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A Case Study on Advancing Learning in An Upper-Level Engineering Course

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Abstract

A case study is condensed from the evolving experience of advancing learning in complex senior-level engineering courses. An advanced high speed aerodynamics course is set in curricular context and described. The need and approach to advance the depth of comprehension and the capabilities of our students are presented, followed by the approach taken, and data on student performance over the past two years. The portfolio of student confirms the excellence demonstrated in tests. However, the end-of semester course evaluation and the present administrative processes project a negative attitude and severe impediments to implementing advancing learning. Pointed comments from the better-performing students reveal intense frustration with the perceived dilution of work ethic and degree requirements, and cites the damage being done to institutions, the industry and the morale of the best students by such practices. The innovative aspects of the course aimed to advance learning are tabulated with their benefits to the learners, and the risks.

Background

What follows is a Case Study, in order to lay out the realities in depth, and help guide progress. The multiple decades of the instructor's experience, the institution has risen to become demonstrably one of the best and best-regarded in the world, privileged to recruit stellar students, but also to have the joy of providing opportunity and ascent paths for many. Several course numbers are used to distinguish various courses, but these may or may not be the precise course numbers at any given institution. The aerospace engineering curriculum in the school where the high speed aerodynamics course is studied, has the mission of preparing engineers as follows[1]: *"At the Bachelors level, our graduates will have the necessary understanding of aerodynamics, structures, vehicle dynamics and control, propulsion, and*

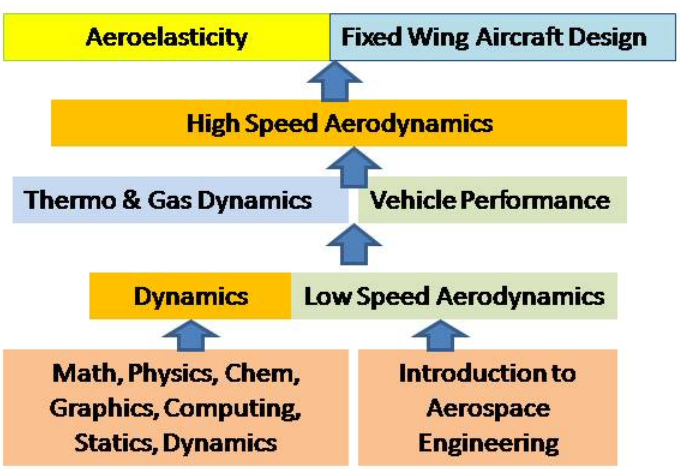

Figure 1: Role of AE3xxx in the curriculum

interdisciplinary design to be well prepared for careers in aerospace and related engineering fields. They will be well-trained to function as professionals who can formulate, analyze and solve problems that may include economic, social and environmental constraints. And finally, they will be prepared to communicate well, function well in the global environment and in teams, and be life-long learners, as required to contribute substantially by doing research, developing, and implementing future systems and applications."

As shown in Figure 1, AE3021, the 3-semester credit course on High Speed Aerodynamics, is the culmination of the fluid dynamics, gas dynamics and aerodynamics curricular stream towards a Bachelor's degree in Aerospace Engineering. This course serves as prerequisite to two final-year core courses: Aeroelasticity, and the 4-credit final semester course in Aircraft Design. These last 2 courses are at extremes of depth versus breadth. Aeroelasticity demands mathematical and numerical insights and delving into basic theory. Aircraft Design, as the final course in the Capstone design track, spends little time on theory but applies results from high speed aerodynamics. Thus AE3xxx must serve to integrate the knowledge gained from the entire fluid dynamics sequence, and prepare students to apply both depth and breadth. The basic content of AE3021 is distilled from the content of over 8 credit hours of engineering science content from the Quarter system that existed in the mid-1980s. To this, substantial content was added, pressed both from the lower level courses and from the aeroelasticity and design requirements. Some specifics follow:

