boulder have significantly larger overall collections that, on average, have consistently added titles at double or more the rate as NMSU for the entire chronological period of this report (Pre-1900 to 2007). Some funding is needed to build up the NMSU Library's monographic collection, for example, focusing on current titles in strategically important subject areas.

C. Periodical collection

According to data compiled during the Library's serials review process (2006-2007), the Library subscribes to 55 journals related to mechanical and aerospace engineering (**Appendix B**). This list does not include journal titles that relate more specifically to other engineering fields, so this number does not necessarily reflect all of the journals that support the field, only the most discipline-relevant. Subscriptions to these 55 ME/AE journals cost approximately $74,000 annually.

Additional access to many titles is provided through specific electronic journal packages (such as ScienceDirect Elsevier Science Journals) and through the Library's aggregator databases – databases offering full-text access to titles in a number of different fields. It should be noted that aggregator databases are reliant upon ongoing negotiations between serial publishers and database vendors, and that access to specific titles and years of coverage can be volatile. The more dependent we are upon

aggregators to provide access to research literature, the more vulnerable we are to these market forces. While the terms of any electronic journal package may also change over time, these typically offer more stable sources of access to research literature.

The following table shows the journals with the top 20 impact factors in the core area of aerospace engineering. The charts include local access to these titles via print or electronic subscriptions. The Library currently lacks access to 12 of the 20 titles on this list. The library/electronic journal catalogs at the University of Arizona and the University of Colorado at Boulder were checked to determine peer comparisons in this area. The University of Arizona has subscriptions to 16 of the 20 titles, and the University of Colorado at Boulder has access to all 20 of the titles.

Y=subscribed
N=not subscribed

Periodical Title	Price	NMSU	UA	UC Boulder
Acta astronautica	$4,332.00	N	Y	Y
Advances in space research	$4,286.00	N	Y	Y
Aerospace science and technology	$381.00	N	Y	Y
AIAA journal (American Institute of Aeronautics and Astronautics)	$1,385.00	Y	Y	Y
Cosmic research	$3,225.00	Y	Y	Y
ESA bulletin. Bulletin ASE (European Space Agency)	free	Y	Y	Y
IEEE transactions on aerospace and electronic systems	$1,045.00	Y	Y	Y
International journal of satellite communications and networking	$2,519.00	Y	Y	Y
International journal of turbo and jet engines	$370.00	N	N	Y
Journal of the British Interplanetary Society	$536.00	N	N	Y
Journal of aerospace engineering	$333.00	Y	Y	Y
Journal of aircraft	$875.00	N	Y	Y
Journal of guidance, control, and dynamics	$775.00	Y	Y	Y
Journal of propulsion and power	$965.00	N	Y	Y
Journal of spacecraft and rockets	$720.00	Y	Y	Y
Journal of the American Helicopter Society	$95.00	N	N	Y
Journal of the astronautical sciences	$170.00	N	N	Y
Proceedings of the Institution of Mechanical Engineers Part G-Journal of AE	$2,095.00	Y	Y	Y
Progress in aerospace sciences	$1,908.00	N	Y	Y
The Aeronautical journal	$590.00	N	Y	Y

Periodical Collection Summary

The Library lacks access to more than 50% of the top periodicals in aerospace engineering. Certainly, current article literature is of importance to the field. College of Engineering departments requested 2,414 articles through the Library's Information Delivery Services during 2007-8 and four of the College's eight departments are among the top 20 (of 95 units) in overall campus units requesting articles.

In order for the Library to increase its subscriptions to match the University of Arizona's subscriptions, $13,337 is needed (based on current year's subscription rates). In order for the Library to increase its subscriptions to match the University of Colorado at Boulder's subscriptions, $14,508 is needed (based on current year's subscription rates). In either case, continuing funding for annual subscription costs is needed.

D. Research databases

There are a number of research databases that provide indexing, abstracting, and access to aerospace engineering literature (journals, proceedings, papers, technical reports, etc.). The chart below provides a comparison of NMSU's access to the prominent databases in the field to the University of Arizona and University of Colorado at Boulder. Cost information is provided for those databases to which the NMSU library does not currently subscribe.

X = subscribes

Database/Index	NMSU	UA	UC	Cost
Aerospace and High Technology Database Contains citations, with abstracts, to literature on basic and applied research in aeronautics, astronautics, and space sciences. The database also includes coverage of reports issued by NASA, other U.S. government agencies, international institutions.		X	X	$14,716
AIAA Online Technical Meeting Papers (1996+) Every year, AIAA publishes about 6,000 papers from 20 to 30 technical conferences. Covering every aspect of aerospace, they represent the most important - and most complete - source of recent research results and innovative thinking in everything from engineering and science to policy and standards. The current year's papers are available via CD-ROM, and/or online.			X	$7,500
Compendex (Engineering Index) via Engineering Village 2 Engineering Index (Compendex) provides international coverage of engineering and applied science literature in over 5000 journals, conference proceedings, and technical reports.	X	X	X	
Inspec Covers the world-wide literature (mainly journal articles and conference proceedings papers) in astronomy, physics, electronics and electrical engineering, computers and control, and information technology.		X	X	$31,050

ISI Web of Science Access to Science Citation Index (1900-present) and Social Science Citation (1956-present).	X	X	X	
NASA Technical Reports Server http://ntrs.nasa.gov/ NASA Technical Report Server provides access to NASA's technical literature, including research reports, journal articles, conference and meeting papers, technical videos, mission-related operational documents, and preliminary data.	X	X	X	Free
NTIS (National Technical Information Services indexes) Containing over 2.0 million bibliographic records, the NTIS Database is the preeminent resource for accessing the latest research sponsored by the United States and select foreign governments. The Database represents billions of dollars in research. Contents include research reports, computer products, software, video cassettes, audio cassettes and more. The complete electronic file dates back to 1964. On average, NTIS has added over 60,000 new records per year to the Database over the past ten years. Most records include abstracts.		X	X	$3,687

Research Database Summary

The Library offers reasonable coverage of research databases related to mechanical engineering, but lacks in areas related specifically to aerospace engineering.

At a minimum, funding is recommended for *AIAA Online Technical Meeting Papers*, which costs $7,500 annually. A more comprehensive recommendation would include requesting funding to purchase access to the remainder of the databases listed above, which would cost in excess of $35,000.

III. Start Up Costs

As evidenced from the above analysis, the Library's current monograph and periodical collections are not currently sufficient to support the proposed graduate programs in aerospace engineering. Additional funding is needed to support monographs, periodical subscriptions, and research database enhancements.

Recommended Start Up Costs

Monographs[2]	$10,000
Periodicals	$13,337
Research Databases	$7,500
TOTAL	**$30,837**

This report recommends that a total of $30,837 be allocated to bring Library collections closer to the level of comparable doctoral-granting peers. We recommend that the external funding be allocated to augment monographic collections ($10,000 will fund approximately 100 new monographic titles), to support several core periodical subscriptions ($13,337), and to establish access to the *AIAA Online Technical Meeting Papers* research database ($7,500).

IV. Ongoing Costs

Library collections designed to support programs at the post baccalaureate level require continuous funding streams, allowing these newly developed collections to grow in their support of the program. A one-time infusion of money can never support ongoing needs for materials required for doctoral-level research, but certainly contributes to establishing a core collection for that program.

The NMSU Library's current material budget is not elastic; in fact, it barely supports our current academic programs. Although the Library has been able to add much needed digital collections and electronic journal backfiles over the past year, these items were purchased through carryforward expenditures (e.g., one time money). In order to sustain the proposed graduate programs in aerospace engineering, the Library will require at least $41,417 per annum be added to its materials budget. This amount will be used to close the gap between NMSU and its peers in annual monographic purchases, to fund ongoing periodical subscriptions, and to fund an ongoing subscription to the *AIAA Online Technical Meeting Papers* database and to add and sustain the *High Technology Research Database with Aerospace* database.

In summary, the Library's current collection is inadequate for a PhD program. The collection is in need of development in all areas, including monographs, periodicals, and research databases. The Library's current materials budget cannot stretch to cover the new resources required to support such a program; thus, it will require at least $30,837 in start up funding as well as $41,417 added to its materials budget to support ongoing costs.

Recommended Ongoing Costs

Monographs[2]	$3,090
Periodicals[3]	$15,000
Research Databases[4]	$23,327
TOTAL	**$41,417**

[1] "Standards for College Libraries, 1995 Edition, Final Version, Approved by the ACRL Board and the ALA Standards Committee, February 1995" *College & Research Libraries News* 56 (1995): 245-57.

[2] Based on the average price of a hardcover book in the field of engineering ($109 per *The Bowker Annual*, NY: Bowker, 2007), the $10,000 in startup funding for monographs would purchase about 100 books.

[2] Based on the above calculations for the average price of a book plus a 5% increase for inflation, this will bolster Library firm order budgets to allow purchasing of an additional ca. 25-27 monographs per year, bringing us closer to our peer institutions.

[3] Based on the current subscription costs plus a 12.5% inflation increase, which is the average for science periodical subscriptions

[4] Based on current costs for *AIAA Online Technical Meeting Papers* and *High Technology Research Database with Aerospace/Aerospace and High Technology Database* plus a 5% inflation increase for science research databases.

