Application for 2015 Lindback Distinguished Teaching Award

Dr. Krishan Kumar Bhatia, Mechanical Engineering

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- I have poured my entire heart into student education and truly love those that sit in my class. Nothing gives me greater joy than being in front of a classroom.

1. Recommendation Letter – Dr. Smitesh Bakrania

Smitesh Bakrania, Ph.D.
Associate Professor
Mechanical Engineering Dept.
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Friday, December 19, 2014

Selection Committee
Lindback Distinguished Teaching Award
Rowan University

Dear Committee Members,

Letter of Support for Dr. Krishan Bhatia

I strongly support Dr. Krishan Bhatia's nomination for the 2015 Lindback Distinguished Teaching Award. By doing so, I hope to recognize the most outstanding engineering professor I have ever come across. Let me elaborate.

There are numerous attributes to Dr. Bhatia's teaching style that sets him apart. Including, but not limited to, his animated lecture style, his command over traditional 'chalk-and-talk' instruction, and his ability to draw attention while lecturing. I would like to highlight three that I particularly admire.

Weaving the human story within engineering. Dr. Bhatia's broad knowledge in engineering and scientific history makes his lectures come alive. He actively develops engineering concepts as they evolved historically. Often discussing experiments conducted by individuals and how they led to the first law of thermodynamics, or ideas about aerodynamics, for instance. Along the way, highlighting the missteps and conventions that are still with us today. Considering majority of the textbooks we currently use rarely provide this perspective, I find his lectures unique with respect to traditional engineering curriculum. Dr. Bhatia weaves the human story while teaching the students about some fairly challenging technical content. These historical perspectives make the concepts more palatable by providing the much needed context for their engineering knowledge.

Making real-world engineering connections. Every student knows that Dr. Bhatia is the 'car guy.' During his personal time, he loves fixing his dad's old sports car and following racing news. He loves anything automotive. Inspired by his passion, he has developed two very popular courses related to automotive engineering. These courses are so popular that they fill up as soon as registrations open. His passion translates to other courses by providing real-world applications to the concepts taught in class. For fluid mechanics, Dr. Bhatia asks students to compare air resistance experienced by the super cars to understand how the different shapes influence their drag characteristics or use 0-60 mph performance data of the world's fastest cars to teach graphing to freshmen engineers - thus effectively mixing fun with learning. To highlight his magnetism, Dr. Bhatia recently gave a talk on the history of racing to the local student chapter of American Society of Mechanical Engineers. Here he highlighted major achievements in automotive engineering that benefited the auto-industry. The talk had an unexpected student turn-out and even though it ran long, students hung around to ask questions afterward.

Developing captivating hands-on design experiences. When I have to develop a laboratory experience, I typically reach for a book or relevant literature for tried-and-tested activities to reinforce concepts. This is true for most of us. Dr. Bhatia, on the other hand has a unique ability to develop hands-on activities that not only emphasize the engineering concepts, but that are loved by the students. Some of the examples include, a Consumer Reports project for students to effectively test consumer products to learn about measurements and data analysis, design of wind turbines for students to learn about parametric design approach, design of a computer model car exteriors for students to recognize the demanding race-car aerodynamics, or design of a thermos for students to learn about heat transfer concepts. Considering these projects are challenging, Dr. Bhatia promotes competition among the students to encourage the students to push the envelope. As a result, I have regularly found students investing endless hours on perfecting their designs at the same time enjoying their experience. These projects have created lasting impression of engineering concepts on the students. Naturally, many of these projects have been adopted by other faculty in the department.

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It is no surprise that many of his students claim that Dr. Bhatia is the best professor they have had at Rowan. A fact that is clearly evident from the popular ratemyprofessor.com website. One of the reviews from 4/25/2014 states:

"Dr. Bhatia is probably the best teacher I've taken so far in college. He taught the material in a way that made it very clear and easy to understand yet I still learned and retained all of the information. He found a way to connect with the class by telling stories and sharing personal thoughts. Overall, it was a great class."

From my experience, the students fail to recognize that Dr. Bhatia will be the best professor these students will ever have. Therefore, I am confident that Dr. Krishan Bhatia's teaching reflects the mission of the Lindback Distinguished Teaching Award. I have no doubt that he sets a high standard for this award and will be an exemplary recipient. In receiving this award, I hope to recognize a particularly talented and passionate teacher at Rowan.

