

AC 2010-858: NEVER TOO OLD TO LEARN: A REPORT ON THE EXPERIENCES IN BOEING'S WELLIVER FACULTY FELLOWSHIP PROGRAM

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Abstract

This paper outlines my experiences in the Welliver Faculty Fellowship Program sponsored by The Boeing Company for the summer of 2009. The experience is traced from first learning of the Welliver Program, the application process, acceptance, actual time spent at Boeing, and what happens post Welliver. From the first contact, Boeing personnel were extremely professional and the Welliver program achieved its overall goals: “to provide faculty with a better understanding of the practical industry application of engineering, manufacturing, information technology and business skills, to help faculty enhance the content of undergraduate education in ways that will better prepare tomorrow's graduates for careers in a global environment and, to have faculty observe the Boeing environments, processes, and procedures with ‘fresh perspectives.’ Faculty will use their expertise to help identify areas for possible improvements and document their observations at Boeing.” Overall, the program was very valuable for me professionally. Boeing also received valued feedback on their operations. Some of the Fellows’ observations led to constructive suggestions offered to help the Welliver program process improve. The paper will also outline how the Welliver program has impacted my teaching in my subsequent courses and how I am able to share my experiences with the faculty and students at my institution. The Welliver Faculty Fellowship Program is something for which Boeing should be commended and remain committed.

Introduction

The Boeing Company is a company dedicated to developing the best engineers in the world. Early on, pioneers such as John McMasters from Boeing, with his unique style of addressing learning^{1,2}, recognized the need to integrate industry and education with the goal of improving the education process. John McMasters and Lee Matsch, from Allied Signal, authored a paper entitled “Desired Attributes of an Engineering Graduate – An Industry Perspective” in 1996 outlining their view of engineering education leading to the practice of engineering³. Eventually Boeing adopted its list of the “Desired Attributes of an Engineer” which has helped shape the ABET assessment process (see Figure 1)⁴. Boeing’s commitment to the engineering education process is evident in the unique program called The Boeing Welliver Faculty Fellowship Program. This is a program that grew out of a series of Boeing-University workshops held in Seattle in February and July of 1994. The program selects university professors to “intern” at Boeing for two months during the summer and this program has been operated by Boeing every summer since 1995.

Boeing List of “Desired Attributes of an Engineer”

- **A good understanding of engineering science fundamentals**
 - Mathematics (including statistics)
 - Physical and life sciences
 - Information technology (far more than “computer literacy”)
- **A good understanding of design and manufacturing processes** (i.e. understands engineering)
- **A multi-disciplinary, systems perspective**
- **A basic understanding of the context in which engineering is practiced**
 - Economics (including business practice)
 - History
 - The environment
 - Customer and societal needs
- **Good communication skills**
 - Written
 - Oral
 - Graphic
 - Listening
- **High ethical standards**
- **An ability to think both critically and creatively - independently and cooperatively**
- **Flexibility - the ability and self-confidence to adapt to rapid or major change**
- **Curiosity and a desire to learn for life**
- **A profound understanding of the importance of teamwork**
- **Global awareness (knowledge of at least one language other than English)**

<http://www.boeing.com/companyoffices/pwu/attributes/attributes.html> **Diversity –wanted and needed**

Figure 1 Desired Attributes of an Engineer⁴

The Welliver program is a unique program designed to:

“... expose a small number of competitively selected professors from U.S. and international universities to key elements and the business realities of industry by enabling them to "look over the shoulder" of working professionals at several levels of the technical, business, and management career paths. They will leave the program with an understanding of Boeing's business including its research needs, with an improved understanding of the practical application of technical and business skills and with a network of contacts within Boeing and among their faculty peers that can form the basis of long-term relationships”⁵

In all, 149 faculty have participated in this program since its inception. Not much has been written about the program in the literature though it deserves more recognition.⁶ The objectives of the Welliver Program are⁵:

1. To provide faculty with a better understanding of the practical industry application of engineering, manufacturing, information technology and business skills
2. To help faculty enhance the content of undergraduate education in ways that will better prepare tomorrow's graduates for careers in a global environment
3. To have faculty observe the Boeing environments, processes, and procedures with "fresh perspectives." Faculty will use their expertise to help identify areas for possible improvements and document their observations at Boeing.