Appendix Group A
NMSU Library - New Academic Program Report
Aerospace Engineering
Monographic Collection Analysis
[Arizona, Colorado, NMSU Comparisons]

University of Arizona

Publication Date	**Totals**	**Pre-1900**	**1900-1949**	**1950-1959**	**1960-1969**	**1970-1979**	**1980-1989**	**1990-1999**	**2000-2007**
Aeronautics - Aerodynamics	365	0	13	27	58	85	74	76	32
Aeronautics - Aeronautical Meteorology	42	0	4	0	4	8	9	12	5
Aeronautics - Aircraft	722	6	47	18	84	139	151	186	91
Aeronautics - Airways, Airports	197	0	8	0	16	35	36	76	26
Aeronautics - Flying, Special Uses of Airplanes	215	1	27	11	17	37	46	46	30
Aeronautics - Gliders & Soaring	35	0	3	3	7	19	3	0	0
Aeronautics - Materials of Construction	61	0	2	3	6	5	9	20	16
Aeronautics - Motors & Propulsion	142	0	12	15	10	31	32	36	6
Aeronautics - Navigation & Instruments	140	0	10	0	9	29	27	37	28
Aeronautics, General	1759	7	134	75	228	421	298	396	200
Astronautics - Artificial Satellites	240	0	0	13	16	34	68	65	44
Astronautics - Astrodynamics	53	0	0	0	21	7	10	9	6
Astronautics - Rocket Propulsion, Rockets	194	0	10	18	52	23	17	43	31
Astronautics - Space Travel, General	950	0	5	62	195	194	189	184	121
Astronautics - Space Vehicle Design & Materials	95	0	0	0	20	12	26	26	11
Astronautics - Systems & Navigation	221	0	0	3	35	21	42	61	59
Totals by Date Range	**5431**	**14**	**275**	**248**	**778**	**1100**	**1037**	**1273**	**706**
Percentage by Date Range		**0.26%**	**5.06%**	**4.57%**	**14.33%**	**20.25%**	**19.09%**	**23.44%**	**13.00%**

Appendix Group A
NMSU Library - New Academic Program Report
Aerospace Engineering
Monographic Collection Analysis
[Arizona, Colorado, NMSU Comparisons]

University of Colorado, Boulder

Publication Date	**Totals**	**Pre-1900**	**1900-1949**	**1950-1959**	**1960-1969**	**1970-1979**	**1980-1989**	**1990-1999**	**2000-2007**
Aeronautics - Aerodynamics	330	0	43	46	63	26	41	71	40
Aeronautics - Aeronautical Meteorology	33	0	8	1	8	2	2	8	4
Aeronautics - Aircraft	568	2	109	35	87	43	51	157	84
Aeronautics - Airways, Airports	148	0	24	4	11	7	15	65	22
Aeronautics - Flying, Special Uses of Airplanes	141	0	27	28	24	13	12	22	15
Aeronautics - Gliders & Soaring	13	0	6	1	1	2	0	3	0
Aeronautics - Materials of Construction	90	0	3	39	6	1	1	20	20
Aeronautics - Motors & Propulsion	146	0	34	22	11	10	14	39	16
Aeronautics - Navigation & Instruments	101	0	20	5	9	9	4	33	21
Aeronautics, General	2455	2	175	93	371	1353	141	210	110
Astronautics - Artificial Satellites	199	0	0	11	21	17	35	69	46
Astronautics - Astrodynamics	75	0	0	0	29	9	8	16	13
Astronautics - Rocket Propulsion, Rockets	210	0	9	21	84	19	14	33	30
Astronautics - Space Travel, General	819	0	3	40	261	106	126	157	126
Astronautics - Space Vehicle Design & Materials	108	0	1	0	32	13	12	26	24
Astronautics - Systems & Navigation	258	0	1	4	52	18	31	83	69
Totals by Date Range	**5694**	**4**	**463**	**350**	**1070**	**1648**	**507**	**1012**	**640**
Percentages by Date Range		**0.07%**	**8.13%**	**6.15%**	**18.79%**	**28.94%**	**8.90%**	**17.77%**	**11.24%**

Appendix Group A
NMSU Library - New Academic Program Report
Aerospace Engineering
Monographic Collection Analysis
[Arizona, Colorado, NMSU Comparisons]

New Mexico State University

Publication Date	**Totals**	**Pre-1900**	**1900-1949**	**1950-1959**	**1960-1969**	**1970-1979**	**1980-1989**	**1990-1999**	**2000-2007**
Aeronautics - Aerodynamics	191	0	18	49	56	22	21	16	9
Aeronautics - Aeronautical Meteorology	18	0	2	0	2	3	1	6	4
Aeronautics - Aircraft	287	1	38	25	47	42	30	69	35
Aeronautics - Airways, Airports	64	0	3	0	1	15	9	21	15
Aeronautics - Flying, Special Uses of Airplanes	118	0	7	10	12	19	18	31	21
Aeronautics - Gliders & Soaring	21	0	2	0	5	12	1	1	0
Aeronautics - Materials of Construction	21	0	1	3	4	2	2	4	5
Aeronautics - Motors & Propulsion	68	0	15	8	6	12	6	17	4
Aeronautics - Navigation & Instruments	55	0	10	2	8	10	7	15	3
Aeronautics, General	829	1	61	81	161	197	105	137	86
Astronautics - Artificial Satellites	67	0	0	7	14	16	12	16	2
Astronautics - Astrodynamics	39	0	0	0	23	4	6	4	2
Astronautics - Rocket Propulsion, Rockets	144	0	7	22	51	19	6	22	17
Astronautics - Space Travel, General	500	0	3	43	155	92	75	92	40
Astronautics - Space Vehicle Design & Materials	30	0	0	0	13	4	0	9	4
Astronautics - Systems & Navigation	105	0	0	4	34	21	16	20	10
Totals by Date Range	**2557**	**2**	**167**	**254**	**592**	**490**	**315**	**480**	**257**
Percentages by Date Range		**0.08%**	**6.53%**	**9.93%**	**23.15%**	**19.16%**	**12.32%**	**18.77%**	**10.05%**

Appendix B
NMSU Library - New Academic Program Report
Aerospace Engineering
Current Mechanical and Aerospace Engineering Journals

Title	Publisher	price06	price05	price04
Aerospace America.	American Institute of Aeronautics and Astronautics	$176.21	$176.21	$176.21
AIAA journal.	American Institute of Aeronautics and Astronautics	$1,410.77	$1,308.07	$1,210.78
Applied mathematics and optimization.	Springer	$954.57	$901.71	$828.79
Applied mechanics reviews.	American Society of Mechanical Engineers	$340.00	$224.49	$800.00
Automotive engineering international.	SAE	$128.38	$123.24	$123.24
Aviation week and space technology.	McGraw-Hill	$81.13	$81.13	$0.00
Combustion and flame.	Elsevier	$1,653.84	$1,567.62	$1,485.90
Communications in Nonlinear Science and Numeric Simulation	Elsevier	$465.00		
Computational mechanics.	Springer-Verlag	$3,028.03	$2,832.47	$2,507.93
Computers & graphics.	Pergamon Press	$1,763.03	$1,671.12	$1,584.00
Design studies.	IPC Science and Technology Press	$832.43	$789.03	$747.90
Experimental mechanics.	Society for Experimental Stress Analysis	$806.46	$779.54	$757.60
Experimental techniques.	Society for Experimental Stress Analysis	$161.24	$143.78	$136.59
Fluid dynamics.	Consultants Bureau	$3,236.63	$3,031.31	$2,833.00
Heat transfer research.	Scripta Technica, Inc.	$2,739.01	$2,305.62	$2,135.14
International journal for numerical methods in engineering.	Wiley	$7,759.56	$7,285.98	$6,841.30

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Aerospace Engineering
Current Mechanical and Aerospace Engineering Journals

International journal of computer integrated manufacturing.	Taylor & Francis	$1,816.76	$1,495.31	$1,385.42
International journal of control.	Taylor and Francis	$5,423.59	$4,975.82	$4,608.15
International journal of multiphase flow.	Pergamon Press	$2,306.97	$2,186.70	$2,072.70
International journal of robotics research.	MIT Press	$1,390.48	$1,283.96	$1,187.25
International journal of vehicle design : the journal of the International Association for Vehicle Design.	Inderscience Enterprises	$956.73	$1,117.12	$908.90
Journal of applied mechanics.	American Society of Mechanical Engineers	$255.00	$252.00	$0.00
Journal of Computational and Nonlinear Dynamics (online)	American Society of Mechanical Engineers	$168.00		
Journal of computing and information science in engineering.	American Society of Mechanical Engineers	$175.00	$172.00	$165.75
Journal of engineering design.	Carfax Pub. Co.	$1,377.21	$1,264.24	$1,170.78
Journal of fluid mechanics.		$2,325.13	$1,971.84	$1,853.73
Journal of fuel cell science and technology (Online)	American Society of Mechanical Engineers	$168.00	$172.00	
Journal of manufacturing science and engineering.	American Society of Mechanical Engineers	$214.00	$210.00	$205.00
Journal of mechanical design.	American Society of Mechanical Engineers	$255.00	$252.00	$178.50
Journal of robotic systems	John Wiley & Sons	$2,620.16	$2,460.25	$2,310.09
Measurement techniques.		$3,260.68	$3,047.36	$2,848.00
Mechanism and machine theory.	Pergamon Press	$2,572.42	$2,438.32	$2,311.20
Numerical heat transfer. Part A, Applications	Hemisphere Pub. Corp.	$4,557.83	$4,181.94	$3,872.82

Numerical heat transfer. Part B, Fundamentals	Hemisphere Pub. Corp.	$1,973.89	$1,811.63	$1,678.12
Optimal control applications and methods	John Wiley & Sons	$2,739.44	$2,572.25	$2,415.26
Progress in energy and combustion science.	Pergamon Press	$1,585.73	$1,503.06	$1,424.70
Regular and Chaotic Dynamics	Turpion Limited	$1,345.00		
S.A.E. transactions.	Society of Automotive Engineers	$3,095.86	$2,643.50	
International Society for Structural and Multidisciplinary Optimization.	Springer-Verlag	$2,449.66	$2,257.35	$2,037.56
The International Journal of Robotics Research	Sage Publications	$1,477.00		
Transactions of the ASME. Journal of biomechanical engineering	American Society of Mechanical Engineers	$255.00	$252.00	$443.00
Transactions of the ASME. Journal of dynamic systems, measurement, and control	American Society of Mechanical Engineers	$219.00	$217.00	$0.00
Transactions of the ASME. Journal of electronic packaging	American Society of Mechanical Engineers	$191.00	$188.00	$178.50
Transactions of the ASME. Journal of energy resources technology	American Society of Mechanical Engineers	$168.00	$166.00	$165.75
Transactions of the ASME. Journal of engineering for gas turbines and power	American Society of Mechanical Engineers	$204.00	$201.00	$205.00
Transactions of the ASME. Journal of engineering materials and technology	American Society of Mechanical Engineers	$175.00	$172.00	$299.50
Transactions of the ASME. Journal of fluids engineering	American Society of Mechanical Engineers	$255.00	$252.00	$238.00
Transactions of the ASME. Journal of offshore mechanics and Arctic engineering	American Society of Mechanical Engineers	$152.00	$150.00	$148.75
Transactions of the ASME. Journal of pressure vessel technology	American Society of Mechanical Engineers	$172.00	$169.00	$370.75
Transactions of the ASME. Journal of solar energy engineering	American Society of Mechanical Engineers	$156.00	$159.00	$362.25