Sincerely,

Smitesh Bakrania

2. Teaching Description

I typically teach Mechanical Engineering upper division required courses, senior level Mechanical Engineering electives, and lower division general engineering design courses. The first representative course I'll describe is my 3 credit senior level Automotive Engineering course.

Automotive Engineering covers a broad range of topics from vehicle dynamics, vehicle aerodynamics, internal combustion engines, transmission design, hybrid powertrains, vehicle safety, and suspension design. I am no good at Powerpoint, so the format is your typical old-school "chalk & talk." However, I supplement with a ton of pictures, videos, and real world examples of cars doing all sorts of amazing things. It is a really fun class and easily my favorite one to teach. My students seem to be natural "gear-heads" so they love the course. The grading is primary based on a few in class exams and a team project. The project usually involves students measuring their own car's various dynamic properties using lab instruments and running simulations on their vehicle's performance (acceleration times, handling ability, fuel economy, etc). They often must redesign certain vehicle features in an effort to gain performance. My grading system and grade cutoffs are all point based and completely transparent to the students. There is no curving, just simple and clear. At the course's end, I want students to master automotive calculations involving engine design, transmission design, suspension design, and aerodynamic design. This is such a fun class and since we are all familiar with cars, it is easy to draw examples from.

The second course I'll describe is my 6 credit junior level Thermal-Fluids Sciences 1 course. This is a required class for all Mechanical Engineering students and covers the basics of Thermodynamics, Fluid Mechanics, and Heat Transfer. Like Automotive Engineering, it is taught on the board and supplemented with pictures, videos, and the relevant subject history. A very large course portion is a hands-on project where the students must design and build an air powered engine using thermodynamics, fluid mechanics, and heat transfer knowledge gained in class (see Section 9 for supplemental material and engine pictures). It is the course's best part and where I think the most learning happens since students apply class knowledge to an actual problem. At the semester's end, students should be able to design and calculate various parameters for a large number of engineering devices, for example: the thermodynamics of steam, jet, gasoline, and diesel engines, the heat transfer in buildings, engines

& heat exchangers, and finally the fluid flow in lakes, rivers, pipes, pumps, and power generating turbines. It is often described by those at other schools as a relatively dry subject since it is so math heavy, but I really don't know what they are talking about. The class has an extremely broad range of applications and there is no shortage of real-world examples to draw from (planes, trains, automobiles, dams, power plants, furnaces, air conditioning systems, etc). I think this real-world connection really draws students into the class. Every single topic ends with something like "and that is how a jet engine works." How can others describe this as a dry subject! Like Automotive Engineering, my grading system is a simple and straightforward point based system. The entire course is out of 100 points and each assignment carries a certain number of points. The students are told at the term's beginning how many points are needed for each letter grade.

3. Student Description

In a typical course, the vast majority of students I teach are undergraduate Mechanical Engineering majors. The remaining students are usually Mechanical Engineering graduate students or those enrolled in the Mechanical Engineering minor. Every few semesters, I do teach our general engineering courses (Freshmen and Sophomore Engineering Clinic 1 and 2), which are equally represented by undergraduate students from all 4 engineering disciplines. In terms of division, my students come roughly equal from all 4 years of our engineering program. As far as motivation for taking the class, roughly 75% of my courses are required for the degree program, so students have little choice. The remaining 25% are senior level technical electives. Students are required to take these courses, but have choice over which specific elective to enroll in. My electives like "Automotive Engineering" and "Advanced Heat Transfer" fill up by 7am on registration day morning, which is gratifying. Lastly, as far as learning styles go, I have never measured them myself. However, my departmental colleagues have measured the learning styles of our student population using various instruments, and I am told they are all over the map! As such, I've never tried to change my own style to target a specific type of learner, but rather just use a ton of methods and a lot of energy. I use example problems, pictures, video, textbook reading, team discussions, history of engineering, and even dancing in class to convey information. I hope every type of learner sitting in my class finds that one of these many outlets makes the material stick.

