Ten Year Review of the Aeronautics and Astronautics Department

I. COMMITTEE:

Per G. Reinhall, Professor and Chair, UW Mechanical Engineering (Committee Chair)
Robert Holzworth, Professor, UW Earth & Space Sciences
Mark I. Goldhammer, Chief Aerodynamicist, Boeing Commercial Airplanes
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II. SUMMARY OF THE REVIEW PROCESS

The review committee received an extensive Self Study document prepared by the Aeronautics and Astronautics (A&A) Department. The committee also received the previous review of the department conducted February, 2001. The review committee conducted a site visit January 30 and 31. The committee met with Jim Hermanson, Chair of the and A&A Department, members the A&A faculty and staff, and students from the undergraduate and graduate student population. In addition the committee conducted a conference call with graduate students enrolled in the department's on-line masters program. The committee also toured the renovated Guggenheim Hall, including classrooms and laboratories. The agenda of the site visit is attached to this report.

III. FINDINGS

Strengths

Undergraduate Program

The Department has strong programs in both aeronautics and astronautics. Notable strong points in the undergraduate curriculum include world-class senior capstone classes in both aeronautics and astronautics. These capstone classes not only teach engineering fundamentals but also teach organizational skills and project management skills. It is notable that the aeronautics capstone class routinely is successful in the design/build/fly aspect of their project every year. Another strong point of the department is the associated undergraduate laboratories. The Kirsten Wind Tunnel[1] is a large scale facility which is also used by industry and gives the students real-world experience that is immediately useful in the aerospace industry. The Lamborghini Advanced Composites Structures Lab[2] provides hands-on experience with composite structures, which is at the forefront of aerospace design and application.

The committee noted strong young faculty in both fluids and controls, fundamental areas for aerospace engineering. The controls area has attracted some research contract work, which provides opportunities for undergraduate student research.

The undergraduate program in A&A focuses on both aeronautics, with emphasis on vehicles that operate in fluids; and astronautics, with emphasis on vehicles which leave the Earth's atmosphere and operate primarily in space. The undergraduate student body is nearly equally split between these two branches of engineering. The A&A Department has faculty with interests in each area, also nearly equally split. While the needs of the

[1] Corrected from "Kristen Wind Tunnel" by the review committee
[2] Corrected from "Ferrari Advanced Composites Structures Lab" by the review committee

student body are met by the dual emphasis, there is concern that for a small department there may not be sufficient resources to do both of these focus areas well enough to be considered in the top echelon of A&A departments. This dual focus issue is exacerbated by the fact that nearly a third of the faculty are focused on plasma physics, a related area but not necessarily integrated with the undergraduate curriculum in either aeronautics or astronautics.

Students that the committee interviewed expressed satisfaction with the program. They found the program to be challenging and of very high quality. The students were pleased with the faculty and their dedication to teaching. It was reported that the professors showed a genuine interest in student learning and that they were available for extra help when necessary. It was felt that the student body develops into a cohesive community in the junior year which promotes a strong desire to work together in groups. The atmosphere in the department is very much appreciated by the undergraduate students. All the students we talked to were happy with their choice of engineering discipline and department. Some students thought that the program was over-emphasizing the aeronautics focus of the A&A discipline at the expense of the astronautics part. Student suggestions for future improvements were to increase the astronautics-related course offerings, and that the courses in the field of structures could be made more A&A specific. The committee notes that the national direction in astronautics is unclear, with the manned-space program having little direction and the mission for NASA unclear. The committee recommends that the A&A Department leadership needs to track and understand national priorities in future strategic planning.

Certificate Program in Aircraft Composite Structural Analysis and Design
The committee was impressed with the impact of the Advanced Composite Structure Certificate Program jointly offered with the MSE and ME departments. To date approximately 275 Boeing employees have completed the program and it is clear that the program serves industry well with distance learning opportunities for their employees. The committee recommends a stronger link to this certificate program with the A&A department, which will also facilitate stronger links to local industry.

Plasma Group
The plasma group has a stellar record and continues to be very productive both when it comes to funding and scholarly output. We found the faculty in the group to be very energetic and involved with interdisciplinary work at the forefront of plasma science and engineering. However the relevance of the Plasma Group to the mission of the A&A Department is unclear. As the committee understands the history, the Plasma Group was merged into A&A when the UW Nuclear Engineering Department was disbanded. The scientific tie to A&A is through fluid mechanics, of course. While the Plasma Group attracts the vast majority of externally funded research grants to the department, the committee is concerned that this small engineering department essentially has three diverse fields to integrate: aeronautics, astronautics, and plasma physics.