Appendix B
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Aerospace Engineering
Current Mechanical and Aerospace Engineering Journals

Transactions of the ASME. Journal of tribology	American Society of Mechanical Engineers	$191.00	$188.00	$205.00
Transactions of the ASME. Journal of turbomachinery	American Society of Mechanical Engineers	$195.00	$191.00	$178.50
Transactions of the ASME. Journal of vibration, acoustics, stress, and reliability in design.	American Society of Mechanical Engineers	$211.00	$207.00	$370.75
Transactions of the ASME.Journal of heat transfer	American Society of Mechanical Engineers	$321.00	$316.00	$0.00
Vehicle system dynamics : international journal of vehicle mechanics and mobility.	Swets and Zeitlinger	$1,263.21	$1,159.48	$1,159.48
	total:	**$74,174.04**		

ATTACHMENT 4:
PROJECTED GRADUATE PROGRAM COST
Estimates and Resources

Institution: New Mexico State University
Proposed Program: MS(PhD) in Aerospace Engineering

Projected Graduate Program Cost Estimates and Resources (in thousands $)

ESTIMATED REVENUES	Year 1 2009/10		Year 2 2010/11		Year 3 2011/12		Year 4 2012/13		Year 5 2013/14	
	Existing	New	Existing	New	Existing	New	Existing	New	Existing	New
Projected University I&G /State Recur.	200.5/ 423.5	0/ 150	210.5/ 573.5		221/ 573.5		232/ 573.5		243.7/ 573.5	
External Grants and Contracts		50		100	100	100	200	200	300	200
Other	209.4	295		205		165		75		80
TOTAL REVENUE	$1,328K		$1,079K		$1,159K		$1,280K		$1,397K	
ESTIMATED EXPENSES	**Year 1 2009/10**		**Year 2 2010/11**		**Year 3 2011/12**		**Year 4 2012/13**		**Year 5 2013/14**	
	Existing	New	Existing	New	Existing	New	Existing	New	Existing	New
Salaries & benefits (Faculty/ Staff)	559/ 156		587/ 148		616/ 154		647/ 162		679/ 170	
Grad Assts.		70	70		75		75		75	
Equipment		50		50		25		25		25
Facil./Modific/ Operations	40		40		45		45		45	
New Fac Startup		390		230		230				
TOTAL EXPENSES	$1,265K		$1,125K		$1,145K		$1,009K		$1,059K	
DIFFERENCE (Rev.- Exp.)	$63K		($46K)		$14K		$271K		$338K	
EST. IMPACT OF NEW PROGRAM	**Year 1**		Year 2		Year 3		Year 4		Year 5	
FTE Enrollment	**50/8/3**		70/16/6		90/18/10		90/20/11		90/22/12	
Projected Annual Credits Generated	**415/120/54**		565/240/108		715/252/168		715/264/174		715/276/180	
Tuition Generated (K)	**195/155/70**		287/310/140		342/326/217		342/341/225		342/357/233	

Explanation

1. Budgeting amounts are shown for entire AE program (undergrad, MS and PhD); individual degree program funding cannot reasonably be separated.
2. For "FTE Enrollment," "Projected Annual Credits..," and "Tuition generated," projections are given for undergraduate, MS, and PhD, respectively in each block of the table. Amounts for tuition generated are in $thousands (numbers taken from Tables 2, 3, and 5).
3. In "Estimated Revenues" the designation "Other" includes estimates of new faculty startup money provided by the NMSU College of Engineering and Vice President for Research, as well as GA support of the teaching functions.
4. Salary and benefits under "Estimated Expenses" are shown separately for AE faculty and for other staff.
5. Assumptions: 1) State line item recurring funding of $423.5K for FY 2009 increased by $150K starting in FY 2010; 2) salary increases of 5% per year; 3) One new $300K/3 years proposal funded in each of years 2 and 3, and two new $300K/3years proposals funded in each of years 4 and 5.

ATTACHMENT 5:
RESUMES OF AEROSPACE FACULTY

Current ME Faculty Associated with AE Program:

Thomas Burton
Eric Butcher
Ou Ma
Igor Sevostianov
Banavara Shashikanth
Mingjun Wei

New AE Faculty Starting at NMSU in Fall 2008:

Chunpei Cai
Young Lee

Biographical Sketch - THOMAS D. BURTON
Department Head of Mechanical and Aerospace Engineering
New Mexico State University

EDUCATION

PhD in Mechanical Engineering and Applied Mechanics, University of Pennsylvania, 1976
MS in Mechanical Engineering and Applied Mechanics, University of Pennsylvania, 1972
BS in Engineering (Major: Aero), California Institute of Technology, 1969

PROFESSIONAL EXPERIENCE

6/05 – present Head, Department of Mechanical and Aerospace Engineering, New Mexico State University, Las Cruces, New Mexico, 88003-8001

7/95-6/05 Chair (7/95 – 8/04) and Professor, Department of Mechanical Engineering, Texas Tech University, Lubbock, Texas 79409-1021.

1997-2008 Affiliate, Los Alamos National Laboratory, Engineering Sciences and Applications, Los Alamos, NM

1977-1995 Professor (1988-1995), Associate Professor (1982-88), Assistant Professor (1977-82), Acting Derpartment Chair (8/91 – 10/92), Department of Mechanical Engineering, Washington State University, Pullman, WA.

1969-1977 Engineer, General Electric Co., Missile and Space Division, Valley Forge, PA: 1975-77: Intelligence Programs Group, Space Sciences Lab; 1969-75: Flight Dynamics Group, Re-Entry and Environmental Systems Division. Primary program work: MM III Mk 12A re-entry vehicle flight dynamics and targeting – analyze full scale flight test data, develop methods of data analysis and targeting calculation; NASA Pioneer Venus program – flight dynamics analysis/simulation and aerodynamic testing in support of small and large probe design. Experimental vehicle programs: ABRES, RVTO, SEE, LAR. Intelligence programs – full scale flight data analysis and targeting accuracy of Soviet strategic missile systems.

Publications relevant to Aerospace experience and to recent Aerospace related research

1. T.D. Burton and R.A. Larmour, "Method for Extracting Dynamic Damping Coefficient from Flight Test Lateral Rate Data," AIAA *Journal of Spacecraft and Rockets*, **8**, 1191-1195 (1971).
2. T.D. Burton and J.M. Abel, "Effect of Lagging Pitching Moment on Re-Entry Vehicle Dynamic Stability," AIAA *Journal of Spacecraft and Rockets*, **9**, 406-409 (1972).
3. T.D. Burton, "Approximate Impact Dispersion Methods for Symmetric Entry Vehicles," AIAA *Journal of Spacecraft and Rockets*, **11**, 777-782 (1974).
4. T.D. Burton, "Simple Numerical Model for Calculation of Entry Vehicle Trim Response," AIAA *Journal of Spacecraft and Rockets*, **15**, 319-320 (1978).
5. T.D. Burton, Introduction to Dynamic Systems Analysis, McGraw-Hill (1994).
6. J-L Ding, J Pazhouh, SB Lin and TD Burton, "Damage Characterization by Vibration Test," *Scripta Metallurgica et Materialia*, **30**(7), 839-844 (1994)

7. TD Burton, C.R. Farrar, and S.W. Doebling, "Two Methods for Model Updating Using Damage Ritz Vectors," Proc. IMAC XVI, pp. 973-979, Santa Barbara (1998).
8. TD Burton and W Rhee, "On the Reduction of Nonlinear Structural Dynamics Models," *Journal of Vibration and Control*; **6**(4), pp. 531-556 (2000).
9. TD Burton, F. M. Hemez and W. Rhee, "A Combined Model Reduction/SVD Approach to Nonlinear Model Updating," Proc. IMAC XVIII, pp. 116-123, San Antonio (2000).
10. J. Kim and TD Burton, "Reduction of Nonlinear Structural Models Having Non-Smooth Nonlinearities, Proc. IMAC XX, pp. 324-330, Los Angeles, CA (2002).
11. J Kim and TD Burton, "Reduction of Structural Dynamics Models Having Nonlinear Damping," ASME 2003 DETC, 19th Biennial Conf. On Vibration and Noise, September 2-6, Chicago, IL (2003).
12. TD Burton, "Numerical Calculation of Nonlinear Normal Modes in Structural Systems," *Nonlinear Dynamics*, 49, 425 – 441 (2007).
13. N Kumar and TD Burton, "Use of Random Excitation to develop POD based reduced order models for nonlinear structural dynamics," Proc. ASME IDETC, Paper DETC2007/VIB-35539, Las Vegas, NV, September 4-7 (2007)
14. E. Butcher, I. Sevostianov, and T. Burton, "On the separation of internal and boundary damage from combined measurements of electrical conductivity and vibration frequencies," to appear *Int. J. Engineering Sciences* (2008).

Aerospace courses taught: Aerodynamics, Flight Dynamics (jr./sr. level); Hydrodynamic Stability (graduate).

Other relevant activities (recent)

NASA Workforce Development Workshop participant; sponsored by NASA ESMD; "PartneringStrategies for Educating and Motivating the Next Generation of Aerospace Scientists and Engineers," Washington DC, June 1, 2006.

Participant, 2007 National Science Symposium for Engineers and Scientists, Santa Fe, NM: Purpose of Symposium: Improve K-12 Science Education in US.

Panel Organizer and Moderator, International Symposium for Personal Spaceflight (ISPS 2005, 2006, 2007), Las Cruces, NM

Spaceport America Educational Committee, Dona Ana County (2007 – present).