4. Teaching Philosophy

My underlying teaching principle comes from Mr. Rogers: "Deep and simple is far more essential than shallow and complex." At the day's end, all engineering concepts are simple in their nature. If it is not simple, then we don't really understand it well enough. Following Mr. Rogers, I try to make my instruction deep and simple. My approach to teaching involves three things: 1) Developing a student-teacher relationship, 2) Emphasis on the simple fundamentals, and 3) Always build something. The first, developing a student teacher relationship, simply involves respect in both relationship directions. The students usually have respect for their instructor, but I must have an even greater level of respect for my students who are dedicating these years of life to seeking out knowledge. I treat my students like my own children, and by the terms end, love them like friends. The second, emphasis on simple fundamentals, involves how I actually teach material once a good relationship is established. Rather than putting the lecture focus on minuet details or memorization, I instead always prefer to emphasize the underlying physics involved in any phenomenon being discussed. This is where Mr. Rogers comes in. Things are naturally simple and my goal is to get students beyond the math and complexity to see this underlying simplicity. The third, always build something, is essential for students to fully understand these fundamentals. You can't teach cooking in a classroom alone and I think the same to true of engineering. Mechanical engineering students must build something mechanical that makes a good noise, moves, and has a life of its own. Hands-on learning may take many forms, but always involves application of knowledge through a real problem solving project or activity.

5. Personal Assessment

Have I done a good job? It has been a long road to become an effective teacher, but I think I have done it. Below is a summary of all student evaluations from the past 10 years (through Spring 2014). The scores represent student answers to the final survey question ("Overall, how would you rate this instructor") on a scale from 1-5, with 5 being Excellent. A detailed evaluation summary for two recent courses, along with all student comments and a grade distribution, is in section 6 of this document. Overall, across all courses listed below, my average score has been a 4.88 out of 5. In addition, on 12 occasions, <u>all</u> students surveyed rated my performance as a perfect 5 out of 5.

Course and Term	***Number of Students Surveyed***	***Average Score***
Freshmen Clinic II – SP05	21	4.71
Fluid Mechanics I – SP05	21	4.95
Fluid Mechanics II – SP05	25	4.92
Thermodynamics I - F05	27	5
Thermodynamics II – F05	25	4.96
Heat Transfer – SP06	26	4.96
Intro. to Auto Engineering – SP06	20	5
Automotive Engineering – SP06	3	5
Freshmen Clinic I – F06	18	5
Heat Transfer – SP07	27	4.92
Advanced Heat (Undergrad) – SP07	13	5
Advanced Heat (Grad) – SP07	4	5
Thermodynamics I - F07	35	4.96
Thermodynamics II – F07	31	4.97
Sophomore Clinic II – SP08	47	4.64
Emerging Topics – SP08	21	4.76
Sophomore Clinic I – F08	111	4.68
Advanced Heat (Undergrad) – F08	21	5
Advanced Heat (Grad) – F08	9	5
Sophomore Clinic II – SP09	33	4.64
Emerging Topics – SP09	27	4.81
Intro. to Auto Engineering – SP09	23	4.91
Automotive Engineering – SP09	7	5
Freshmen Clinic I – F09	16	4.88
Sophomore Clinic I – F09	108	4.45
Sophomore Clinic II – SP10	39	4.77
Advanced Heat - SP10	18	4.89
Sophomore Clinic I – F10	54	4.56
Automotive Engineering I (Undergrad and Grad) – F10	29	4.69
Sophomore Clinic II – SP11	32	4.91
Automotive EngineeringII (Undergrad and Grad) – SP11	25	4.84
Freshmen Clinic I – F11	24	5
Thermodynamics II – F11	37	4.93
Fluid Mechanics I & II – SP12	39	4.87
Advanced Heat (Undergrad and Grad) – SP12	27	4.96
Thermal/Fluid Sciences I - F12	38	5
Thermal/Fluid Sciences II - S13	34	4.91
Thermal/Fluid Sciences I - F13	25	5
Automotive Engineering - SP14	31	4.94

Over the years, to enhance my teaching effectiveness, I have done a number of specific, concrete things:

- Made sure to include a hands-on project in every course (i.e. the “always build something” part of my teaching philosophy).
- Include the history of every topic before teaching the technical details.
- Include a real-world engineering example of every topic before teaching the technical details.
- Switched 10% of my course content from deductive (i.e. top-down teaching) to inductive learning (i.e. student driven bottom-up discovery, mainly through course projects).

- Switched my outside of class communication methods from email & course websites to face-to-face & over the phone. I'm not anti-technology, but this more personal approach had made a big difference.

6. Colleague Assessments – Dr. Eric Constans and Dr. Jennifer Kadlowec

Below are teaching assessments from two of my colleagues. After each letter, I have provided a short reflection and response.