The program is an obvious win/win situation for all involved. I was privileged to have been selected to participate as a Boeing Welliver Fellow this past summer of 2009. The fellows were assigned to various locations of the Boeing Company which were of professional interest to the fellow. It was an unprecedented opportunity to observe various aspects of Boeing's operation. I spent two weeks at the St. Louis, MO location and six weeks in Seattle, WA. With the exception of the orientation week and the closing week in St Louis, MO, fellows had the freedom to visit all aspects of the Boeing site, from assembly lines to research and development laboratories. One of Boeing's requirements for completion of the Welliver Program was to write an individual report on my experiences. For Boeing, the individual report was a great opportunity to have a "fresh" set of eyes looking at how the organization and the Welliver program operate. For me, the experiences gained greatly enhanced my teaching at Baylor University. The individual report was written in the final week and presented to key personnel of the Boeing administration at the end of the summer program. This paper will chronicle my experiences with the Welliver Program; the application process, selection and paperwork, orientation week, site visits, and closing week.

Application Process

I first learned about the Welliver Program through two research grant tracking sites, Refworks-COS⁷ and SPIN Matching and Retrieval Service (SMARTS)⁸. These search engines send a daily e-mail listing possible grants that match keywords placed on file by the user at each location. Aerospace, aeronautics, and aircraft are some of the search words I use. The Welliver application comes out in early fall and, since there is always a need for summer employment, this particular listing was of interest. Subsequently, advertisements for the Welliver Program were also seen in the professional journals, particularly Aerospace America published by AIAA and the ASEE publication, PRISM.

The e-mail which I received highlighting the Welliver Faculty Fellowship Program outlined what sounded like a perfect match for my aeronautical skills and interests. The criteria for selection Welliver selection follows⁶:

1. All participants (U.S. and international) are required to have five to fifteen years of full-time teaching experience, and be **currently teaching undergraduates**.
2. Ability to get the complete application package in before/by the deadline (application, curriculum vita, recommendation letters no more than 20 pages in all).
3. Motivation to improve teaching and student learning.
4. Motivation to acquire a better understanding of the practice of engineering, manufacturing, business, and information technology in industry and champion undergraduate curricula improvement.
5. Abilities and qualifications that align to Boeing needs.

An obvious emphasis is teaching undergraduate students in areas of interest to Boeing. After exploring the website, I decided to call Trina Medley, Program Manager listed on the website, to get some clarification on the program and selection criteria. Trina and others in University Relations at Boeing are extremely busy so e-mail became the more preferred method of communication as these individuals are often traveling. My main concern with the application process was that I might be ineligible because of the listed target requirement of

five to fifteen years of full-time teaching experience. I personally had 18 years of teaching at the time, which was past the target age/experience group. Trina was very supportive and encouraged me to apply for the program anyway. According to Trina, my qualifications, Airline Transport Pilot rating and experience teaching undergraduate fluids/thermo topics (to include aeronautics and aircraft propulsion systems), made me competitive. An application and telephone interview were required. It turns out I was not “too old” to learn what Boeing had to offer.

The application process was straightforward from the website. It required a form to be filled out with an attached CV. A 20 page limit makes the process a challenge but it is not unlike any other grant application. Two requirements could cause challenges. First, the application is due during the Christmas Break which means this process competes with other activities of during holidays. Second, letters of recommendation are necessary from both the Dean/Chair and from a student. Again, if these are not coordinated prior to the Christmas Break it will be difficult to arrange otherwise. After applying, it is approximately a two month wait to find the final determination of the application. This is a somewhat lengthy wait as summer employment plans need to be made. Should an applicant not be selected for the current year, they are encouraged to apply the following year. Several 2009 Fellows had applied for a second time.

In the application, the applicant is required to pick a first and second choice for locations to visit. This implies that each applicant only gets to visit one place on the Welliver Fellowship. The reality is that at least one selected professor visited three locations this past summer. This section of the application needs further clarification on what the Welliver Program expects for future Welliver Fellows (i.e. only visit one site or that multiple visits are possible). For someone who is not as familiar with the different Boeing locations, access to a Boeing web address (more than available to the general public) should be provided to allow applicants more informed descriptions of the Boeing locations. Unfortunately, the external website was organized functionally and not geographically making it difficult to rank the first and second choices. The selection is necessary because Boeing people match applicants with Boeing experts in appropriate fields when possible.