Member (2000-2006), external review panels for ASC predictive simulation programs in Mechanics (Sandia National Lab and Los Alamos National Lab)

Member, Editorial Board, *Journal of Vibration and Control*

Guest editor, *Nonlinear Dynamics* (2 special issues)

Responsible for all aspects of development of Aerospace Engineering degree programs at NMSU, including management of line item state funding (2005 – present)

PI on AFOSR grant (co-PI A. Barhorst), "Predictive Dynamic Simulation of Structures with Non-Smooth Nonlinearities;" (2002 – 2005), $252,000.

PI on NASA EPSCoR grant (co-PI's E. Butcher and I. Sevostianov), "Structural Health Monitoring and Self-Healing of Aerospace Structures (10/2007 – 9/2010), NMSU MAE share = $404,000.

BIOGRAPHICAL SKETCH of ERIC A. BUTCHER

Department of Mechanical and Aerospace Engineering
New Mexico State University, Las Cruces, NM 88003
Phone: 1-575-646-6179 Fax: 1-575-646-6111
e-mail: eab@nmsu.edu

Education

Ph.D. (Mechanical Engineering), 1997, Auburn University, Auburn, AL. Advisor: Prof. S. C. Sinha
M.S. (Mechanical Engineering), 1995, Auburn University, Auburn, AL. Advisor: Prof. S. C. Sinha
B.S. (Engineering Physics) with distinction, 1993, University of Oklahoma, Norman
B.M.A., 1991, University of Oklahoma, Norman

Professional Experience

2007- : Associate Professor, Mechanical and Aerospace Engineering Dept., New Mexico State University
2003-2006: Associate Professor, Mechanical Engineering Dept., University of Alaska Fairbanks (tenured)
1998-2003: Assistant Professor, Mechanical Engineering Dept., University of Alaska Fairbanks
1997-1998: Postdoc/Technical Staff Member, Structural Dynamics and Vibration Control Department, Sandia National Laboratories, Albuquerque, NM. Supervisor: Dr. Daniel Segalman

Awards/Honors

Inaugural holder of Chapman Endowed Professorship, Mechanical and Aerospace Engineering Dept., New Mexico St. Univ.

Recent Publications related to Aerospace Research

1. Deshmukh, V., E. A. Butcher, and E. Bueler, "Dimensional Reduction of Nonlinear Delay Differential Equations with Periodic Coefficients using Chebyshev Spectral Collocation," *Nonlinear Dynamics* 52, 137–149 (2008).
2. Voronov, S. A, A. M. Gouskov, A. S. Kvashnin, E. A. Butcher, and S. C. Sinha, "Influence of Torsional Motion on the Axial Vibrations of a Drilling Tool," *J. Computational and Nonlinear Dynamics* 2, 58-64 (2007).
3. Deshmukh, V., H. Ma, and E. A. Butcher, "Optimal Control of Parametrically Excited Linear Delay Differential Systems via Chebyshev Polynomials," *Optimal Control Applications & Methods* 27, 123-136 (2006).
4. Gouskov, A. M., S. A. Voronov, E. A. Butcher, and S. C. Sinha, "Nonconservative Oscillations of a Tool for Deep Hole Honing," *Comm. Nonlinear Science & Numerical Simulation* 11, 685-708 (2006).
5. Butcher, Eric A., P. Nindujarla, and E. Bueler, "Stability of Up- and Down-Milling Using Chebyshev Collocation Method," proceedings of 5th International Conference on Multibody Systems, Nonlinear Dynamics, and Control, ASME DETC'05, Long Beach, CA, Sept. 24-28, 2005.
6. Ma, H. and E. A. Butcher, "Stability of Elastic Columns Subjected to Periodic Retarded Follower Forces," *Journal of Sound and Vibration* 286, 849-867 (2005).
7. Ma, H., V. Deshmukh, E. A. Butcher, and V. Averina, "Delayed State Feedback and Chaos Control for Time-Periodic Systems via a Symbolic Approach," *Comm. Nonlinear Science & Numerical Simulation* 10, 479-497 (2005).
8. Butcher, E.A., Ma, H., Bueler, E., Averina, V., and Szabo, Z., "Stability of Linear Time-Periodic Delay-Differential Equations via Chebyshev Polynomials," *Int. J. Num. Meth. Engr.* 59, 895-922 (2004).
9. Ma, H., E. A. Butcher, and E. Bueler, "Chebyshev Expansion of Linear and Piecewise Linear Dynamic Systems with Time Delay and Periodic Coefficients Under Control Excitations", *J. Dynamic Systems, Measurement, and Control* 125, 236-243 (2003).
10. Segalman, D. J. and E. A. Butcher, "Suppression of Regenerative Chatter via Impedance Modulation," *J. Vibration and Control* 6, 243-256 (2000).

Aerospace Courses Taught

Astrodynamics (Orbital Mechanics and Satellite Attitude Dynamics)

Other Relevant Activities

Member of ASME Technical Committee on Multibody Systems, Nonlinear Dynamics, and Control (MSNDC)

Co-PI on NASA EPSCoR project *Structural Health Monitoring and Self-Healing of Aerospace Structures*, $741,144, Oct. 1, 2007-Sep. 30, 2010.

PI on NSF project *Symbolic Stability and Bifurcation Analysis of Time-Periodic Differential-Delay Equations: Applications to High-Speed Machining Models*, $205,610, Sept. 15, 2001-Jan. 31, 2006.

PI on AFOSR project *Order Reduction of Large Scale Systems via Nonlinear Normal Modes*, $475,911, May 15, 2001-Nov. 14, 2004.

PI on Alaska Space Grant project, *Directional Stability and Nonlinear Dynamics of a Dual-Spin Satellite*, 1999.

Participant, 2008 NASA Minority Serving Institutions Research Partnership, May 12-14, 2008.

Biographical Sketch – Ou Ma

Department of Mechanical and Aerospace Engineering, New Mexico State University

EDUCATION

- **Ph.D., 1991,** Mechanical Engineering and Center of Intelligent Machines (CIM)**,** McGill University, Montreal, Canada
- **M.Eng, 1987,** Mechanical Engineering and Center of Intelligent Machines (CIM), McGill University, Montreal, Canada
- **B.Sc., 1982,** Mechanical Engineering, Zhejiang University, Hangzhou, China.

PROFESSIONAL EMPLOYMENT

August 2002 – present, Associate Professor
Also supervising the UAV/MAV Lab and the Robotics Lab
Department of Mechanical and Aerospace Engineering, New Mexico State University
P.O. Box 30001, MSC 3450, Las Cruces, NM 88003, USA

July 1996 - July 2002, Senior R&D technical leader and project engineer
MDA Space Missions (also called MDR or "MD Robotics Ltd.").
9445 Airport Rd., Brampton, Ontario, Canada L6S 4J3

May 1991 - June 1996, Control and analysis engineer
Spar Aerospace Ltd.
9445 Airport Rd., Brampton, Ontario, Canada L6S 4J3

SELECTED PUBLICATIONS (only those in recent 4 years and related to aerospace)

[1] Ma, O., Dang, H., and Pham., K., "On-orbit identification of inertia properties of spacecraft using a robotic arm", to appear in the *AIAA Journal of Guidance, Control and Dynamics*, 2008.

[2] Krovi, V. N. and Ma, O., "Space Robotics", a chapter in *Aerospace Engineering Handbook*, edited by R.H. Bishop, CRC, to be published in 2008.

[3] Ma, Z., Ma, O., and Shashikanth, B., "Optimal Approach to and Alignment with a Rotating Rigid Body for Capture", *Journal of the Astronautical Science*, Vol.55, No.4, 2007, pp.407-419.

[4] Ma, O. and Wang, J., "Model order reduction for impact-contact dynamics simulations of flexible manipulators", *Robotica*, Vol. 25, Issue 4, 2007, pp.397-407.

[5] Ma, O., Dang, H., and Pham, K.., "On-orbit identification of inertia properties of spacecraft using robotics technology", *Proc. of the AIAA Guidance, Navigation, and Control Conf.*, Hilton Head, SC, Aug. 20-23, 2007, Paper # AIAA-2007-6815.

[6] Ma, Z., Ma, O. and Shashikanth, B., "Optimal control for spacecraft to rendezvous with a tumbling satellite in a close range", *Proc. IEEE Int. Conf. on Intelligent Robots and Systems (IROS'06)*, Beijing, China, Oct.9-15, 2006, pp.4109-4114.

[7] Ma, O. and Yang, G., "Validation of a satellite docking simulator using the SOSS experimental testbed", *Proc. IEEE Int. Conf. on Intelligent Robots and Systems (IROS'06)*, Beijing, China, Oct.9-15, 2006, pp.4115-4120.

[8] Weber, M., Ma, O., and Sharf, I., "Identification of contact dynamics model parameters from constrained robotic operations", *ASME J. of Dyn. Syst., Meas., and Ctrl*, Vol.128, 2006, pp.307-318.

[9] Diao, X., Ma, O., and Paz, R., "Study of 6-DOF cable-robots for potential application of HIL microgravity contact-dynamics simulation", *Proc. AIAA Modeling and Simulation Technologies Conference and Exhibit*, Keystone, CO, August 21-24, 2006, AIAA-2006-6732, pp. 1097-1110.

[10] Ma, O. and Horan, S., "NMSU Nanosatellite with robotics capabilities", *Proc. of 8th Int. symp. on Art. Intell., Rob. and Auto. in Space (i-SAIRAS'05)*, Munich, Germany, Sept.5-9, 2005, pp.145-152.

[11] Ma, O. and Wang, J., "Model order reduction for contact dynamics simulations of flexible multibody systems", *Proc. of the 46th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics & Materials Conference*, Austin, Texas, Paper # 2005-2262, April 18-21, 2005.

[12] Ma, O., Wang J., Misra S., and Liu M., "On the validation of SPDM task verification facility", *Journal of Robotic Systems*, Vol.21, No.5, 2004, pp.219-235.