Teaching Assessment

Instructor: Dr. Krishan Kumar Bhatia, Associate Professor
Date: February 3, 2015
Observer: Eric Constans, Chair of Mechanical Engineering

Over the past several years I have had many opportunities to observe Dr. Bhatia's teaching both in my role as Department Chair and as a colleague in team-teaching situations. Dr. Bhatia has the most natural talent of any instructor in the Mechanical Engineering program, and probably within the College of Engineering as a whole. Every department has its "rock star" teacher, but I believe that there is something more in the case of Dr. Bhatia. I will provide illustrative examples in the paragraphs that follow that will explain my support for Dr. Bhatia's nomination for the Lindback Distinguished Teaching Award.

Course Observations

Shortly before he was granted tenure, I made a final course observation in Dr. Bhatia's Automotive Engineering class. This is an extremely popular elective among our seniors, and we always need to place strict limits on enrollments. Dr. Bhatia is such a popular teacher that I have even received emails and telephone calls from parents (of seniors!) requesting that their son or daughter be admitted to the class after it was full. Below are some excerpts from my observation:

> *The general topic of Dr. Bhatia's lecture was vehicle dynamics. In particular, Dr. Bhatia discussed how the properties of a car (weight distribution, stiffness, etc.) affect its ability to negotiate turns safely at high speeds. While much of the discussion was mathematical in nature, Dr. Bhatia took great pains to emphasize the "real-world" nature of all of the terms in each formula.*
>
> *During the lecture, Dr. Bhatia kept the students engaged by asking them questions and eliciting feedback. One effective method he used was to illustrate abstract concepts (e.g. understeer gradient) using data from production automobiles that the students were familiar with. In a memorable example, he showed a video clip of a British car with pronounced understeer – the car's wheels were turned but it plowed straight ahead! The use of pictures, real-world examples and videos made what could have been a dry mathematical lecture very engaging and fascinating.*

The major theme from my observations is the ability of Dr. Bhatia to translate from abstruse mathematics into practical, everyday experience familiar to students. I have noticed him employing these techniques to great effect when teaching Thermodynamics and Fluid Mechanics, two other highly mathematical subjects. The result, as I have observed on countless occasions, is that his students *retain* the theoretical, abstract concepts much better than they do in classes where the concepts are presented as "pure math".

As an aside, let me note that the "pure math" method of instruction is preferred by most engineering faculty. It demands very little from the instructor, requiring only the copying of mathematical derivations from the lecture notes to the whiteboard. It is well-documented in the research literature that students have difficulty understanding the concepts presented in these courses, but the method persists, just the same.

Of course, the math used in engineering was developed for use in practical, real-life situations, but conveying this takes more energy and initiative than most engineering instructors are willing to give. This, I believe, is Dr. Bhatia's main reason for success as a teacher – his passion and love for the subject matter have given him a depth of understanding that he is able to communicate to his students. Sometimes it looks "effortless" to outside observers, but having known Dr. Bhatia for several years, I know it comes as the result of hard work, dedication and commitment.

Outside the Classroom

I am the faculty advisor to the Rowan Motorsports team, which designs, builds and competes with an off-road vehicle (SAE Baja) and a high fuel economy vehicle (SAE Supermileage). I am not a "car guy" by nature, so it is fortunate that Dr. Bhatia's commitment to teaching does not end with the classroom. For the past several years, he has served as a valuable mentor to students (and to me) in the Rowan Motorsports team. His passion for all things automotive has helped improve the Rowan Motorsports team from moderately successful to the point where we took home a 2nd Place trophy in one of the Dynamic Events in SAE Baja last year.

The main reason for this success goes back to his ability to translate abstract mathematical theories into practical designs. Last year he spent countless hours helping one of the students on the team to translate a book on race vehicle dynamics into a practical, yet innovative five-link suspension design (with passive rear-steer) that enabled the Rowan Baja car to navigate a treacherous, challenging maneuverability course with ease. Dr. Bhatia's ability to communicate a very difficult subject matter – which is the very essence of distinguished teaching – created the conditions for success for the Rowan Motorsports team. I should note that Dr. Bhatia does this every year outside his normal workload hours, without compensation. His passion for teaching and his delight in student success have been his only rewards in this sphere of activity.

