Developing WEB-based tools for a General-Education course in Aerospace

Scott Eberhardt
Dept. of Aeronautics and Astronautics, University of Washington

Abstract

WEB-based tools have been introduced into a general education engineering class. This paper outlines some of the tools used and shows how they impact student learning. Students were surveyed about specific tools and over 92% made use of the tools and 70% claimed that the tools helped them learn. Comments are included from both student and faculty perspectives, and include a discussion of barriers in using WEB resources.

Introduction

Air and Space Vehicles, AA101, was introduced by the Department of Aeronautics and Astronautics, at the University of Washington, in the fall of 1997. The course is designed for non-engineering/science students and can be used to fulfill a University graduation requirement. The course is extremely popular, filling all 160 seats in the auditorium all three offerings each year. This paper will discuss the development of web-based tools used to facilitate teaching to this large group of students.

The basic structure of AA101: Air and Space Vehicles was described in the ASEE *Journal of Engineering Education*, Jan. 2000[1]. In summary, the course is a 5-credit course consisting of four lecture hours a week and a two-hour lab section. Hands-on labs are designed to re-enforce concepts and expose students to a cooperative laboratory environment. Student groups participate in two conceptual design projects, one a flight vehicle, the other a space mission. Multi-media presentations provide the framework for the concepts. To attract the widest range of students possible, analysis has been eliminated in favor of conceptual understanding.

AA101 has always made use of the web for providing information. In the past, the web page was static. The AA101 web page has now transitioned to a dynamic resource where students can interactively determine such things as how range or speed affects aircraft weight. They can interact with a visualization tool to understand simple controls. Students can participate in discussion groups. And, students take weekly on-line tests used for feedback.

Motivation for enhancing the web page comes from recognition of different learning styles. In her book, “They’re not Dumb, They’re Different,” Sheila Tobias[2] describes how a variety of students, who are turned off by science, can do well in science courses, given the right learning environment. An interactive web page is only one element in

multi-faceted learning environment but may be the element that appeals most to a certain cross-section of students.

WEB page enhancements

This year several changes have been made to the AA101 web page to increase interactivity. Tools include interactive 3D models, estimators and on-line quizzes.

An interactive web tool, developed by *Pulse*[3], is used to allow students to learn how airplane controls work. The utility uses a 3D model of a "stick figure" airplane with moving control surfaces. The student can rotate the model to any view and then select pre-programmed controls for pitch, roll and yaw.

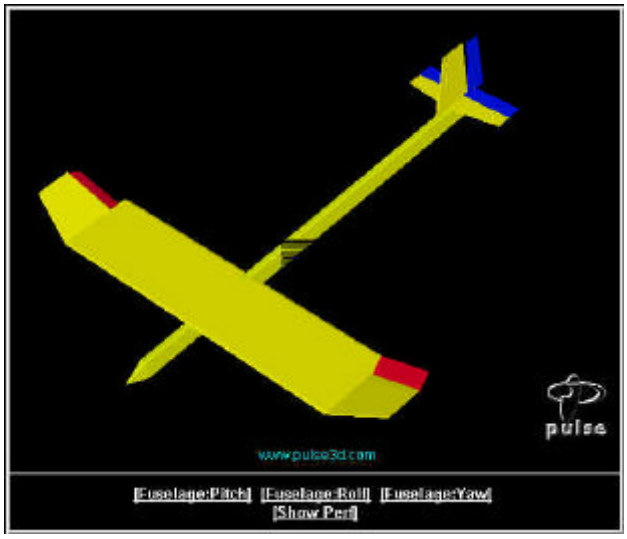

Figure 1: 3D interactive model of stick figure airplane

The advantage of this tool is that students, who are unfamiliar with the basic control surfaces and responses of a basic airplane, can explore the controls on their own. The stick figure airplane is similar to one that the students build in a lab, so they can understand ahead of time how to configure the control surfaces for turns, etc.

Students work in teams on a conceptual airplane design projects. In the past, these designs dealt more with marketing and knowledge of similar designs. Students are warned to make their designs realistic, but have very little experience to know what is realistic. This put an extra burden on the instructor and TA's to help with each project. Web-based tools were introduced to overcome some of this problem.