INVITED SEMINARS (only those in recent 4 years and related to aerospace)

- "Cable-Robot based Reduced-Gravity Simulation for EVA Training", an invited presentation at the Johnson Space Center, NASA, Houston, Jan. 25, 2008.
- "Contact Dynamics Model Parameters Identification and Model Order Reduction", an invited presentation at the Johnson Space Center, NASA, Houston, Jan. 24, 2008.
- "On-Orbit Identification of Inertia Properties of Spacecraft using Robotics Technology", an invited presentation at the Air Force Research Laboratory, AFRL/VSSV, Kirtland, NM, Sept. 27, 2006.
- "Experimental Validation of CDT-Based Satellite Docking Simulations Using SOSS Testbed", an invited presentation at MDA Space Missions, Toronto, Canada, May 30, 2005.
- "Contact Dynamics for Space Robotics", an invited presentation at NASA/AMES Research Center, Moffett Field, CA, July 27, 2005.
- "Robotics-based Hardware-in-the-Loop Contact Dynamic Simulation", an invited presentation at Air Force Research Laboratory, AFRL/VSSV, Kirtland, NM, November 4, 2005.

RESEARCH ACTIVITIES (only those in recent 4 years and related to aerospace)

- Principal Investigator: "Model Reduction for Contact Dynamics of Flexible Multibody Systems", $210,000, sponsored by the Army Research Office, 2008-2011.
- Principal Investigator: "Concept study of using a passive mechanism to simulate walking on the Moon", $25,000, NASA EPSCoR project sponsored by NMSGC, 2008-2009.
- Principal Investigator: "UAS Research: MAV Test and Evaluation", $206,000, sponsored by the US Air Force through the Physical Science Laboratory of NMSU, 2007-2009.
- Co-Principal Investigator: "Scaled hummingbird models for studying the dynamics of hovering and low speed forward flight", (PI: Dr. James Allen), $415,000, sponsored by AFOSR, 2006-2009.
- Principal Investigator: "On-Orbit Identification of Inertia Property of Spacecraft using Robotics Technology", $38,000, sponsored by AFOSR, 2005-2006.
- Co-Principal Investigator: "NMSU Nano-Satellite II", (PI: Dr. Stephen Horan), $110,000, sponsored by AFOSR and NASA, 2005-2007.

AEROSPACE INDUSTRIAL EXPERIENCE (1991-2002)

- Principal developer of a space robotics development and simulation system which has been used to support the design, verification and operation of the Space Shuttle robotic system, the International Space Station (ISS) robotics systems, and the Orbital Express robotics system.
- Project engineer for developing and validation of a robotics-based hardware-in-the-loop simulation facility for verification of difficult space robotics tasks for the ISS Program.
- Participated in the analysis and evaluation of the concepts of several satellite docking and on-orbit servicing missions sponsored by the Canadian Space Agency, NASA and aerospace industry.

Biographical Sketch – IGOR SEVOSTIANOV

Associate Professor, Department of Mechanical and Aerospace Engineering
New Mexico State University

EDUCATION

PhD in Solid Mechanics, St. Petersburg State University (Russia), 1993
BS/MS in Solid Mechanics, St. Petersburg State University (Russia), 1988

PROFESSIONAL EXPERIENCE

8/01 – present	Assistant (01-06)/Associate(06-present) Professor, Department of Mechanical and Aerospace Engineering, New Mexico State University, Las Cruces, New Mexico, 88003.
8/98-7/01	Senior Research Associate, Department of Mechanical Engineering, Tufts University, Medford, Massachusetts 02155.
5/97-7/98	Senior Research Associate, Department of Mechanical Engineering, University of Natal, Durban, South Africa
6/93-12/96	Visiting Scientist, Max-Planck Research Group "Mechanics of heterogeneous solids", Dresden, Germany.

Publications relevant to Aerospace experience and to recent Aerospace related research (last 5 years)

Sevostianov, I. and Kachanov, M. Contact of rough surfaces: a simple model for elasticity, conductivity and cross-property connections, *Journal of the Mechanics and Physics Solids* **56** (2008), 1380-1400.

Sevostianov, I. and Kachanov, M. Normal and tangential compliances of interface of rough surfaces with contacts of elliptic shape, *International Journal of Solids and Structures* **45** (2008) 2723-2736.

Sevostianov, I. and Kachanov, M. Explicit elasticity-conductivity connections for composites with anisotropic inhomogeneities, *Journal of the Mechanics and Physics of Solids*, **55**, 2007, 2181-2205.

Sevostianov, I. Dependence of the effective thermal pressure coefficient of a particulate composite on particles size, *International Journal of Fracture* **145**, 2007, 333-340.

Mear, M.E., **Sevostianov, I.** and Kachanov, M. Elastic compliances of non-flat cracks, *International Journal of Solids and Structures* **44** (2007) 6412-6427.

Sevostianov, I. and Kachanov, Contacting rough surfaces: Hertzian contacts versus welded areas, *International Journal of Fracture,* **145**, 2007, 223-228.

Sevostianov, I. and Sabina, F. Cross-property connections for fiber reinforced piezoelectric materials, *International Journal of Engineering Sciences*, **45** (2007), 719-735.

Sevostianov, I. and Kachanov, M. Nanoparticle reinforced materials: effect of interphase layers on the overall properties. *International Journal of Solids and Structures* **44** (2007) 1304-1315.

Sevostianov, I. Thermal conductivity of a material containing cracks of arbitrary shape *International Journal of Engineering Sciences*, **44** (2006), 513-528.

Sevostianov, I., Kováčik, J. and Simančík, F. Elastic and electric properties of closed-cell aluminum foams. Cross-property connection *Materials Science and Engineering, **A-420***, 87-99.

Sevostianov, I. and Kachanov, M. Homogenization of a nanoparticle with graded interface. *International Journal of Fracture* **139**, 2006, 121-127.

Sevostianov, I., Yilmaz, N., Kushch, V. and Levin, V. Effective elastic properties of matrix composites with transversely-isotropic phases. *International Journal of Solids and Structures* **42**, 2005, 455-476.

Kachanov, M. and **Sevostianov, I.** On quantitative characterization of microstructures and effective properties. *International Journal of Solids and Structures* **42**, 2005, 309-336.

Sevostianov, I., Kachanov, M., Ruud, J., Lorraine, P., Dubois, M. Quantitative characterization of microstructures of plasma-sprayed coatings and their conductive and elastic properties. *Materials Science and Engineering-A,* **386**, 2004, 164-174.

Kushch, V. and **Sevostianov I.** Effective elastic moduli tensor of particulate composite with transversely isotropic phases. *International Journal of Solids and Structures* **41**, 2004, 885-906.

Sevostianov, I. Explicit relations between elastic and conductive properties of a material containing annular cracks. *Philosophical Transactions of the Royal Society of London: Mathematical, Physical and Engineering Sciences*, **361**, 2003, 987-999.

Other relevant activities (recent)

Associate Editor, *International Journal of Theoretical and Applied Multiscale Mechanics*
Member, Editorial Board, *International Journal of Engineering Sciences.*
Guest editor, *International Journal of Engineering Sciences* (2 special issues)
Mechanics of Materials (1 special issue)
Co-chair of symposium "Micromechanics of Materials" in the framework of ASME Mechanics and Materials conference, Austin, TX, June 2007.
Member of International Scientific Committee of 15-th International Conference on Composite Materials, Durban, South Africa 2005.
Subcontractor on NASA grant"Novel Nanoparticle-Filled Matrices for Thermal Stress Reduction in Polymer Matrix Composites: Multi-Scale Modeling and Experimental Validation"" (1/2007 – 12/2009), $85,000.
Co-PI on NASA EPSCoR grant "Structural Health Monitoring and Self-Healing of Aerospace Structures (10/2007 – 9/2010), NMSU MAE share = $404,000.

Biographical Sketch – BANAVARA SHASHIKANTH

Mechanical and Aerospace Engineering Department
New Mexico State University

Education:

- Ph.D. Aerospace Engineering, University of Southern California, 1998
- M.E. Aerospace Engineering, Indian Institute of Science, Bangalore, India, 1991
- B.Tech. Aerospace Engineering, Indian Institute of Technology, Madras, India, 1989

Professional Experience:

- Assistant Professor (Tenured), Department of Mechanical Engineering, New Mexico State University, 2001- present
- Postdoctoral Scholar, Control and Dynamical Systems, California Institute of Technology, Pasadena, USA, 1998-2000
- Graduate Assistant, Department of Aerospace and Mechanical Engineering, University of Southern California, Los Angeles, USA, 1993-1998
- Research Scientist, Experimental Aerodynamics Division, National Aerospace Laboratories, Bangalore, India, 1991-1993

Current Funded Projects:

Publication/Presentation List:

Journal Articles:

- Hamiltonian structure for a neutrally buoyant rigid body interacting with N vortex rings of arbitrary shape: the case of arbitrary smooth body shape, B. N. Shashikanth, A. Sheshmani, S. D. Kelly and J. E. Marsden, *Theoretical and Computational Fluid Dynamics,* vol. 22, pp.37--64, **2008**.
- Symmetry reduction and control of the dynamics of a 2-D rigid circular cylinder and a point vortex: vortex capture and scattering, B. N. Shashikanth, *European Journal of Control,* vol. 13(6), pp. 641--657, **2007**
- Vortex interaction with a moving sphere, J. J. Allen, Y. Jouanne and B. N. Shashikanth, *Journal of Fluid Mechanics,* vol. 587, pp. 337-346, **2007**.
- Symmetric pairs of point vortices interacting with a neutrally buoyant two-dimensional circular cylinder, B. N. Shashikanth, *Physics of Fluids*, vol.18, 127103, 17 pages, **2006**. (**pdf**)
- Poisson brackets for the dynamically interacting system of a 2D rigid cylinder and N point vortices: The case of arbitrary smooth cylinder shapes, B. N. Shashikanth, *Regular and Chaotic Dynamics*, vol.10(1), pp. 1--14, **2005**.