Summary

Every department has a charismatic, popular teacher beloved by students. While I believe Dr. Bhatia was born with his ability to communicate clearly with students, it is his passion, drive and hard work that have made him into a distinguished teacher. I often see students discussing abstract concepts like "Carnot efficiency" and "vortex shedding" with him many semesters after having taken his Thermal-Fluid Sciences class. Clearly, Dr. Bhatia's teaching has had a profound effect on these students, one which will endure throughout their careers as engineers. This is surely the mark of a distinguished teacher, and I am grateful that Dr. Bhatia has become such an integral member of the Mechanical Engineering program.

Constans Letter, Reflection – Dr. Eric Constans is a thoroughly experienced with over 15 years at Rowan (with 6 serving as department chair) and is a widely loved professor among the student body in Mechanical Engineering. I was honored that he described me as a "the most natural talent of any instructor in the Mechanical Engineering program." His letter brought up an issue I had never really thought about before: most of us in engineering tend to attack complex subjects with pure math. He went on to describe my tendency to reduced the complex math to simple, real-world experiences. I guess my Mr. Rogers approach has worked! Sometime I actively prepare for this, but I think he is correct that it comes naturally in my lectures. Likewise, Eric brought up our activities together with the SAE Baja team and how I usually relate things back to actual experience. When talking to students about something like suspension design and vehicle grip, I can see the look of confusion on their faces. Instead of throwing more theory at them, my reaction is to say something like "What do you drive?" followed up by "Did you feel the back end of your car slide in the snow last week? That is exactly the same reaction we are trying to design out of this Baja car." Like Eric mentioned, students just randomly approach me in the hallway and say "Explain vortex shedding to me." I think they do this because they know I can tell them what it is and what causes it in less than a minute. Again, I never thought about it before reading Eric's letter, but I think this simple technique has been responsible for much of my success as an instructor. I will most certainly continue this in the future.

Lindback Teaching Award Assessment

To: Lindback Award Committee
From: Dr. Jennifer Kadlowec
Re: Assessment of Dr. Krishan Bhatia's Teaching
February 2, 2015

Dr. Krishan Bhatia joined the Mechanical Engineering program in January of 2005. During his time at Rowan University, he has become a key member of the Mechanical Engineering faculty as well as across the College of Engineering. He is an extremely effective instructor and his teaching evaluations are truly outstanding. He typically receives 5 out of 5 when teaching junior and senior courses, the best evaluations in the department. My assessment here of Dr. Bhatia's teaching is based on observing him in the classroom when he taught Thermodynamics II in the Fall of 2011 and my experience team-teaching Freshman Engineering Clinic I with him in the Fall of 2009 and Sophomore Clinic 2 with him in Spring 2014.

Thermodynamics II

I had the opportunity to observe Dr. Krishan Bhatia during a class session for a junior level Thermodynamics II course. The topic of for the day was engine cycles. Dr. Bhatia began the class by showing animations of piston engine cycles, then clearly describing each step and process of the cycle while pausing the animation at that point in the cycle. This was an excellent way to discuss a thermodynamic cycle by starting with an application. After gaining the students' interest and attention with the physics of an engine, Dr. Bhatia seamlessly moved into concepts and principles to develop pressure-volume diagrams. This was an interactive exercise with the students as he asked them questions as they related the associated processes in the diagram to that in the engine cycle. This was an excellent learning opportunity for the students to reinforce concepts and terms from the course and apply them in this new situation. I was truly impressed at how clearly he explained the material (I learned more about engine cycles that I didn't know before), his command of the material and his overall enthusiasm. Students were engaged and interactive with him in class.

The second half of the class involved review using Classroom Response System applications developed by fellow faculty member, Dr. Smitesh Bakrania. Dr. Bhatia worked closely with him on the topical content and administering the polling questions in class. This opportunity benefited both the students and Dr. Bakrania. The students had further opportunity to review the material and Dr. Bhatia could address questions by getting feedback from the entire class. The experience also provided Dr. Bakrania with pilot data for a proposal application and publication as well as direction to continue work on student feedback and learning. Dr. Bhatia is a team player, who works to achieve student outcomes in his courses, provides a positive learning environment and is a master in the classroom.