Tools such as the weight estimator give students the ability to add "real numbers" to their design projects. The airplane design project requires information, such as weight and cost. In the past, it was up to the student to determine these with no analytical tools. Students had to research equivalent airplanes. In the current situation students still must research similar airplanes, but they can view tradeoffs of performance and weight. Below is a screen shot of the "Weight Estimator".

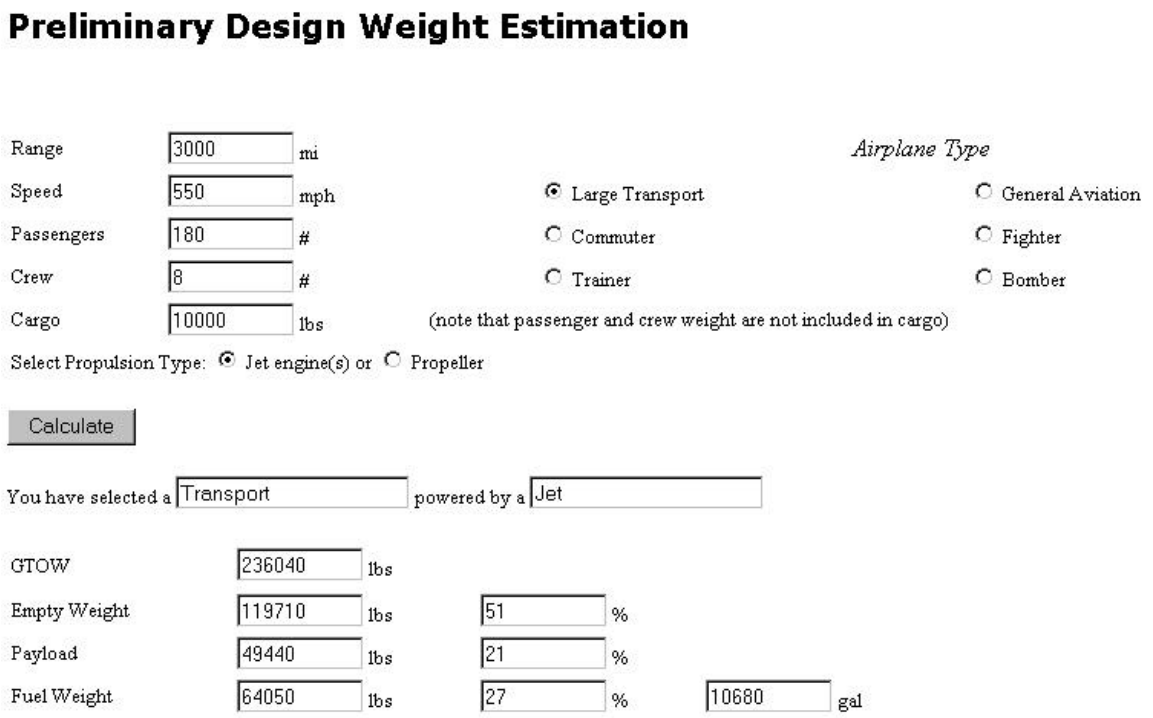

Figure 2: Example of weight estimator tool

Other tools compute wing area and stall speed, and, for more advanced purposes, coefficients of lift, drag and the lift-curve slope. These tools are very simplistic, but they give reasonable estimates for the students.

The University of Washington has a program, known as Catalyst[4], which provides useful tools for faculty. There is a discussion group utility, anonymous e-mail, listserv, and survey utilities. Currently, the discussion group, anonymous e-mail and survey utilities are used. The survey utility has been adapted to provide on-line "feedback tests" to the students. Originally, the on-line test was to be a competency exam but the current version of the tool does not provide feedback to the students. The Catalyst program plans to provide this in the future, but for now the use of the tool is limited (it is felt that without interactive feedback the competency exam had to be downgraded to merely a feedback tool).