Publications in Conference Proceedings:

- Optimal Control for Spacecraft to Rendezvous with a Tumbling Satellite in a Close Range, Z. Ma, O. Ma and B. N. Shashikanth, *Proceedings of the IEEE/RSJ International Conference on Intelligent Robots and Systems, Beijing, China, October 9-15, **2006.***
- Dynamics and control of the system of a 2-D rigid circular cylinder and point vortices, Z. Ma and B. N. Shashikanth, *Proceedings of the 2006 American Control Conference, Minneapolis, Minnesota, USA, June14-16, **2006.*** (**pdf**)

- An Investigation of van der Waals Forces in the assembly of Micro Devices, D. Vasquez, J. Cecil and B. Shashikanth, *Proceedings of the Industrial Engineering Research Conference, Atlanta, May 14-18, **2005**.*

The Hamiltonian structure of a 2D rigid circular cylinder interacting dynamically with N point vortices, B. N. Shashikanth, J. E. Marsden, J. W. Burdick and S. D. Kelly, *Proceedings of the Fourteenth International Symposium of Mathematical Theory of Networks and Systems, Perpignan, France, June 19--23, **2000***

Conference Presentations and Invited Talks:

- Geometric mechanics of vorticity fields and neutrally buoyant rigid bodies, *Universidad Nacional Aut* *noma de M* *xico, Instituto de Investigaciones en Matem* *ticas Aplicadas y en Sistemas, Mexico city, Mexico, May 17, **2007**.*
- Symmetric pairs of point vortices interacting with a neutrally buoyant 2D circular cylinder, *IUTAM Symposium on Hamiltonian Dynamics, Vortex Structures and Turbulence, Russian Academy of Sciences, Moscow, Russia, August 25--30, **2006**.*
- Dynamics and Control of a Moving Cylinder and Point Vortices, *77th Annual Meeting of the Gesellschaft fur Angewandte Mathematik und Mechanik (GAMM), Technische Universitat, Berlin, Germany, March 27-31, **2006**.*
- Poisson brackets for rigid bodies in vortical fluids, *Workshop on Dynamical Systems Methods in Fluid Dynamics (organizers: Jerrold E. Marsden and Jurgen Scheurle), Mathematisches Forschunginstitut Oberwolfach, Oberwolfach, Germany, July31-Aug5, **2005***

Biographical Sketch - MINGJUN WEI
Mechanical and Aerospace Engineering Department
New Mexico State University, Las Cruces, NM 88003
mjwei@nmsu.edu, (575) 646-6034, Fax: (575) 646-6111

Education:

Ph.D. Theoretical and Applied Mechanics, **Univ. of Illinois at Urbana-Champaign** Dec. 2004
M.S. Mechanical and Aerospace Engineering, **Univ. of California, Los Angeles** Fall 2001
M.Engr. Modern Mechanics, **Univ. of Science and Technology of China** June 1998
B.S. Modern Mechanics, **Univ. of Science and Technology of China** June 1996

Professional Experience:

2006 – present: Assistant Professor, Mechanical and Aerospace Engineering Department, New Mexico State University
2006 June : Invited Researcher, 2nd European Forum on Flow Control, Poitiers, France, April–June, 2006
2005 – 2006 : Postdoctoral Research Associate, Mechanical and Aerospace Engineering Department, Princeton University

Current Research Activities:

- Direct numerical simulation of compressible and incompressible flows
- Control and optimization
- Low-dimensional modeling
- Aeroacoustics

Current Funded Projects:

- "Reduced-Order Modeling of Shear Layers", supported by Sandia National Laboratories
- "Flapping and Twisting Aeroelastic Wings for Propulsion", supported by Army High Performance Computing Research Center (AHPCRC)

Courses Taught:

Fluid Mechanics (jr/sr. level); Computational Fluid Mechanics (graduate)

Professional Memberships:

American Institute of Aeronautics and Astronautics (AIAA) member
AIAA Acoustics Technical Committee member
American Physical Society (APS) member

Publication/Presentation List:

Journal Articles:

- **M. Wei**, and C. W. Rowley, "Low-dimensional models of a temporally evolving free shear layer", *Journal of Fluid Mechanics* (submitted), 2008
- Samanta, J. B. Freund, **M. Wei**, and S. K. Lele, "Robustness of acoustic analogies for predicting mixing-layer noise", *AIAA Journal*, Vol 44, No. 11, pp. 2780–2786, 2006
- **M. Wei**, and J. B. Freund, "A noise-controlled free shear flow", *Journal of Fluid Mechanics*, Vol. 546, pp. 123–152, 2006
- X. Y. Yin, D. J. Sun, **M. J. Wei**, and J. Z. Wu, "Absolute and convective instability character of slender viscous vortices", *Physics of Fluid*, Vol. 12, No. 5, pp. 1062–1072, 2000
- **M. Wei**, D. Sun, X. Yin, and J. Wu, "Stability analysis on supersonic trailing-line vortex", *Acta Mechanica Sinica* (Chinese), Vol. 31, No. 6, pp. 694–699, 1999

Technical Report:

1. **M. Wei**, J. B. Freund, and J. Kim, "Aeroacoustic Optimization and Control", final report for AFOSR (Air Force Office of Scientific Research), 2004 (approved for public release)

Conference Papers and Proceedings:

1. B. N. Shashikanth, A. Sheshmani, S. Kelly, and **M. Wei**, "Hamiltonian structure and dynamics of a neutrally buoyant rigid sphere interacting with thin vortex rings", ITP-07-26, Proceedings of ITP-07, 2007 Interdisciplinary Transport Phenomena V, Bansko, Bulgaria, October, 2007
2. **M.Wei**, and P. Jordan, "An optimally defined sound source in mixing layers", *AIAA* paper 2007-3869, Miami, FL, 2007
3. D. Eschricht, P. Jordan, **M.Wei**, J. Freund, and F. Thiele, "Analysis of noise-controlled shear-layers", *AIAA* paper 2007-3660, Rome, Italy, 2007
4. S. Ahuja, C. W. Rowley, I. G. Kevrekidis, **M. Wei**, T. Colonius, and G. Tadmor, "Low-dimensional models for control of leading-edge vortices: equilibria and linearized models", *AIAA* paper 2007-709, Reno, NV, 2007
5. **M. Wei**, and C. W. Rowley, "Low-dimensional models of a temporally evolving free shear layer", *AIAA* paper 2006-3228, San Francisco, CA, 2006
6. J. Freund, A. Samanta, **M. Wei**, and S. Lele, "The robustness of acoustic analogies", *AIAA* paper 2005-2940, Monterey, CA, 2005
7. J. B. Freund, and **M. Wei**, "Some small changes that make a mixing layer quiet", *AIAA* paper 2005-0997, Reno, NV, 2005
8. J. B. Freund, S. K. Lele, and **M. Wei**, "The robustness of acoustic analogies", Center for Turbulence Research, Proceedings of the Summer Program 2004
9. J. B. Freund, and **M. Wei**, "An emperical 'lower bound' on free-shear-flow noise", *XXI ICTAM*, Warsaw, Poland, 2004
10. J. B. Freund, and **M. Wei**, "Adjoint-based control of free shear flow noise", *AIAA* paper 2003-3570, Orlando, FL, 2003
11. **M. Wei**, and J. B. Freund, "Noise control using adjoint-based optimization", *AIAA* paper 2002-2524, Breckenridge, CO, 2002
12. **M. Wei**, and J. B. Freund, "Optimal control of free shear flow noise", *AIAA* paper 2002-0665, Reno, NV, 2002
13. X. Y. Yin, D. J. Sun, **M. J. Wei**, and J. Z.Wu, "Absolute/convective instability of incompressible and compressible swirling vortex", *AIAA* paper 99-0140, Reno, NV, 1999

Other Presentations:

1. **M.Wei**, and C. W. Rowley, "Low-dimensional modeling for both temporally and spatially developing free shear layers", *Bulletin of the American Physical Society*, Vol. 52, No. 17, Salt Lake City, Utah, 2007
2. **M.Wei,** "Low-dimensional modeling for temporally developing free shear layers", invited talk at Sandia National Laboratories, Oct. 29, 2007
3. **M.Wei**, and C. W. Rowley, "Low-dimensional models of a temporally evolving free shear layer using template-based methods", *Bulletin of the American Physical Society*, Vol. 51, No. 9, Tampa Bay, FL, 2006
4. **M.Wei**, and J. B. Freund, "Jet noise mechanism studied by optimal control", *Bulletin of the American Physical Society*, Vol. 48, No. 10, East Rutherford, NJ, 2003
5. **M. Wei**, and J. B. Freund, "Adjoint-based control and analysis of free-shear flow noise", *14th US National Congress of Theoretical and Applied Mechanics*, Blacksburg, VA, 2002
6. **M. Wei**, and J. B. Freund, "Adjoint-based control of noise from two-dimensional mixing layer", *Bulletin of the American Physical Society*, Vol. 46, No. 10, San Diego, 2001

Biographical Sketch – Chunpei Cai

Department of Mechanical and Aerospace Engineering
New Mexico State University

EDUCATION

Ph.D. in Aerospace Engineering, University of Michigan, Ann Arbor, Michigan, December 2005

M.Sc. in Mechanical Engineering, **Cornell University**, Ithaca, New York, August 1999

M.Sc. in Fluid Mechanics, Institute of Mechanics, **Chinese Academy of Sciences**, Beijing, July 1997

BEng. Naval Architecture, Harbin Engineering University, Harbin, China, July 1994

RESEARCH AND INDUSTRIAL EXPERIENCE

Assistant Professor of Aerospace Engineering, Department of Mechanical and Aerospace Engineering, New Mexico State University (beginning) August 2008

CFD Specialist, ZONA Technology Inc., Scottsdale, Arizona 11/2005-present

Graduate Student, Department of Aerospace Engineering, University of Michigan, 01/2002- 10/2005

Graduate Student, Sibley School of Mechanical and Aerospace Engineering, Cornell University, 09/1997 -05/1999

Graduate Student, Department of Aerodynamics and Aerophysics, Institute of Mechanics, Chinese Academy of Sciences 07/1994-05/1997

Software Developer, HyperWorks Development, Altair Engineering Inc., Troy, Michigan 05/1999- 10/200

FUNDING RECORD

Topic: Automated Design Optimization for Hypersonic Plasma-Aerodynamics **(PI)** 11/2005-11/2007 AFOSR-STTR Phase II project, funding amount $750,000, collaborating with Stanford University.