Freshman Engineering Clinic I

In the fall semester of 2009, Dr. Krishan Bhatia and I team-taught Freshman Engineering Clinic I, both as instructors from Mechanical Engineering. The Freshman Clinic is a hands-on introduction to engineering course where students learn measurements and basic skills. Together we developed a new laboratory component of the course around bioengineering and the humanitarian engineering theme of "Designing for Those Living on Less than $10 a Day." The student teams were tasked with finding a world-regional population, defining their need, and designing a human-powered device to meet that need (pump water, crush grain, etc.). They gained measurement experience by conducting experiments to determine human-power using arms and legs. As a non-biomechanics expert, I was impressed at Dr. Bhatia's high level of excitement in working with me in taking on this part of the challenge. His expertise in energy and design helped us produce meaningful student activities. He also brought a great atmosphere to the lab when as he explained to students the concepts of max force versus max power as we found he was much stronger (max force) than I, yet I could generate more power (force x velocity). Based on our body sizes/builds and different genders, the students were quite amazed.

Beyond the technical aspects of the course, Dr. Bhatia contributed to the social justice and ethics elements in the course. I distinctly remember his lecture where he mentioned and discussed some issues, which were powerful and important experiences for students and myself. Two examples from the discussion were Cochlear Implant – Hearing Solution or Non-consenting Body Modification and Human-Powered Transportation – CO_2 Solution or Unreasonable Work Condition. For the first example he explained briefly the great engineering technology of the implant to improve hearing, yet the fact that a deaf friend of his was personally unsupportive, since it infringed on a culture and sign language in the deaf community. In the second example, he showed rickshaw bicycle transport yet also provided examples of poor working conditions of bicycle transport workers when visiting family in India. This was particularly powerful coming from Dr. Bhatia as an expert in energy, someone who has conducted scholarly work in various alternative energies, and has personally seen this in India. Both examples provide powerful take-aways, in both cases engineers (and others) can develop amazing technologies, yet we need to be mindful of the problems to solve and the people involved. These are important issues that engineers need to consider when designing solutions, and I was impressed, particularly as an undergraduate of a liberal arts college that Dr. Bhatia taught technical and professional issues so well in this course.

Sophomore Engineering Clinic 2

Most recently, in the spring of 2014, Dr. Bhatia and I had the opportunity to team-teach once again, along with a new engineering instructor, Dr. Morgan. Based on our previous experience in Freshman Engineering Clinic 1, I was absolutely ecstatic to team-teach with him again. Engineering design and public speaking are team-taught in the Sophomore Engineering Clinic 2 course. As a team of engineering faculty, we developed a design project and worked with our technical support staff to implement.

The key learning objectives were for students to recognize a need; define goals, objectives and constraints for a design problem; generate multiple solutions through brainstorming; perform

engineering analyses; choose an optimal solution and effectively communicate design and decisions. The project for the students was to design, analyze, build and test an underwater remotely operated vehicle (ROV). We carefully planned learning activities to map to course objectives, and our team covered material based on teaching expertise and all contributed to a successful student experience.

Dr. Bhatia covered hydrodynamics and stability, once again taking the essence of some advanced topics and discussing them at a conceptual level that sophomore engineering students could more easily understand and apply to their ROVs. Additionally, he guided students to use software to run simulations, once again parsing out the most relevant information for just-in-time learning and relating concepts to topics that some of us other faculty had covered in previous sessions of the class. Through, this team-taught approach, and excellent work by Dr. Bhatia, students achieved the goals of building working ROVs that completed the design challenges of timed races and obstacle courses. Additionally, students were able to communicate their design decisions and final designs to the faculty team as part of the learning goals.

In summary, Dr. Bhatia is an outstanding instructor and extremely worthy of the Lindback Distinguished Teaching Award. I am truly impressed with his rapport with students, ability to clearly explain material with great enthusiasm and promote student learning. If you have any questions, please feel free to contact me at kadlowec@rowan.edu or (856) 256-5344.