Results obtained from a recent "feedback tool" are shown below

Question 5: Which are Newton's laws (select all that apply)		
Answer	**Number of responses**	**Percentages**
Action/reaction	94	98.95%
Orbits sweep equal distance in equal times	3	3.16%
A body remains at rest or straight line motion, unless an external force is applied	93	97.89%
The thrust of a rocket is the amount of mass ejected times the velocity of that mass	77	81.05%
If anything can go wrong, it will	1	1.05%
the energy of a mass is it's mass times the speed of light squared	5	5.26%

Figure 3: Typical results from survey tool

Note that the survey used in this paper was accomplished using this tool.

A major flaw is that individual statistics, such as who took the test, are hard to obtain so taking the exam cannot be required. Other utilities exist which can perform the required tasks for an on-line exam (for example WWWAssign[5]), but they are not supported on our University's Computers. This is supposed to change with a future release of the Catalyst tool.

Finally, links were provided to public domain tools, such as NASA's rocket engine calculators, for a group space mission project and homework.

Results of student survey

Students were polled to determine the use of the tools and whether they contributed to learning. Of the 160 students enrolled in the course, 107 responded to this optional survey, a 67% response. Students were asked how many times a week they used the web for AA101 and how much they specifically used the tools and whether they helped learning. The results are shown in the graphs below:

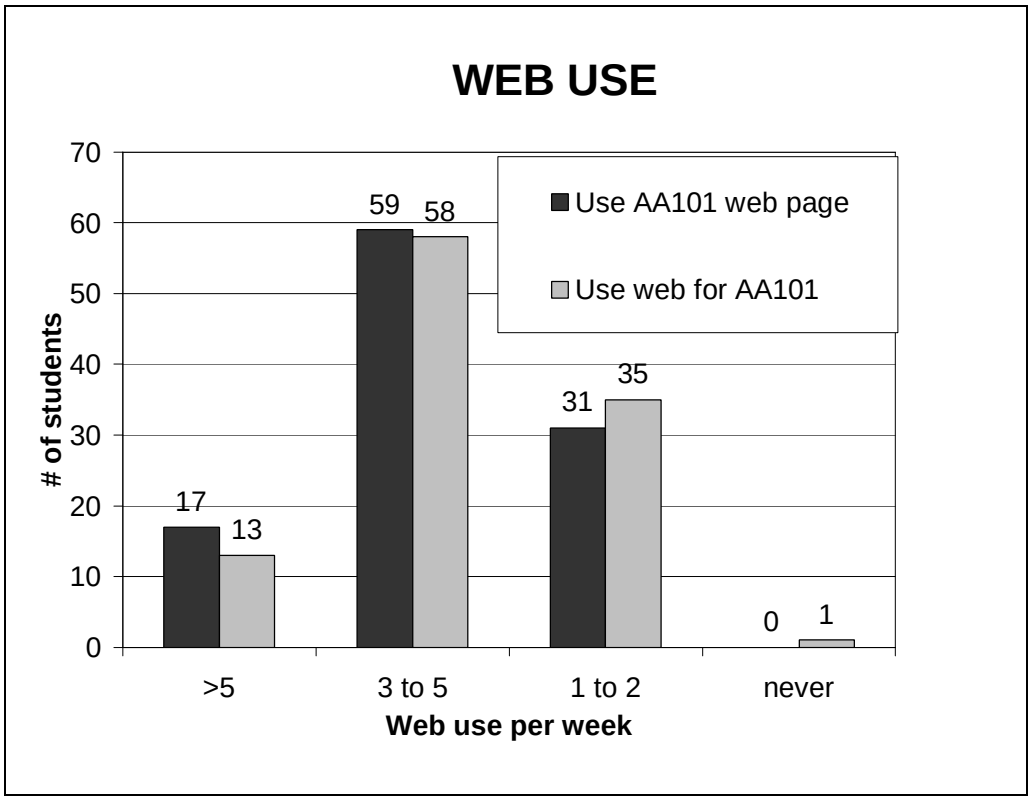

Figure 4: Summary of web use

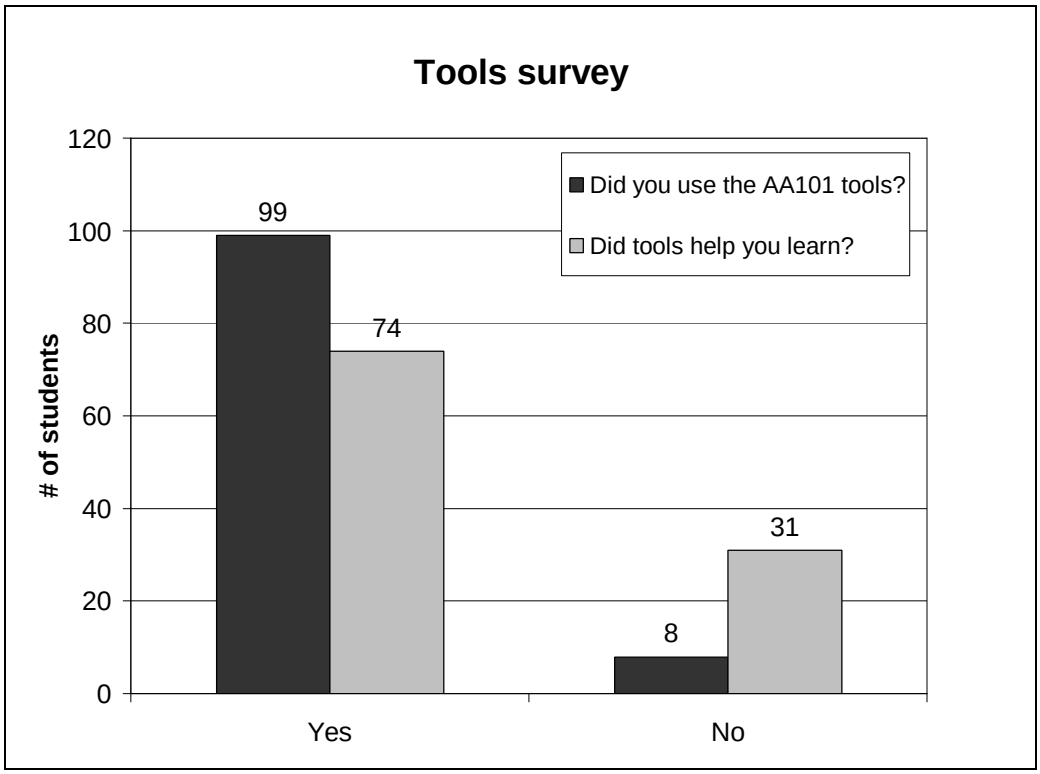

Figure 5: Summary of tool use.

Students were asked, on the survey, how they found the tools useful, what helped them learn and any other comments. There was an overwhelming response indicating that the course web site made locating information simple. Many students said that by having a web site with all the course information, tools and links saved them time. In addition to this response, some selected quotes follow:

How did you find the tools useful?

They gave concrete data about things we talked about in class. I could also see the correlation and effect of one factor on another.

The tools are simple to use and gives us an idea of the estimates of the many calculations involved in this subject. Not only does it eliminate the actual calculating it also enables us to appreciate the many fields of input needed. And the output that the inputs result in.

They allowed me to understand of things (such as lauch vehicle cost) that I would otherwise not know where to begin interpreting.

They showed how certain things on planes and spacecraft relate to different aspects of the vehicle.

Some of them were neat- like the one that showed how elevators and aelorons worked. Others were just necessary to complete the homework assignments.

I could explore different values of how different characteristics affected flight.

I was interesting to see how certain figures and variables would change the results of the various tools.

it helped mt to understand the weights and loads on the wings of an airplane, and especially helped on the design project.

they helped in our application of such tools, but their use prevents us from learning the calculations involved

I said no because the only time I used it was for homework and only then did I enter data, just so I could get an answer.

Were there any other aspects of the AA101 web site that helped with your learning?

Helpful!!!

the links to other sites.sometimes it is hard to find good websites, but those links were very helpful with getting me started on the right track.

Yes, the lecture notes and the links help. And the discussion group is particularly useful if you have a question to ask but think it may be dumb to ask or that it's not really relavant.

I liked the e-post part where you could e-mail the whole class. And being able to get the homework off the web page and then the answers was nice, especially the way it was laid out on the page, very organized and easy to follow.