Topic: Integrated Aero-Servo-Thermo-Propulso-Elasticity (ASTPE) for Hypersonic Scramjet Vehicle Design/Analysis **(Co-PI)** 03/2007-03/2009 AFOSR-STTR Phase II project, funding amount $750,000, collaborating with the University of Colorado at Boulder.

Topic: Nonlinear Aerodynamic ROM-Structural ROM Methodology for Inflatable Aeroelasticity in Hypersonic Atmospheric Entry **(Co-PI)** 01/2008-11/2008 NASA STTR-Phase I, funding amount $99,000, 10 months, collaborating with Arizona State University.

PROFESSIONAL AFFILATIONS

American Institute of Aeronautics and Astronautics, Senior Member;
American Society of Mechanical Engineers; American Physical Society; American Vacuum Society

PAPERS AND PRESENTATIONS

Book Chapter

Liu, D. D., and **Cai, C.**, Perturbed-Euler Similitude for Energy Deposition on Pointed Profiles with Attached Shock Waves, book name undetermined, Editor, Hafez, M..

Refereed Journal Publications

Cai, C. and Boyd, I. D., Theoretical and Numerical Study of Several Free Molecular Flow Problems, Journal of Spacecraft and Rockets, Vol.44, No.3, pp.619-624, May-June, 2007.

Cai, C., Energy Deposition/Absorption Effects on a Planar Shock Wave, Journal of Thermophysics and Heat Transfer, Vol.21, No.1, January-March, pp.252-254, 2007.

Cai, C., Boyd, I. D. and Sun, Q., Rarefied Background Flow in a Vacuum Chamber Equipped with One-Sided Pumps, Journal of Thermophysics and Heat Transfer, Vol.20, No.3, pp.524-535, July-September, 2006.
Cai, C., Boyd, I. D. and Sun, Q., Free Molecular Background Flow in a Vacuum Chamber Equipped with Two-Sided Pumps, Journal of Vacuum Science and Technology (A), 24(1), pp.9-19, January-February, 2006.

Sun, Q., **Cai, C.** and Boyd, I. D., Computational Analysis of High-Altitude Ionization Gauge Flight Measurements, Journal of Spacecraft and Rockets, Vol.43, No.1, pp.186-193, January-February, 2006.

Non-refereed Journal Publications
Cai, C., Heat Transfer in Vacuum Packaged MEMS Devices, accepted by Physics of Fluids, to appear. **Cai, C.** and Boyd, I.D., Collisionless Gas Flow Expanding into Vacuum**,** Journal of Spacecraft and Rockets, Vol.44, No.6, pp.1326-1330, November-December, 2007.

Cai, C., Sun, Q. and Boyd, I.D., Gas Flows in Microchannels and Microtubes, Journal of Fluid Mechanics, Vol.589 (2007), pp.305-314.

Cai, C. and He, X., Energy Deposition/Extraction Effects on Oblique Shock Waves Over a Wedge, AIAA Journal, Vol.45, No.9, pp.2267-2272, September, 2007.

Cai, C. and Boyd, I.D., Compressible Gas Flows in a Two-Dimensional Planar Microchannel, Journal of Thermophysics and Heat Transfer, Vol.21, No.3, pp.608-615, July-September, 2007.

Cai, C., Boyd, I.D. and Sun, Q., Background Free Molecular Flows Between Two Plates with Pumps, Journal of Thermophysics and Heat Transfer, Vol.21, No.1, January-March, pp.94-104, 2007.

Papers Submitted for Publication
Cai, C., Rarefied Gas Flows Over a Flat Plate, submitted to Physics of Fluids, under review. **Cai, C.,** Heat Transfer Inside Vacuum Packaged MEMS Devices, submitted to Journal of Microelectro mechanical Systems.

Cai, C. and Liu, D. D., Asymptotic Solutions for Low Magnetic Reynolds Flow Inside a 2D Microchannel, submitted to Physics of Fluids, under review.

Tang, H.Z., Xu, K. and **Cai, C.**, Gaskinetic BGK Scheme for Three Dimensional Magnetohydro dynamics, submitted to Journal of Computational Physics, under review.

Cai, C., Liu, D. D. and Xu, K., A One-Dimensional Multi-Temperature Gaskinetic BGK Scheme for

Planar Shock Wave Computations, submitted to AIAA Journal, under review.

Xu, K., He, X. and **Cai, C.**, Multiple Temperature Gaskinetic Model and Multi-scale Gaskinetic Method for Nonequilibrium Rarefied Flow Computation, Submitted to Journal of Computational Physics.

Young S. Lee

Department of Mechanical and Aerospace Engineering
New Mexico State University

EDUCATION

- Ph.D., Mechanical Engineering, University of Illinois at Urbana-Champaign, 2006
- M. Eng., Mechanical Engineering, Inha University, South Korea, 1995
- B. Eng., Mechanical Engineering, Inha University, South Korea, 1993

RESEARCH INTERESTS

Nonlinear dynamics, nonlinear system identification, fluid-structure interactions, targeted energy transfer and resonance capture dynamics

PROFESSIONAL POSITIONS

Assistant Professor, Department of Mechanical and Aerospace Engineering, New Mexico State University
(beginning) August 2008

Research Experience

- Postdoctoral Research Associate, Department of Aerospace Engineering, University of Illinois at Urbana-Champaign, 2007-2008
- Visiting Assistant Professor, Departments of Mechanical Science and Engineering, and of Aerospace Engineering, University of Illinois at Urbana-Champaign, 2006-2007
  - Targeted energy transfer using vibro-impact nonlinear energy sinks (NSF Grant CMS03-24433)
- Graduate Research Assistant, Departments of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, 2002-2006

Teaching Experience

- Visiting Assistant Professor, University of Illinois at Urbana-Champaign, 2006-2007
  - Mechanical Design II (ME 371), Instructor, Department of Mechanical Science and Engineering, Fall 2006
  - Structures and Control Lab (AE 360), Grader, Department of Aerospace Engineering, Spring 2007
- Graduate Teaching Assistant, University of Illinois at Urbana-Champaign, 2003-2006
- Graduate Teaching Assistant, Inha University, South Korea, 1994

Industrial Experience

- Researcher, Research and Development Center, Choongwae Medical Corporation, South Korea, 1999-2001
- Researcher, Environmental Department, Kumho Institute of Construction Technology, South Korea, 1995-1998

PUBLICATIONS (within the past three years)

Papers in Archival Journals

1. Y. S. Lee, A. F. Vakakis, L. A. Bergman, D. M. McFarland, G. Kerschen, Francesco Nucera, S. Tsakirtzis and P. N. Panagopoulos, "Passive Nonlinear Targeted Energy Transfer (TET) and Its Applications to Vibration Absorption: A Review," *Journal of Multi-Body Dynamics,* in review.
2. Y. S. Lee, A. F. Vakakis, L. A. Bergman, D. M. McFarland and G. Kerschen, "Enhancing Robustness of Aeroelastic Instability Suppression Using Multi-Degree-of-Freedom Nonlinear Energy Sinks," *AIAA Journal*, accepted for publication.
3. G. Kerschen, A. F. Vakakis, Y. S. Lee, D. M. McFarland and L. A. Bergman, "Toward a Fundamental Understanding of the Hilbert-Huang Transform in Nonlinear Structural Dynamics," *Journal of Vibration and Control*, in press.
4. Y. S. Lee, G. Kerschen, D. M. McFarland, W. J. Hill, C. Nichkawde, T. W. Strganac, L. A. Bergman and A. F. Vakakis, "Suppressing Aeroelastic Instability Using Broadband Passive Targeted Energy Transfers, Part II: Experiments," *AIAA Journal*, **45** (10), 2391-2400, 2007.
5. Y. S. Lee, A. F. Vakakis, L. A. Bergman, D. M. McFarland and G. Kerschen, "Suppressing Aeroelastic

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2. Y. S. Lee, A. F. Vakakis, D. M. McFarland, L. A. Bergman and G. Kerschen "Identifying Triggering Mechanisms and Suppressing Aeroelastic Instabilities by Passive Targeted Energy Transfers: Nonlinear System Identification, Modal Interactions and Resonance Captures," *Aeroelastic and Fluid/Structure Interaction Symposium, 2007 Society of Engineering Science (SES) Technical Meeting*, College Station, Texas, 21-24 October 2007.

3. Y. S. Lee, A. F. Vakakis, L. A. Bergman, D. M. McFarland and G. Kerschen, "Passive Suppression of Aeroelastic Instabilities of In-Flow Wings by Targeted Energy Transfers to Lightweight Essentially Nonlinear Attachments," *International Forum on Aeroelasticity and Structural Dynamics (IFASD) 2007*, Stockholm, Sweden, 18-20 June 2007.

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11. Y. S. Lee, G. Kerschen, D. M. McFarland, L. A. Bergman and A. F. Vakakis, "An Overview of Targeted Energy Transfer Phenomena in Coupled Oscillators: Theoretical and Experimental Results and System Identification," *11th Nonlinear Vibrations, Stability, and Dynamics of Structures Conference*, Blacksburg, Virginia, 13-17 August 2006.