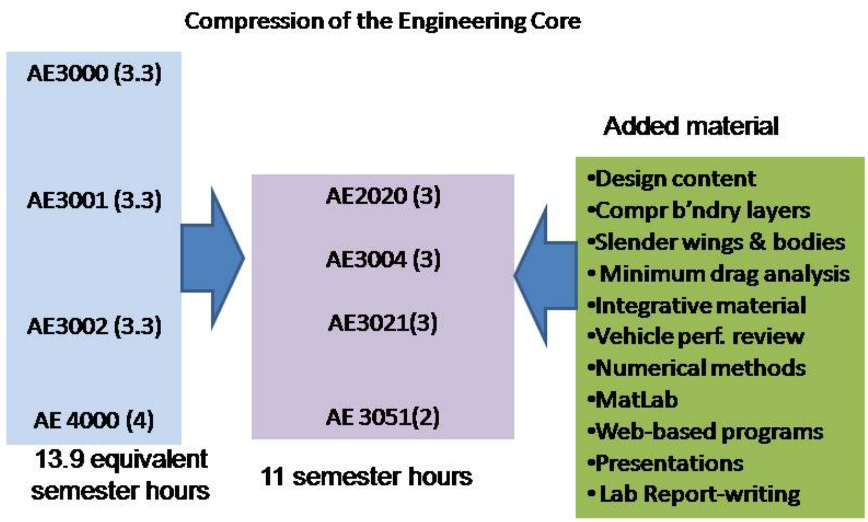

Figure 2: Compression of the Fluids/Aerodynamics curriculum

1. As the curriculum was compressed, the time available to teach the basics of fluids and aerodynamics shrank from 20 quarter-credit hours spread over 4 courses with built-in lab experiences (13.9 semester hours), down to 11 semester hours over 4 courses including 2 hours of laboratory instruction. One of those lab hours was for propulsion/combustion.
2. Personal computers allowed use of numerical techniques in classes in the 1990s.
3. In the 2000s, various applets and on-line calculators from schools around the world helped students obtain real-world experience, both of using applications and terminology from around the world, and dealing with uncertainty when different codes gave different results.

Two other developments claimed an increasing share of instruction time.

1. Worried by the blank stares of students when we tried to extend concepts, a substantial introduction section was added, to review results and concepts from low speed fluid dynamics, aerodynamics and gas dynamics and introduction to aerospace engineering.

2. Means to improve class participation and experiential learning were required. Unlike in the former curriculum, the flexibility of the new one and its keepers enabled many students to defer the 2-hour laboratory course until after their last semester, beyond AE3021. The practical experience of dealing with actual flowfields could no longer be assumed.

Relation to Global Realities

High speed aerodynamics uses classical theory developed since the 19th century, along with modern applications, applied methods developed in the 1940 – 60s, and numerical techniques. It is fundamental to the development of airliners and military aircraft, space launchers, re-entry vehicles, meteors and missiles, as well as to textile technology as in manufacturing the fabric for diapers. It is a topic of worldwide interest and intense competition[2,3], although the pool of qualified people is quite small. Innovation is key to our industry, and our focus here is to develop the capability of our graduates to innovate[4,5] in a field that requires depth and intense comprehension. The applied mathematicians and aerospace engineers who led the remarkable advances in high speed designs in the latter half of the 20th century are either retired or nearing retirement. Transferring their knowledge base to the upcoming generation is a concern[6], because the recipient must have the preparation and discipline needed to grasp the knowledge. This puts the onus teachers to ensure that candidates aspiring to jobs in the leading aerospace establishments have firm basic knowledge and personal discipline in this core area.

Summary of Approaches

The approaches of different instructors has varied, over and within the years and sections. In one or two sections, the apparent strategy used was (judging from the history of near-100% A-grade achievement in those sections) to bring the level of the course down as need to win the most happiness from the students. In another, the practice was to simply cover the theory and give homework problems such as those from the latest edition of the textbook (to which the students had solutions). This avoided surprising the students, but ignored opportunities to achieve any gains enabled by modern capabilities, beyond the textbook.