Jennifer Kadlowec, PhD
Professor and Chair, Mechanical Engineering

Kadlowec Letter, Reflection – Like Dr. Constans, Dr. Jennifer Kadlowec has over 15 years of experience as a professor and is a long-time anchor of our Mechanical Engineering program. She currently serves as the chair of the mechanical engineering department and is thus a unique position to evaluate teaching effectiveness. As noted in her letter, we have team taught several courses in the past. She is one of the sharpest and fastest thinking people I have ever met, and I truly value her input and observations. Because of this, I was humbled by her mention of learning a lot herself in my Thermodynamics II course when she sat in to observe. In her description of our team teaching activities in Freshmen Clinic, I was happy to see that my excitement came across. Furthermore, I was shocked that she remembered details and the two specific examples I had in my lecture to the students on engineering ethics. That specific lecture was many years back! This further reinforces my belief that real-world examples help long-term student knowledge retention. I remember in undergrad one of my professors saying right before a lab demo "You are never going to forgot this." He was right, and I think concrete examples and projects are key to making material stick. I have tried to carry this forward throughout all my instruction. Towards the end of her letter, Dr. Kadlowec mentioned our recent collaboration in teaching Sophomore Clinic II and my rapport with the students. This goes back to my teaching philosophy (section 4) about establishing a student-teacher relationship. I have no walls with my students and believe radical in honesty. Some may criticize it, but I joke, laugh, bang on tables in class, get frustrated, and bury my face in my palms in the middle of a bad lecture, all in front of our students. We are all human, and this honesty and emotion builds trust (I had plenty of professors in school whom I was convinced were robots!). I am glad this honesty has paid off, and Dr. Kadlowec recognizes my rapport with the students.

7. Student Evaluations

Below are my student evaluations from 2 courses in the past 3 years (Automotive Engineering in Fall 2014 and Thermal-Fluid Science 1 in Fall 2012). Please note that I have included **all** student comments, not just a cherry-picked select few. Also included is the grade distribution for the courses and my own reflection.

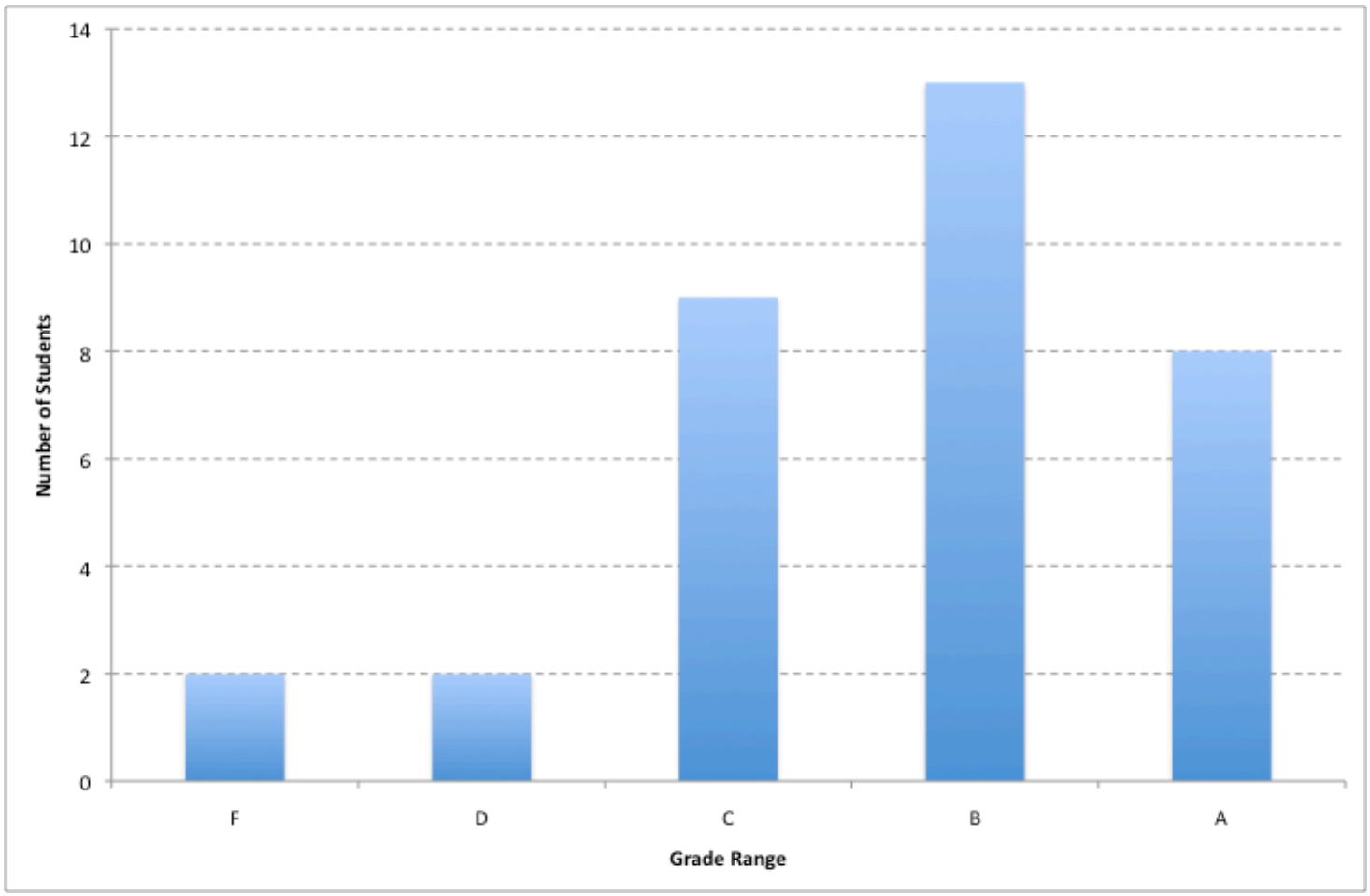
Course: Automotive Engineering 1
Number of Student's Surveyed: 34
Date: Fall 2014