For last summer, approximately 80 applications were received and nine faculty selected. Faculty came from both domestic and international academic institutions, large state schools and small private schools, and a variety of disciplines. There were traditional aerospace engineering faculty in disciplines that you would expect at Boeing, such as aeronautical, mechanical and electrical engineering, however, there were also other disciplines represented, such as systems engineering. Part of the strength of the program for me was to see the “non-traditional” disciplines at Boeing and their importance to the organization. Boeing would do well to advertise this fellowship to a broader audience to attract a stronger variety of disciplines. A possibility is a mass mailing to targeted schools that would support the undergraduate emphasis in these desired areas. It is my opinion that the application process should start earlier in the fall semester with a timeline of selection by Thanksgiving. This would be a very ambitious timeline given the limited number of personnel administering the program. These are highly qualified individuals with a vision for the program, some of whom are volunteers from operational divisions in Boeing. They do an extremely professional job with the resources at hand.

Post-Selection Planning

Once selected, there was the usual paperwork required by Boeing for release, six or seven documents in all. These eventually allowed each fellow to receive Boeing ID cards which were critical to the success of the program. Boeing does support the Fellow with a per diem. A per diem was to be paid for living at the chosen location, however the amount was not clear until the site locations were known and the paperwork processed. Using the per diem, each fellow was responsible for arranging plane reservations, car rental, lodging, and food for their six week site visits. The money received for per diem was sufficient to cover expenses for the six weeks but it meant being careful in selection of a hotel or rental car company. Not being familiar with my site location, the chosen Boeing mentor was a big help. Suggestions have been made to pair the newly selected Fellows with a Fellow that visited the site during the previous year. Since Welliver Fellows have been visiting sites, such as Seattle, for several years, a suggestion was made to develop a list of acceptable living places that people have used in the past. Other helpful information, such as the exorbitant cost of the rental cars from the Seattle airport, could be communicated prior to making reservations.

The Mentors and their relationship to the Fellows is a key component to the success of the program. This relationship needs to be established prior to arrival on site. Phone calls and e-mail well ahead of time are a must to ensure success. Thus, goals for the summer are set out ahead of time as well as arrangements for visits to key organizations on site. The Welliver Fellows have a unique opportunity to see Boeing from a perspective that not even Boeing employees get to see. For this reason, prior planning is absolutely essential to maximize the effective use of time during the summer. Eight weeks seems like a long time however, it goes by very quickly. The more involved the Mentor is with the planning process the better.

Kickoff Week

The Kickoff Week was accomplished at the Boeing Leadership Center outside of St Louis. This facility is dedicated to leadership training for Boeing employees. Its “country-club” atmosphere isolates residents from the outside influences and allows the participants to focus on the training at hand. The accommodations are second to none in both rooms and cuisine. The dress is business casual which sets the tone for the week, relaxed yet professional. This week was pivotal to the Welliver Program as it allowed the Fellows to meet and develop the necessary team spirit for required team research projects. During this week the Boeing staff had icebreaker exercises to help the Fellows learn about each other, informational presentations on topics such as the Welliver Heritage, Boeing organizations, and Boeing’s university affiliations. Administrative procedures such as the Boeing ID card and being issued a Boeing laptop computer were also accomplished. Field trips were taken to the Boeing St. Louis site and to a Cardinals baseball game. The week was entirely too short but the goal was accomplished. All Fellows felt “connected” and equipped to take the next step in the process, site visits.

In all, the kick-off week was a fantastic success. Having the orientation at the Boeing Leadership Center was the perfect location. It was very professional. The presentations gave insight into Boeing and provided much needed information on the different organizations. A meeting with the Boeing Technical Fellows at the St. Louis site was particularly useful. The night at Busch Stadium attending the baseball game was memorable. I feel that I got to know

the other Welliver fellows well during the orientation week. Working together, eating together, and playing together gave us an opportunity to develop a connection. I looked forward to meeting with the other Fellows weekly for lunch or dinner on site in Seattle. The only criticism of the Kickoff week was that the level of planned activities did not leave enough time for the new fellows to interact with each other informally.