In the sections traced in this paper, the course evolved with each teaching since 1985. The notes were keyed to specific textbook chapters for extra reading. The primary learning resource was the course notes, which were condensed from the thick binders of our chalkboard past, to sets of PowerPoint slides for each section. These notes were uploaded to the course website prior to the start of the course, and then updated after teaching each section, based on errors corrected or new ways of explaining identified. The same notes, perhaps one semester of iteration lagging, were placed for access by all students, on our EXTROVERT project website[7], linked to similar notes for several disciplines and courses, as well as solved problems, engineering tools and other resources. In particular, this enabled students to access the notes for all the pre-requisite courses, so that the excuse of not being able to find material taught in prior courses, was removed. In the Fall of 2011, the notes were also built into an e-Book format, for students to download at no additional cost. Similar eBooks for the Introduction course and for Low Speed Aerodynamics were also provided. Unlike notes on the course website (which are in files containing one section each) or web-based notes (which are available at random, but placed in sequential order), the eBooks allow students to download the entire course to their laptop computers or smartphones, and search at random through the whole course for specific concepts. Thus they are of special value when doing integrative or review assignments.

Assessment Bases

Formative assessments in the first part of the semester included several homework assignments. Past mid-semester, the class was given a large open-ended assignment that served to integrate the theory and prepare the students to do aerodynamic design. Since the switch to the semester system in 2000, this assignment, done in teams of two, has been to select two high-speed airplanes, and use aerodynamic analysis to determine their lift to drag ratio at a subsonic cruise condition and a supersonic dash (or cruise if possible) condition. The weight at each condition (and hence the lift) was to be estimated from performance estimates of the aircraft given in the literature, and the drag was to be calculated using the methods of aerodynamics. Aspect ratio effects in subsonic flight, estimates of profile drag from airfoil data, and estimates of shock drag and pressure drag in supersonic flight, were developed. The skin friction drag was estimated using strip theory methods for laminar and turbulent boundary layers, for both incompressible and compressible boundary layers. Students were able, over the years, to refine these calculations to obtain very good estimates of aircraft limiting speed and ceiling.

Table 1: Course Outline

No.	Topic
1	Results from Low speed aerodynamics and Gas Dynamics
2	Review of conservation equations
3	Full Potential Equation and linearized forms
4	Subsonic Similarity
5	Airfoils in Supersonic Flow
6	Nonlinear techniques for supersonic flows
7	Wings and Bodies in Compressible Flow
8	Transonic aerodynamics
9	Review of boundary layer theory
10	Laminar boundary layers
11	Transition to turbulence; Turbulent Boundary Layers
12	Effects of compressibility in boundary layers
13	Integrative problems: Introduction to Hypersonic Aerodynamics

This practice enabled several students to pull far ahead of the average performance – and hence drove the average expectation up a little each year. To recognize this wide spread in performance, the instructor started the practice, similar to that reported in a recent ASEE paper[8] of awarding as much as 20 percent bonus points. Thus the top 10 percent or so of the class typically had over a 100 percent average before the final exam. Since grades higher than an A which only requires a 90 percent average, cannot be awarded, their reward was to be exempted from taking the final examination. Thus these students were free to concentrate on the other courses. This scheme also allowed the weaker students to pass the course, provided they reached acceptable absolute levels of performance.

Problem Statement

The problem discussed in this paper is as follows. The requirement stated by senior aerospace engineers in industry is for graduates with the depth to enable knowledge transfer, and to develop the next generation of innovations. In sharp contrast, the modern cohort appears to be increasingly resistant to the idea that they must become conversant in the logic of engineering, a.k.a. "derivations". The pressures from institutional administrators resonate with the whining from the least interested students, to produce a cacophony that drowns out the efforts of instructors, and obstructs our best efforts to improve our students' knowledge and comprehension levels.

Refinements over the years steadily advanced the capabilities available to the students in AE3021. Accordingly the performance of the best, and indeed the average, student also rose steadily, until by Fall 2011, the performance had reached quite impressive levels, and had begun to reach the levels required for effective knowledge transfer. At the same time, there was in every class, a subset of perhaps 5 to 10 students who came in unprepared, paid no attention in class and put in no effort on assignments, and whose knowledge therefore did not advance. Some realized that their trajectory would not get them through the course, and dropped. However, some others were so disinterested that they never showed up to pick up their test papers until close to the end of the semester, and appeared to be quite unaware of most things, including the fact that they were not going to get A grades, or indeed D grades. At the end of the course, these students had capabilities that were vastly inferior to those of the average student. The issue arose in dealing with this reality, in an environment where the administrators are vastly different in priorities and ethics from the prior generations that helped us to pull our school's and institution's reputations for excellence to where they stood last year.