Center for Advanced Materials in Transport Aircraft Structures (AMTAS)

The FAA sponsored AMTAS, managed out of the ME Department, is clearly an asset to University of Washington. Since future aerospace vehicle designs will require a plethora of advances in lightweight composites structure engineering and manufacturing, an expansion of AMTAS through an increased involvement by the A&A Department would seem to create significant opportunities for the near future. This center has also the potential of strengthening the connection between the A&A Department and Boeing.

Junior Faculty
The department has been able to hire five faculty members within the last 10 years. The committee met Assistant Professors Ferrante and You and Associate Professors Dabiri and Morgansen. The committee was impressed with the quality and enthusiasm of the junior faculty as a whole. The junior faculty has invigorated the controls focus of the Department and brought in research in that area. They are considering developing a Center of Excellence for controls. One potential improvement identified by the junior faculty members is to introduce procedures to enable adoption of new strategies and initiatives.

On-line Masters Program -- EDGE
The Committee got an opportunity to discuss the department's on-line masters program with six registered students. The overall opinion of the students is that the on-line masters program through EDGE works very well. Some areas for improvement include better access to faculty, especially getting help through e-mail; and improved course offerings. Apparently, lack of enrollment in specific courses had led to limited distance-learning course offerings.

Graduate Advising
The graduate students praised the graduate advisory staff during our meeting. They all found the availability and the quality of the advising office to be excellent.

Opportunities
Strategic partnership with industry
The location of Boeing and many of its suppliers in the Pacific Northwest make Seattle a world center for aerospace engineering and manufacturing. The A&A Department therefore has a wonderful opportunity to establish close strategic partnerships with key companies within the aerospace industry. These partnerships could result in an increase in research funding and better research opportunities, higher impact on industry, better opportunities for undergraduate and graduate students, and an increase in endowments.

Grow composite work to support industry's long-term goals, including nano-technology
The next generation of composite aircraft presents a host of engineering problems to be overcome in areas such as design architecture and optimization, aeroelasticity, damage tolerance, material properties optimization, electromagnetic properties, surface finish, and acoustics and vibrations. The department therefore has an opportunity to implement fundamental composite research that may support the long-term goals of industry and attract research funding. The department can also play an important role in the

Northwest region in educating future composites engineers, which will be in tremendous demand by local and national employers.

Industrial Advisory Board
The department needs to revitalize its industrial advisory board to improve its strategic plan and a means of implementing it. The department now has an opportunity to reconstitute its advisory board with new members from local and national aerospace industries. It is the opinion of the committee that the members of the board should be from industry and that there is little need to select members from academia as has been done in the past. At the minimum the board should meet twice a year to advise the department about issues such as current needs and trends in research, development and implementation of a strategic plan, funding and entrepreneurial opportunities, capstone design, curriculum needs, on-line programs, and how industry and the department can serve each other better.

Leverage growing entrepreneurial opportunities in civilian space development
There is an ongoing paradigm shift in space exploration. The shift is away from NASA centered programs towards smaller programs managed by private companies. The committee believes that there might be opportunities associated with this shift that the department can exploit to its advantage. For example, there are many groups and commercial organizations who are actively building small or miniaturized satellite (cubesat, nanosat and smaller) programs. A large number of commercial companies are now getting into the business of building the commercial launch vehicles as well as developing systems engineering parts for these novel types of satellite systems. NASA's Office of the Chief Technologist is actively promoting this activity. It is the opinion of the committee that this national shift to smaller satellites and commercialization of launch vehicle systems may present an opportunity for the department to increase its focus on astronautics in both teaching and research.

Fill the Boeing Endowed Professorship
The Boeing Endowed Professorship has been unassigned since 2005 and has accumulated a significant amount of unused funds. The Department should make it a priority to fill this position to strengthen the faculty, be prepared for near-term retirements, and to satisfy its commitment to Boeing. The on-going search for a new faculty member in the controls area may provide a good opportunity to fill this endowed professorship.

Appoint active affiliate professors from industry
An effective way to improve connections with industry is to appoint strategically selected technical experts as affiliate professors. For example, there might be several nationally recognized researchers at the Senior Fellow level at Boeing who would be willing to initiate collaborative research programs and to teach and develop graduate courses and to advise graduate students.

Improve communication within the department by forming a staff advisory committee

The staff as a group (or as sub-groups) does not have regular meetings with the Chair of the department. As a result there seems to be some lack of coordination between the staff and the faculty. The committee believes that there exists an opportunity to improve the working relationships within the department if staff committees were set up to meet regularly with the Chair to discuss issues regarding advising, academics, and infrastructure.