The weekly surveys, it kept me up with the information given to the class.

The website is very user-friendly and I had appreciated all the links to other sites which helped me learn more about things we discussed in class.

The feedback surveys actually helped because it let me know where my learning ability was in the class and whether I needed to study one subject more then the other.

The Discussion Group, annoucements, homework postings. In particular, homework posted online was a reliable and single source of info. We did not have to speculate or guess as to our assignment. The Feedback surveys also helped in keeping us accountable and checking to make sure we were processign the class lecture info.

i liked how the class was web-based. the lecture notes, homework, annoucencemnts. everything was on the web, so if you missed something it was useful to just check the web

Please add any comments you might have relating to the AA101 web site.

Definitely one of the most useful class webpages I've used so far.

The competecy exams were helpful

It is a good website. Without it, I could do my homework or even find out about the homework.

It provided many useful things in helping me learn about 'Air and Space Vehicles.'

I thought that it was a really good web page. It provided a lot of information. And i liked the likes to other web pages part, that saved me a lot of research time.

very worth-while tool to enhance the class

Perhaps incorporate it more. You should but news articles and historical facts up on the web and make the students interact with them some more.

I felt that even though everything is on the web, that you should still consistently remind students at the beginning of every week, that the website has been updated and there is HW posted up and little stuff like that. Other than that, the web site is great!

The website is well developed. Perhaps a link to a useful Search Engine such as GOOGLE or some other Search Engine might help.

Obstacles

Unfortunately, developing an interactive web page has its obstacles. Some of these can be overcome, but some are deeply embedded in server maintenance issues, primarily security.

A Java program to create a workspace area for design projects was started, but security and support issues have prevented it from being available. The workspace area included the estimation tools, whose data would be saved in reserved group space. Unfortunately, security problems exist because of the necessity to read and write files. This author is not well versed in methods of computer hacking and so does not know how to protect against it. The second issue of support is a local problem. Our computer system manager is

over-extended and cannot manage the burden of additional 160 students, each quarter, requiring user account maintenance.

Another issue is obtaining quality development tools. Software licensing is an expense that is difficult for a small department to justify. There are some sophisticated tools available, but licenses are prohibitive when the budget for such items is zero.

Finally, in order to produce an interactive web page, it is up to the faculty to pursue the development. This may be construed to be in conflict with the roll of a faculty member in an aerospace department. Specialty offices that perform such services charge for those services. But, as in the software budget, there is no money given to departments to support professional web development.

Conclusions

The introduction of new web based tools is in "Air and Space Vehicles" are helping most of the students learn. A variety of tools were implemented autumn quarter, 2001, and have shown to have a positive impact. The overwhelming feeling among the students was that the web site as a whole was a great source of information that made learning easier. Some students pointed to the models, estimators and posting tools to be particularly effective.

Building a course-specific web site is a big, but fun, challenge. Judging from student feedback in "Air and Space Vehicles", it appears to be a worthwhile challenge.

Bibliography

1. Eberhardt, S., "Airplanes for Everyone: A General Education Course for Non-Engineers," **Journal of Engineering Education**, Jan. 2000, pp. 17-20.
2. Tobias, S., *They're Not Dumb, They're Different: Stalking the Second Tier*, Research Corporation, Tucson, AZ, 1990.
3. Pulse3D, http://www.pulse3d.com/index.asp, Pulse | 654 Mission Street | San Francisco, CA 94105, Copyright 2001 Pulse, all rights reserved
4. Catalyst, http://catalyst.washington.edu/home.html, University of Washington, 2000.
5. WWWAssign, Dr. Larry Martin, http://www.admin.northpark.edu/lmartin/WWWAssign/, North Park University
   Chicago, IL, 1997

Biography

SCOTT EBERHARDT

Assoc. Prof. Scott Eberhardt has been at the University of Washington since 1986. After completing his Ph.D. at Stanford University in 1985, Prof. Eberhardt spent two years as a Research Engineer at NASA Ames Research Center. Prof. Eberhardt holds a B.S. and M.S. in Aeronautics and Astronautics from MIT.