Methods of Approach

Manifestations of the problem included startling findings, listed with remedies administered:

1. In the first test in AE3021 in Fall 2010, about 50% of the class left the two short "derivation" questions blank. Apparently they simply did not attempt to follow the logic of derivations, focusing exclusively on capturing the final "formula" to substitute numbers. The grade distribution is shown in Figure 3, compared to that in Fall 2011.
2. Directed to a set of formative survey questions provided on the Internet, students had the opportunity to answer questions on concepts. When the same questions were included on a 20-minute pop quiz with negative points assigned to discourage guessing, the performance was bimodal. But the idea was beginning to sink in, that honest effort was needed to pass.
3. Some students were found to just select a formula and substitute numbers, with no regard to physical reality. Thus, for instance, a question to determine the speed for minimum drag of the Solar Pathfinder aircraft (with a picture and description of its mission given), produced answers such as "19,700 fps". To deter such casual thoughtlessness, the instructor assigned negative points for such answers, and a few students managed to get net negative points on one test or another. (Note: this would imply that the student's performance on another test would be dragged down by the negative points, but in reality the score was recorded as zero in grade sheets to avoid that).

4. On the team assignments, determining individual effort and comprehension is a challenge. The instructor rejected ideas such as signing the Honor Code, that do not provide meaningful results in undergraduate classes any more than on Wall Street. Instead, the system followed for several years is that one or more questions on each test and final examination would ask about significant results of the assignments, such as "*what was the lift-to-drag ratio of your aircraft in supersonic cruise?*" Students who had spent many hours thinking and working on the assignment would answer these with ease, while those who contributed little would be very uncomfortable. Grading on such questions heavily rewarded students who did the work.
5. This generation of students, with their vaunted social media skills, would be expected to be much more articulate and willing to express their ideas. However, the opposite is seen when it comes to expressing technical ideas. The resistance to being invited to help solve problems on the board, proved to be extreme, to the point where the instructor stopped the practice, instituted 2 decades ago. The reasons are not clear.

By the end of the second test (last one prior to Drop Date) of the semester, the grade distribution had improved vastly, as shown in Figure 4. In Fall 2010 this was dramatic. In Fall 2011, something strange happened: several students simply did not submit the first two assignments, and did poorly on the second test; however, they did not bother to come by and pick up their tests, nor did several drop the course as they should have. What is clear is the substantial number of students who were excelling by now, so that the distribution looks roughly bimodal.

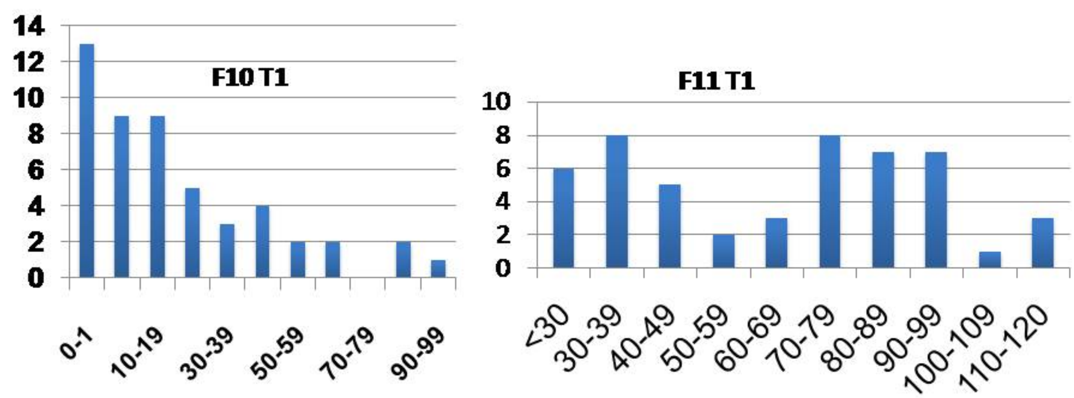

Figure 3: Grade distribution after the first test: Fall 2010 and Fall 2011.