Creation of an advisory role for the students
The department lacks any formal student involvement in its committee structure. There are no students on any of the standing committees and the Chair is currently not meeting regularly with student's representatives. We believe that this lack of student participation is a missed opportunity and should be corrected.

Leadership in pursuing large multidisciplinary grants
To increase the department's national stature and to strengthen its PhD program, the department would be well advised to increase its activity level and leadership role in the pursuit of large multidisciplinary grants such as MURIs, GANNs and IGERTs (the department is currently involved in one MURI (Morgansen)).

Weakness

The department does not have adequate industry connections
This weakness needs to be addressed in the department's strategic plan. We are especially troubled by the fact that the department is not particularly well connected with Boeing and its research needs. Researchers at Boeing have much stronger relationships with A&A departments at universities that are located at a great distance away from the Pacific Northwest. The department needs to make it a priority to reach out to Boeing and to show a willingness to conduct research that is relevant to the aircraft industry. It should be noted, however, that industry connections are not solely formed by reaching out to industry but that it also requires faculty to be leaders in research areas that are in demand by industry. We believe that this needs to be considered in the selection of new faculty. It is recommended that improving industry relationships needs to be a long-term commitment of the Department. It will take some time and patience for these relationships to form, for industry-relevant research to be established, and for industry to become more interested in partnering with the UW A&A Department in research projects of significance.

The external advisory board is not effectively used
The department has an external advisory board with members from industry and academia. However, this board is not being effectively used in that it has not been meeting regularly. A functional and active industrial advisory board is a crucial asset to the department in the development and implementation of a strategic plan.

The Plasma Group is responsible for the majority of the research expenditure
The research expenditures of the controls, fluids, and structures groups need to be increased. The junior faculty members in these groups are active but the average research productivity of the groups is too low.

Risk

Age structure
The department has excellent senior faculty in a wide range of areas. However, several faculty members are close to retirement and the average age in the department is high. The challenge in the view of this departmental age structure will be to define areas for hire that will allow the department to fill teaching needs and build strength in new directions that link across departmental boundaries. We therefore urge the department to place these future hires in the context of a well thought out strategic plan.

No systems engineering
The department does not offer any undergraduate or graduate courses in systems engineering. Being multi-disciplinary in nature, aerospace engineering is an ideal environment for systems engineering concepts. Coupled with improved local industry relationships, a systems engineering curricula could present a growth area for the Department in place of mature traditional aerospace focus areas. Our recommendation is that there should be some attention given to a possible expansion of the curriculum to include system engineering courses.

Low graduated PhD/faculty
The department has had a graduation rate of approximately 4PhDs/year the last 10 years. This equates to about 0.27 PhD/year per faculty. This is low compared to peer institutions (Purdue, Michigan, Texas A&M, Maryland, etc). The department would be well advised to increase the PhD graduation rate to achieve its goals as stated in department's strategic plan of increasing its national and international recognition and significantly increase national and international recognition.

IV. RECOMMENDATIONS

The unanimous opinion of the members of the review committee is that:

1. The Aeronautics and Astronautics Department BS, MAE, MSAE, and PhD Programs should be renewed for 10 years with no need to file an interim report

2. The department should reinvigorate its industrial advisory board. This board can advise the department about issues such as current needs and trends in aeronautics and astronautics research, development and implementation of a strategic plan; funding and entrepreneurial opportunities, capstone design, curriculum needs, on-line programs, and opportunities for joint Department/industry interactions. The department needs to make active use of the board with a minimum of two meetings per year.

3. The department needs to develop a comprehensive 10-year strategic plan that involves the development of *strategic partnerships with the aeronautics and astronautics industry* and then set up a system to implement the plan. This should be done in close working relationship with the industrial advisory board.

4. The department should track and understand national priorities in astronautics in future strategic planning. The national shift to smaller satellites and commercialization of launch vehicle systems may present an opportunity for the department to increase its focus on astronautics in both teaching and research.

5. Hiring of new faculty must be a high priority in order to enable the department to improve its nationally ranked graduate and research program. We recommend that the hiring be done in the context of a well thought out strategic plan. It is recommended that the Boeing Endowed Professorship be filled as soon as possible.

6. The hiring of lecturers should be a priority. The hiring of lecturers would allow an increase in enrollment without increasing the faculty teaching load. The additional use of lecturers would also improve the opportunities environment for faculty to pursue additional research.

7. Appointment of active Affiliate Professors to enhance research cooperation with industry. We believe that the Boeing Senior Fellows are valuable local resources who should be considered for appointment.

8. The department needs to pursue a vigorous program to increase the research expenditures of the controls, fluids, and structures groups. Success of both large team grants and individual investigator grants will naturally lead to an increase in graduate student productivity