ATTACHMENT 6: AEROSPACE ENGINEERING PERIODICALS

Attachment 6: Aerospace Engineering Periodicals

Publication	Publisher	Main Topics	Mem-ber price	Univ. price	Subscribed	New sub
AIAA Journal	AIAA	Aerodynamics, the aerospace environment, lasers and plasmas, fluid mechanics and reacting flows, and structural mechanics and materials	$70	$1100	x	
Journal of Aircraft	AIAA	Applied aircraft systems, design, operations, flight mechanics, flight and ground test, flight safety, computer applications, systems integration, aerodynamics, structures, and structural dynamics	$55	$600		$600
Journal of Guidance, Control, and Dynamics	AIAA	Dynamics, stability, guidance, control, navigation, optimization, electronics, and information processing, including applications of recent research to practical engineering problems	$60	$615		$615
Journal of Propulsion and Power	AIAA	Airbreathing, electric, and advanced propulsion, solid and liquid rockets, combustion, fuels and propellants, power generation and conversion for aerospace vehicles, and terrestrial energy devices and systems.	$50	$660		$660
Journal of Spacecraft and Rockets	AIAA	Spacecraft and tactical and strategic missile systems, including subsystem design and application, mission design and analysis, developments in space sciences, and applications of space technologies to other fields.	$50	$570		$570
Journal of Thermophysics and Heat Transfer	AIAA	The properties and mechanisms involved in thermal energy transfer and storage in gases, liquids, and solids, including conductive, convective, and radiative modes alone or in combination.	$50	$570		$570
Student Journal	AIAA	Features articles pertinent to a student's professional development: current trends in the aerospace industry, graduate school profiles, listings of companies who offer employment opportunities, and AIAA student branch activities	Free	$25		$25
Aerospace America	AIAA	Its feature writers and correspondents cover the engineers, scientists, and technologists developing the critical	Free	$140	x	

		research and directing many of the world's most important aerospace-related projects. Every month, it offers compelling features on design, electronics, materials, computer applications, science, and policy that affect aviation, space, and defense				
Space News	Space News	The weekly newspaper provides in-depth analysis of the important space events and issues.		$99		$99
Aviation Week and Space Technology	McGraw-Hill	The world's leading source of in-depth news and authoritative analysis of the technology, business and operations shaping the aviation and aerospace community in the three key markets: commercial, military and space		$95	x	
Aerospace and Electronic Systems Magazine	IEEE	Articles dealing with aspects of earth and space systems, radar, navigation, guidance and control and communication data handling as well as systems for their simulation and test		$310	x	
Aerospace and Electronic Systems, IEEE Trans. On	IEEE	The equipment, procedures, and techniques applicable to the organization, installation, and operation of functional systems designed to meet the high performance requirements of earth and space systems.		$640		
Journal of Dynamic Systems, Measurement, and Control	ASME	Areas of interest include but are not limited to: adaptive and optimal control; uncertain systems and robust control; nonlinear systems and control; intelligent control; distributed systems and control; energy systems and control; fluid control systems; instrumentation; manufacturing technology; aerospace systems; mechatronics; power systems; robotics; transportation and bio-medical systems.	$50	$300	x	
Journal of Turbomachinery	ASME	The journal publishes the best technical papers worldwide that further the technology of turbomachinery related to gas turbine engines. Fluid Dynamics and Heat Transfer Phenomena in Compressor and Turbine Components of Gas Turbine Engines, Turbine Blade and Measurement Advancements, and the Impact on Cavity Leaking Flows on Performance	$50	$250	x	
Total for subscriptions➔				**$5974**		
	Total for existing subscriptions➔				**($2195)**	
		Total increase in subscription expense➔				**$3779**

ATTACHMENT 7:
COMPARISON OF AEROSPACE ENGINEERING GRADUATE PROGRAMS

Attachment 7: Comparison of Aerospace Engineering Programs

Comparison of Master of Aerospace Engineering Programs											
Institution	**University Admission Requirements**				**Department Admission Requirements**				**Degree Completion Requirements**		
	Degree	GPA	GRE	Other	Degree	GPA	GRE	Other	Option 1	Option 2	Option 3
New Mexico State U	Accredited Institution	3.0/4.0	By dept.		ABET Accredited Institution	3.3/4.0	Qual. Exam		Thesis + 24 hrs course work + refeered conference or refeered journal article in review by graduation NO PROJECT OPTION		30 hours of coursework
U of Arizona	Recognized Institution	3.0/4.0	x	x	Recognized Institution	3.25/4.0	General	3 letters of recommen-dation	Thesis + 26 hours of coursework	Project + 29 hrs coursework	32 hours of coursework
U of Kansas	Equivalent Institution	3.0/4.0	x	x	Equivalent Institution	3.5/4.0	x	x	Thesis + 24 hours of coursework	Project +30 hrs coursework	
U of Oklahoma	Accredited Institution	Department recommendation			Accredited Institution	3.0/4.0 + grad din top 1/3	X (rec. combined 1200 score)	3 letters of recommen-dation	Thesis + 24 hours of coursework		36 hours of coursework
U of Cincinnati	Accredited Institution	3.0/4.0	x		Accredited Institution	3.0/4.0	x	2 letters of recommend-dation	Thesis + 33 hours of coursework		48 hours of coursework
West Virginia U	BS	2.75/4.0			Accredited Institution	3.0/4.0	x	3 letters of recommen-dation	Thesis + 24 hours of coursework		
SUNY at Buffalo	Per specific department				BSAE or BSME	3.0/4.0			Thesis + 24-27 hours of coursework	Project + 27 hrs coursework	33 hours of coursework + compr exam
U of Colorado at Boulder	Per specific department				Accredited Institution	3.0/4.0	x	4 letters of recommen-dation	MS:Thesis + 26 hours of coursework M.Eng:30 coursework	Project + 24 hrs coursework	Independent study + 24 hours of coursework

Comparison of Doctor of Aerospace Engineering Programs

Institution	University Admission Requirements				Department Admission Requirements				Degree Completion Requirements						
	Degree	GPA	GRE	Other	Degree	GPA	GRE	Other							
New Mexico State U	Accredited Institution	3.0/4.0	By dept.		Accredited Institution	3.3/4.0	Qual. Exam		48 hours beyond BS	18 hours of supporting research area	24 cr. hours of research	Qualify-ing exam	Oral & written comprehen-sive exam	Doctoral thesis defense	1 published & 1 accepted journal publication
U of Arizona	Recognized Institution	3.0/4.0	x		Recognized Institution	3.25/4.0	General	3 letters of recommen-dation	30 hrs course work	3 cr hrs of AME 696G	18 cr hrs disserta-tion	Qualify-ing exam	Oral & written comprehen-sive exam	Doctoral thesis defense	Dept seminar presentation
U of Kansas	Equivalent Institution	3.0/4.0	x		Equivalent Institution	3.5/4.0	x	x	60 hours beyond BS		15 cr hrs disserta-tion	Qualify-ing exam	Oral & written comprehen-sive exam	Doctoral thesis defense	
U of Oklahoma	Accredited Institution	Department recommendation			Higher level of academic achievement and research potential than MS candidates			3 letters of recommen-dation	42 hours beyond BS	36.25 hrs in major	60 hrs research inc. 45 for dissert.	Qualifying and general examination combined			
U of Cincinnati	Accredited Institution	3.0/4.0	x	Accredited Institution	3.0/4.0	x		2 letters of recommend-dation	135 quarter credits beyond BS		48 hrs course work	Qualify-ing exam		Doctoral thesis defense	
West Virginia U	MS from Accredited Institution			Accredited Institution	3.0/4.0			3 letters of recommen-dation	18 cr hrs course work		Minimum of 24 cr hrs of research	Qualify-ing exam		Doctoral thesis defense	
SUNY at Buffalo	Per specific department			MS	3.0/4.0	x			Minimum: 48 hrs of course		12-24 hrs dissertation	Qualify-ing exam		Doctoral thesis defense	
U of Colorado at Boulder	Per specific department			Equivalent of MSAE from CU/Boulder	3.25/4.0	x		4 letters of recommen-dation	36 hrs course work		30 hrs dissertation	Qualify-ing exam	Comprehensive exam	Doctoral thesis defense	

Institution: New Mexico State University
Proposed Program: MS(PhD) in Aerospace Engineering

Projected Graduate Program Cost Estimates and Resources (in thousands $)

ESTIMATED REVENUES	Year 1 2009/10		Year 2 2010/11		Year 3 2011/12		Year 4 2012/13		Year 5 2013/14	
	Existing	New	Existing	New	Existing	New	Existing	New	Existing	New
Projected University I&G /State Recur.	200.5/ 423.5	0/ 150	210.5/ 573.5		221/ 573.5		232/ 573.5		243.7/ 573.5	
External Grants and Contracts		50		100	100	100	200	200	300	200
Other	209.4	295		205		165		75		80
TOTAL REVENUE	$1,328K		$1,079K		$1,159K		$1,280K		$1,397K	
ESTIMATED EXPENSES	Year 1		Year 2		Year 3		Year 4		Year 5	
	Existing	New	Existing	New	Existing	New	Existing	New	Existing	New
Salaries and benefits (Faculty/ Staff)	559/ 156		587/ 148		616/ 154		647/ 162		679/ 170	
Grad Assts.		70	70		75		75		75	
Equipment		50		50		25		25		25
Facil./Modific/ Operations	40		40		45		45		45	
New Fac Startup		390		230		230				
TOTAL EXPENSES	$1,265K		$1,125K		$1,145K		$1,009K		$1,059K	
DIFFERENCE (Rev.- Exp.)	$63K		($46K)		$14K		$271K		$338K	
EST. IMPACT OF NEW PROGRAM	Year 1		Year 2		Year 3		Year 4		Year 5	
FTE Enrollment	50/8/3		70/16/6		90/18/10		90/20/11		90/22/12	
Projected Annual Credits Generated	415/120/54		565/240/108		715/252/168		715/264/174		715/276/180	
Tuition Generated (K)	195/155/70		287/310/140		342/326/217		342/341/225		342/357/233	

Explanation

1. Budgeting amounts are shown for entire AE program (undergrad, MS and PhD); individual degree program fundings cannot reasonably be separated.
2. For "FTE Enrollment," "Projected Annual Credits..," and "Tuition generated," projections are given for undergraduate, MS, and PhD, respectively in each block of the table. Amounts for tuition generated are in $thousands (numbers taken from Tables 2, 3, and 5).
3. In "Estimated Revenues" the designation "Other" includes estimates of new faculty startup money provided by the NMSU College of Engineering and Vice President for Research, as well as GA support of the teaching functions.
4. Salary and benefits under "Estimated Expenses" are shown separately for AE faculty and for other staff.
5. Assumptions: 1) State line item recurring funding of $423.5K for FY 2009 increased by $150K starting in FY 2010; 2) salary increases of 5% per year; 3) One new $300K/3 years proposal funded in each of years 2 and 3, and two new $300K/3years proposals funded in each of years 4 and 5.