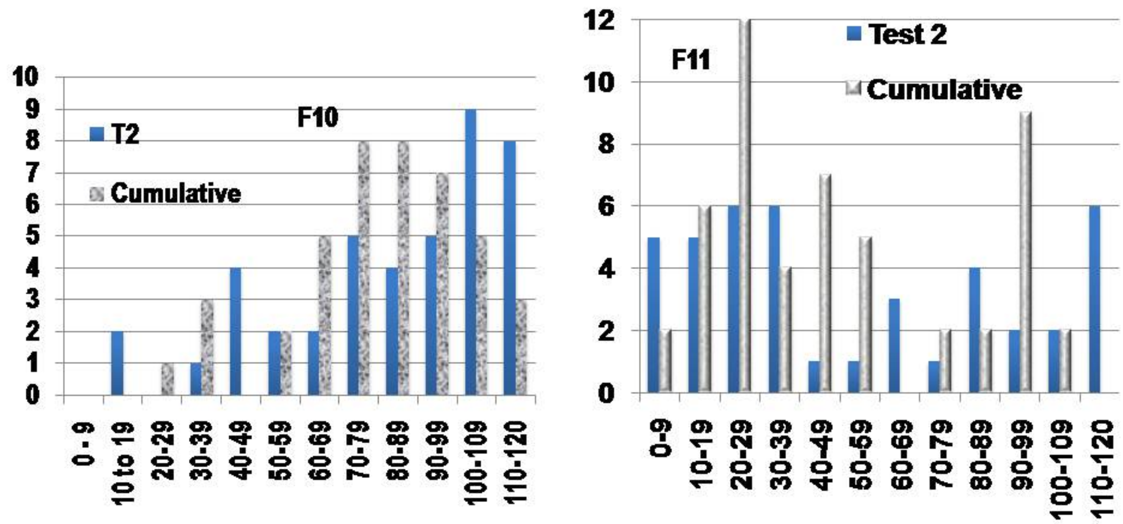

Figure 4: Grade distribution after the second test, Fall 2010 and Fall 2011.

Multiweek Assignment

The last several weeks of the semester were devoted to an assignment to refine the design of supersonic airliners in Fall 2010. One of the students in the class had participated in a team research exercise and presented a paper[9], subsequently accepted to a peer-reviewed journal[10], on the development of supersonic hydrogen-fuelled aircraft. He gave a 30-minute introductory presentation on how to make estimates in the face of first-order uncertainty, when developing concepts that ventured into the unknown.

Following this exercise, the class was provided with a spreadsheet showing the conceptual design of a hydrogen-fuelled supersonic airliner, along with calculation methods for wave drag and skin friction drag in supersonic cruise. They were asked to use a combination of a CAD program of their choice, and conventional calculating aids such as MatLab scientific computation software, to calculate and improve the performance of a supersonic airliner, beyond the baseline design provided to them. The CAD program was to be used to facilitate the calculation of wave drag by automatically calculating the configuration area intersected by Mach cones from different points. This would help implement the well-known double integral in the classical wave drag estimation methods from 1942, using the modern convenience of CAD.

Lessons Applied in Fall 2011

The experience in Fall 2010 motivated several changes in 2011:

1. Early conceptual design assignment to get a sense of numbers and magnitudes.
2. Emphasis on derivations.
3. More student involvement in problem-solving.
4. Faster-paced delivery, with web-based notes and eBooks provided, leaving more time for classroom discussion.
5. 6-week integrative assignment on advanced concept development.
6. Early end to lecture phase to allow more time for discussion on the assignment.

The results were quite exhilarating. The grade distribution in the first test is shown in Figure 3, substantially improved from Fall 2010, with the majority of students now taking the trouble to learn the derivations and become able to answer questions on core concepts and logic. Performance improved from there, the histogram shifting to the right with each test, as shown in Figure 4. Interesting things happened after Drop Day. In 2010, the message seems to have sunk in early, so that those who were doing little, mostly dropped out before the second test before Drop Day. This partially accounts for the left side of the histogram getting cleared. In Fall 2011, nine students dropped the course. Of these, one had to drop because he found himself overloaded with 19 semester hours of AE courses, and AE3021 was the only one he could drop without delaying graduation. He emailed the instructor, who had taught him two prior course, to express regret. Most of the others did not even complete the first "sense of numbers" assignment, and did poorly on the first two tests. But others were too disinterested to pick up their test papers and hence do not appear to have thought about their prospects for passing the course until much closer to the end of the semester.