Site Visits

The site visits were the heart and soul of the Welliver Program. My mentor was part of the Boeing Research and Development branch at the Developmental Center (DC) in Seattle. This was an excellent match for my mechanical engineering skills as I actually was able to work with a Boeing engineer on an actual engineering research project during part of my stay in Seattle. Because my Mentor was assigned somewhat late in the process due to unforeseen circumstances, little was done to pre-arrange visits to other sites in the Seattle area. To help with visits, each week the Boeing Welliver Administrative Staff arranged a visit to a major facility for all Welliver Fellows in the Seattle area followed by either lunch or dinner. During this time we traded notes on how our experiences were going and helped each other with suggestions for future visits. These weekly visits had to be arranged well in advance as driving between Seattle sites (i.e. DC, Everett, Seattle, and Renton) can take as long as an hour and a half due to the Seattle traffic. I spent the first week of my site visit planning what Boeing areas might be of interest to visit. Most of the time I was successful with arranging visits. I eventually found that with a Boeing ID card and a parking pass I could get into most any facility. Boeing employees whom I called to arrange visits were at first unfamiliar with the Welliver program but, after explaining the program, they were most helpful and accommodating. Again, it is a matter of information, or lack of it, that kept me from visiting many other places. Figure 2 shows a partial list of the Seattle locations I visited. In spite of the Boeing ID card and being considered a Boeing employee for the summer, I had many questions that could not be answered by Boeing. This is not unusual for a large organization. Either I did not have a “need to know” or things were “Boeing Proprietary”. Sometimes sensitive topics were discussed on occasion with the understanding that this information would not be repeated outside of Boeing. Thus, it was possible learn some interesting information about many facets of Boeing and its operation, however, much of this information could not be used at Baylor in courses or repeated to students. This protection of intellectual property was necessary for Boeing.

My mentor was a great individual and we developed a relationship through his research. We wrote a research manufacturing procedure for one of the experiments with which he was involved. Over the course of the six weeks, my mentor and I discussed four possible collaboration topics for future research using technologies developed by his research group. These topics are still under consideration.

The group assignment for my team of Welliver Fellows was to examine the state of the engineering pipeline and offer advice to Boeing on how to become an integral element in the cultivation and development of emerging engineering talent. This group topic was chosen from a list of topics presented by the Boeing administration. The approach chosen by the Welliver group was to first identify the key characteristics of an engineer, next to examine the current state of the STEM education pipeline and Boeing’s interaction with it, and finally to present

recommendations to Boeing based on critical analysis. Results were gleaned from data gathered through interviews conducted with early career engineers and supervisors at Boeing, during the Welliver experience. This information gathering also competed during the site visits. The final report was written and delivered during the final week of the program.⁹

- Renton Assembly Line
- Swarm
- Smart Memory Metals
- Synthetic Jets
- Service Engineering
- 787 Thermal Analysis
- Configuration and Analysis
- Biofuels
- Engine Performance Cycle Analysis
- Propulsion Technology
- Advanced System
- New Airplane Product Development
- Boeing Gallery
- Customer Service Center
- 787 Wing Design
- Flight Test
- Transonic Wind Tunnel
- Museum of Flight
- Museum Archives
- Nacelles
- Engine Installation Thermal and Cooling
- Platform Performance Technology
- Environmental Control Systems
- CFD in BCA
- Meetings with managers
- Meetings with new hires
- Unmanned Airborne System
- Everett Assembly Line

Figure 2 Locations Visited in Seattle

Highlights

One of my favorite experiences was flying the C-17 simulator in St. Louis. All the fellows had an opportunity to do this activity. The Everett and Renton Factory tours really demonstrated Boeing's core aircraft manufacturing business. Renton makes anyone who sees the before and after pictures of the assembly lines a believer in Lean+. I also enjoyed the Boeing Gallery showing the new interior of the 787. Likewise, the Customer Service Center showing the other interiors was also very informative. One of the most informative times I spent was with the 787 Thermal Analysis Group. I visited them twice and the second time toured the 787 from a thermal perspective. Discussion on environmental considerations and biofuels with a Boeing expert was very interesting and very enlightening. I enjoyed my discussions with those in the management chain about hiring and Boeing operations in general. People were extremely honest and I feel I have a good understanding of Boeing procedures. Other highlights were visiting the Museum of Flight, Heritage Flight Collection, and the Air Park at Fort Lewis. I took over a 1000 pictures of airplanes and their features for use in my courses.