Well before Drop Day, the class was introduced to the idea of developing advanced concepts. A 40-page eBook was developed to describe the assignment that was to be done in the subsequent weeks. This document explained the Cold War nuclear standoff, along with the issues underlying strategic deterrence and Mutually Assured Destruction. This set the stage for students to understand the basis for developing a missile defense system. Briefly, the purpose was to reduce the probability of success of a first surprise strike to such a low value that the attacker would need an unacceptably high number of missile launches. In other words, the advantage had to be shifted to the side of the defender, along with the certainty that the defender's retaliatory strike would wipe out the aggressor. Students were then asked to work in self-selected teams of two each, and submit project updates in the form of an updated 'final report" each week through the School's course administration website. Each week, there was a substantial discussion in class on the progress of the assignment. The aerodynamic missile defense system had four stages:

a) Low speed/subsonic performance of the carrier aircraft
b) Transonic cruise/ climb of the carrier aircraft
c) Mach 4 climb of the supersonic UCAVs from the carrier, up to 100,000 feet.
d) Mach 8 climb of the hypersonic missiles from the UCAV.

In the first weeks, students had to do conceptual design to size the 3 types of aircraft involved. They then went about calculating the aerodynamics of each stage, using the class of methods appropriate to each. Thus this assignment took students through the entire fluids/gas dynamics/ aerodynamics curriculum, and reviewed a considerable part of their knowledge in Vehicle Performance, and in some cases jet propulsion.

Results

Table 2 below, from Ref (11), summarizes the relation of our efforts to ABET criteria. Table 3 lists each of the special strategies and tactics that were employed to benefit the students. The benefits are listed in the second column, and the risks to the instructor in the third.

Table 2: Relation of Student Educational Outcomes to ABET

Outcome	**Mode of Address**
A. Fundamentals: Ability to apply knowledge of mathematics, science, and engineering.	Vertical streams of rigorous content in technical disciplines, with problem-solving.
C. Design: an ability to design a system, component, or process to meet desired needs.	Design-centered introduction, case studies and concept development exercises
E. Problem-solving: an ability to identify, formulate, and solve engineering problems.	Module-based surveys, solutions library, enabling deeper problem sets and tests.
H. Broad education to understand the impact of engineering solutions in societal context.	Advanced concept development exercises.
I. Life-long learning: a recognition of the need for, and an ability to engage in life-long learning.	Experience of having to solve problems in areas outside formal lectures. College instructors help learn these techniques.

Table 3: Benefits and risks associated with trying to advance learning.

Strategy/tactic	Benefits	Risks
Early conceptual design assignment	Remind students of the ease of making initial estimates; means of checking the magnitudes of answers against logic	Ill-motivated students drop out; administration worried more about Drop Rate than Learning Rate
Negative points for grossly thoughtless answers at a senior level (counted as zero in actual grade)	Sharp lesson in the need to be more responsible when giving answers, discourages "blowing off" assignments and thought. Industry employers endorse this heartily.	Triggers complaints of "cruelty" with no forum to address them fairly.
Derivation questions on tests	Quickly encouraged most students to learn the logic of engineering. The worst-prepared students left these questions blank, and dropped.	The worst-prepared students left these questions blank, and dropped the course.
High-value test questions to gauge individual participation on 2-person assignments	Provided nonlinear rewards for effort on assignments, strong reinforcement on need for individual participation. Avoids "Honor Code" signatures.	Generates complaints from the students who do not participate but help equally thoughtless administrators fill their time.
Multiweek assignments with in-class discussions and opportunity to improve.	Excellent opportunity to discuss issues in class with students after they have focused on the problem but before final grades have to be assigned. Most students benefit greatly from the discussion	Worst students did not prepare or participate, skipped classes or came in with blank stares. False complaints of "inadequate feedback".
Discussion forum on class site for students to discuss technical problems	Students learn from each other; nonlinear gains in learning as students explain solutions to each other with instructor observing,	The least-prepared students do not participate nor read the discussions; complain that items were not

	intervening only when needed.	discussed in lectures.
Setting tests with upto 20% bonus points achievable	Students are rewarded for excellence, race out to fabulous performances. Class grade histogram shifts to the right (high grades) as semester progresses.	Non-performers find that they are isolated at the left end of the histogram and drop out; administration unhappy at Drop Rate.
Exempt high scorers with 100+ averages from final exam.	Tangible reward for hard work: more time to work on other courses in finals week. No sense in lecturing during Dead Week since no tests can be given per Student Bill of Rights, and best students are done with the course.	With the best students done and gone, the Course Evaluation is filled by the non-performers, and bears no relation to reality. Administration looks only at this as metric of teaching!
Complete lectures 2 weeks ahead.	Essential if meaningful assignments are to be completed. Students can iterate on their knowledge before final exam. Interactions with instructor discuss the assignment.	Prompted complaints that the instructor stopped lecturing and abandoned the class! Administration happy to see this as being against Policy.
Giving 4 tests including a comprehensive test before the final exam	Final exam worth only 20%, thus reducing stress during finals week. Opportunity to boost grades. The best could be exempted since their test scores make the final irrelevant.	The best students were gone, the middle pack did OK, but the rest prepared poorly given the relatively low weightage.
Focus group discussion with outside experts	Help most students realize how much they have gained, relative to the traditional mode of courses.	Provide a forum for the occasionally-present to plot complaint strategy.

Administrative Demoralization

Three weeks before final exams, the class was asked to participate in a focus group discussion administered by an external expert. A small set of students used this forum instead to organize (having showed up as a rare appearance, and being surprised to hear that the course content had already been covered) to complain about the workload and thought-demands in the course. Finding resonance among themselves, they appear to have gone immediately to file complaints. Asked to provide a written complaint, only one agreed to sign it, the rest presumably deterred by the Honor Code should the facts be examined. The complaint claimed that the “course organization was changed after Drop Day”. The cited basis was the instructor’s comment that the formal lecture phase of the course was over as of Nov. 16 as per the syllabus, with the rest of the time to be devoted to iterative application of the knowledge, preparation and conduct of a comprehensive test, discussion of the test, a further lecture to address issues seen in the test, and discussions of the final stages of the assignment. It is not known if the complainers attended any of these; they certainly did not go and correct the false complaint, let alone apologize. Some of the comments on the course evaluation had interesting statements such as “there was no textbook or syllabus in the course". Obviously, had there been any merit to the complaints, or if the awareness-challenged students or administration were interested in remedying any concerns, there was plenty of time left in the semester, and most students were still participating intensely with the instructor in learning, to address the problem if any, and all they had to do was to inform the instructor in a timely and accurate manner.

As it turns out, there was no such interest, and the facts were never allowed to be examined. A cryptic query to the instructor, 3 weeks later, asked for "clarification" on the complaint that the course organization had been altered, to which the instructor responded with a request for clarification as he was aware of no such reorganization. No response came, other than a parroting of the complaints (months later!) and a declaration that the Drop Rate was "above the norm" for the level of the course. Eventually the interested students in the class conveyed their own opinions through strong, signed letters, expressing deep concern over the way that the least interested students in the class were devaluing the degree earned from the Institution. Several sample comments are shown in Table 3. There is no evidence that the administrators in question bothered to read these comments, had them read to them, understood or cared if they did either.

Table 3: Comments from Interested Students

Comment
One of the purposes of the course was to be able to design a military defense system. This project was due on one of the last days of the semester and in order to do it we had to apply all the knowledge learnt during the course. It is not true that we had no textbook. It was not very used during the classes. But (the prof) gave us the syllabus the first day of class, and there were all the topics of the course were related with the corresponding chapters of the book.
He is not afraid to give the grades that one deserves. He has given me 40's and has given me 120's, and every time I deserved the grade I received. "What you earn is what you get." So I can see how there could be some frustrations from students. (Referring to practices in other courses): It is really disappointing for students who understand the material to get the same grade as students who barely got by in the course. This is highly encouraged because the faculty are pressured by the (deleted) "infrastructure" to have what is called a good professor review score. (Apparently this is how they get raises and promotions, which seems PATHETIC to me.)
If a student is uninterested enough to fall asleep in a class and gets woken up, followed by questions they cannot answer, it is their problem not the professor's problem.
If the clowns in the class decide to sleep through (the professor's) instructions, they should assume responsibility for their actions.
When a student graduates as an aerospace engineer without even understanding the fundamentals, it degrades the entire program and everyone in it.
Every ignorant student that walks at graduation pulls us down, lowers our value.
It makes me cringe when my peers make glib, inaccurate statements because they will make those same stupid remarks a few years down the line if they do not learn now, and someone will then either believe them, making a potentially dangerous mistake, or group their ignorance with my alma mater, causing my degree to lose respect and value. Plus, if I can't differentiate a poor claim from an accurate one, I look even worse.
To be frank, AE 3021 is a senior level course that should wrap up the fundamentals of aerodynamics at XXXX , so it should be expected that the course would be tough unlike some