Recreation in Seattle

Six weeks in the Seattle area are more than enough to learn about the area. Weekends were free to explore places such as Mt Rainer, Mt Saint Helens, Whidbey Island, and Downtown Seattle. There are also many tours such as whale watching, and of course, many air museums, such as the Museum of Flight. Weekends are an excellent time to spend with other Welliver Fellows or with the Mentor.

Closing Week

The final week of the program was conducted at the Boeing Leadership Center. Now familiar with the Center, it was an excellent time to finish both the individual and group reports, the deliverables to complete the Welliver Faculty Fellowship. Writing these reports occupied a majority of the time, both scheduled and “free.” Having so much writing in the last week detracted from the enjoyment of the Center but the writing needed to be done. Both individual and group reports were presented to Boeing administration, some being present in the room and other through a web connection. It was an excellent opportunity to discuss things learned over the summer. Again, outside observers, such as the Welliver Fellows, are an excellent way to gain insights into company operations. Some of my observations given during my individual presentation are below:

1. I am not used to cubicles and they seemed noisy. I found them distracting however those around me did not.
2. Boeing is such a large company that it is difficult to share information groups. I observed that a lot of interesting technologies were being developed in my functional area and it was not clear to me the mechanism to make the technologies known to the rest of Boeing. Technologies could exist that would solve many challenges but people may be unaware of the technology’s existence.
3. Flex time and working at home are nice options for employees. This shows trust in the employee on the part of the company to get the job done. Good managers are ones that let people do their job with a minimum of interference. Communication is key.
4. The casual nature of dress in the workplace was somewhat unusual for me but is becoming the standard in many industries. This points out the need to understand the “culture” of a business.
5. Boeing employees spend a lot of time in meetings. The use of the web tool is an excellent way to involve people from off-site however; it means that many more individuals can be involved in the dialogue. People must guard their time and not attend meetings unnecessarily.
6. Boeing is a leader in Lean+ innovation. Boeing is undergoing an education process on Lean+ for its employees. Boeing would like to apply lean principles in areas other than the assembly line.
7. Boeing is faced with the same workforce issues that other aerospace companies are seeing, an aging workforce and possible age gaps in technical expertise. Boeing is working on ways for technology to transfer from senior, experienced people to the new employees. More effort should be given to this important topic.

Teaching Style/Curriculum Adjustments/Other Applications

The obvious application from this summer program is that I have more experiences to incorporate into the classroom. This past fall I taught Introduction to Aeronautics and was able to directly apply in the classroom what I learned over the summer to give a more complete educational experience. I am already looking to incorporate more of the pictures of aircraft design features taken in museums into my aeronautics class. The class is taught from a design perspective and the time I spent with Boeing engineers was invaluable. Boeing should consider

having instructional materials for release to the Fellows that are approved for use in the classroom. This would be mainly photographs and video clips to enhance subjects important to Boeing.

Most engineering programs do not talk about topics such as the global market or lean engineering. This needs more emphasis in any engineering curriculum. Boeing is a global company typical of what is happening in the business world today. Concepts such as “Lean Engineering” need more emphasis in the engineering classroom. I also think that university programs need to do more to develop the modeling skills of their students, such as CFD projects with sensitivity studies. I consistently saw engineers doing trade studies to find the “sweet spot”. Often design projects at the university level stop when an answer is found. This may not be the best answer depending on constraints.

There are always many technical challenges to be solved highlighting the need for continued research. University partnerships with companies such as Boeing can lead to a win-win situation for all involved. Boeing might consider broaden their targeted universities to allow for additional involvement by other schools, especially schools represented by the Welliver Fellows.

Conclusions

The Boeing Welliver Faculty Fellowship Program is an outstanding opportunity for faculty of any age to renew connections with the engineering profession. The window of insight that results from participation in this program will have a lasting impact on my teaching for years to come. I enjoy reading the trade journals to continue to learn about the Boeing Company. My experience with Boeing this summer helps me understand the company in a new light. I now have a greater credibility in the classroom and can better advise my students on aerospace opportunities since I have recent aerospace experience. The Welliver Program is one that I can recommend to other faculty. If I could only experience the program again knowing what I know now...

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