easy courses such as the (courses in history/social studies).
..thoughtful enough to allow the students to keep working on the semester long open-ended project (beyond the lecture-only phase).
We covered all the material with I think week or two left in the semester. This was extremely beneficial because we had a comprehensive project (design a Hypersonic Ballistic Missile Defense System) and I don't know if my partner and I could have finished the Hypersonic Design without that material, or even if we had gotten it a week later.
I may have been direly challenged, and had my mental aptitude pushed farther than I have had in many a class here during my tenure at the XXXXX. I left this class with an "A" and exempted the Final. But this was an "A" that I felt I earned every point of and left with a level of understanding to back it up.
After the bulk of the material was covered, the focus of the class shifted to the integrative assignment on the design of a missile defense system. Throughout the semester (the instructor) continued to provide assessments of the progress and abilities of the students.
One of the hardest classes in the curriculum.. also the class where I found myself retaining the most material. Tasked to explore the unexplored.. I would spend hours studying the online e-Book.. to supplement examples taught in lecture or the derivation of equations,. Class cultivated the character to gain the ability to take ownership of projects.
AE3021 is a senior level course. As a senior in AE there are some basic things that need to be remembered at all times. This brings meaning to our degree and enables XXX to have a top 2 ranked program. As an example, if vou don't know the lift coefficient slope of a thin ideal airfoil (a result that has been drilled into our heads as a freshman/ sophomore) you should not be allowed to pass this class (nor) its predecessor, AE2020 (low speed aerodynamics). I don't want to share a degree with someone who makes this school look that bad. I am sorry but I work entirely too hard to be devalued by association.
Please understand that the more people who do not want to work are passed through this school, the lower we will fall in the eyes of potential international students, potential out-of-state students and potential employers.

Postscript: Spring 2013

In the latest iteration of AE3021, the problem of "blowing off derivations" persists, with the expected consequences in the first test. Given the experience of Fall 2011, the instructor decided not to set tests out of 120 any more, since that would result in the best students not having reason to attend classes in the last week, and that would violate the administration's rules. The number of tests was reduced to 2 from 4, so that the class is again facing a bimodal distribution going into the second test. After a couple of individual problem-solving assignments, the class was introduced to the urgent need for a runway-based space launch and recovery system in order to make space-based solar power viable on a global scale. The students were given a summary of the rationale and experience described in this paper, and then a Poll was assigned, where students could give their opinions on whether they wanted a large Integrative Assignment on runway-based space launch to be done in teams of two, or problem sets based on course content, to be done individually. In either case, the submissions were to be done to professional standards. Only 26 of the 60 students bothered to vote at all, all voting for the Integrative Assignment. As this occurred on the web-based forum, students had a clear view of the apathy problem. However, at this writing, 42 have submitted Stage 2 of the space launch system, while 6 have submitted the problem sets, the rest remaining to be accounted. Meanwhile the Administration has come out with an exhortation to honor the holy observance of Drop Day, beyond which no changes are to be made in courses.

Conclusions

- Curricular compression has cut the time available to convey depth in engineering.
- Student capabilities and motivation show a very large spread.
- Resistance to analytical skills poses a competitive threat.
- An iterative learning solution can be implemented within the constraints of a core course.
- Proper opportunity to do integrative projects implies early completion of material.
- Appropriate rewards for excellence include bonus points and exemption from the final exam.
- Deterrence to blind formula substitutions is needed, and can be achieved.
- The end-of-semester student course evaluations appear to be dominated by those who have not attended class, read the syllabus nor paid attention to the Honor Code, yet this is the prime metric for teaching used by university administrators.
- Comments from the top students show strong concerns regarding the above.
- Administrative policies and apathy are the leading obstacles to quality improvement.

Acknowledgement

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