Question	Rating System (1 to 5 Scale)	Average
1. Were your class sessions characterized by a clearly presented lecture and/or learning activity?	1=Never, 5=Frequently	**4.94**
2. Was your understanding of course concepts enhanced by your professor's presentation of the material?	1=Not at all, 5=Very Well	**4.97**
3. Did your professor encourage questions and comments during the class?	1=Did not encourage, 5=Frequently encouraged	**5.00**
4. Was your professor responsive to students' questions and ideas?	1=Not responsive, 5=Very Responsive	**5.00**
5. Was your professor's evaluation of students' work impartial and unbiased?	1=Partial/Biased, 5=Impartial/Unbiased	**4.97**
6. Did your professor stimulate thinking in this course?	1=Not stimulating, 5=Very Stimulating	**4.88**
7. Did your professor require a high level of student performance in this course?	1=Not at all, 5=Usually	**4.76**
8. Overall, how would you rate your professor in this course?	1=Poor, 5=Excellent	**5.00**

Student Survey Comments on Professor

- #1 Teacher of all time! Totally rad dude. Gnarly class.
- Dr. B is a great professor. Auto 1 has been my favorite class so far at Rowan.
- Dr. Bhatia is very excellent overall. The course was interesting and engaging.
- Fantastic class, Dr. Bhatia displays a mastery of the subject material.
- Really, really, really, really good.
- Good stuff, keep it going.
- Great professor. His passion for the material is extremely encouraging + motivating.
- Class was very fun, enjoyable and engaging.
- Best class at Rowan
- Dr. B is great!
- Best class offered @ Rowan
- Dr. B is the man. Best class I've ever taken.
- Dr. B is the man!
- Great course. Dr. Bhatia made it enjoyable and easy to understand.
- Easily one of the best professors in the program. Give him more classes. Only criticism is the high grade scale.
- Dr. B is awesome.
- Dr. B is extremely knowledgeable and enthusiastic about Automotive. Hi is able to answer 99% of all questions in the field (relevant or not) and is more than willing to research anything he is not familiar. Excellent teacher.
- Combination of lectures, along with working out problems and writing Matlab simulation stimulated a high level of learning and comprehension.
- Explanations are very clear and the instructor is always eager to help students. More availability outside of class would help.
- There isn't a single person in the world that is more qualified to teach and passionate about Automotive Engineering than Dr. Bhatia.

- HEEEEEEEEE'S GREAT!
- Dr. B is the man
- Very knowledgeable about the subject
- He is an expert!



Reflection: Automotive Engineering is my favorite course to teach. This is the course that makes me want to come to work every day. Vehicle dynamics, powertrain design, hybrid vehicles, engine combustion, and transmission design are just a few of the topics we cover. Given the student comments, I think I achieved my goals! When asked "Overall, how would you rate your professor in this course?" every single student gave me a 5 out of 5. I always put a tremendous amount of effort into this class, and I am glad it paid off. The students in this class are seniors, and I was humbled that so many said it was the best course they have taken at Rowan. As for grades, I had a good distribution. Unfortunately, I did have a few Ds and Fs, but this is a tough class despite how much fun it is for the students. One student even mentioned in his comments that the grading scale is very high. In the future, I plan to do a better job of ensuring that no one fails this course. I will do this by meeting with every student who does poorly on the first exam and try to figure out what we can do to ensure success.

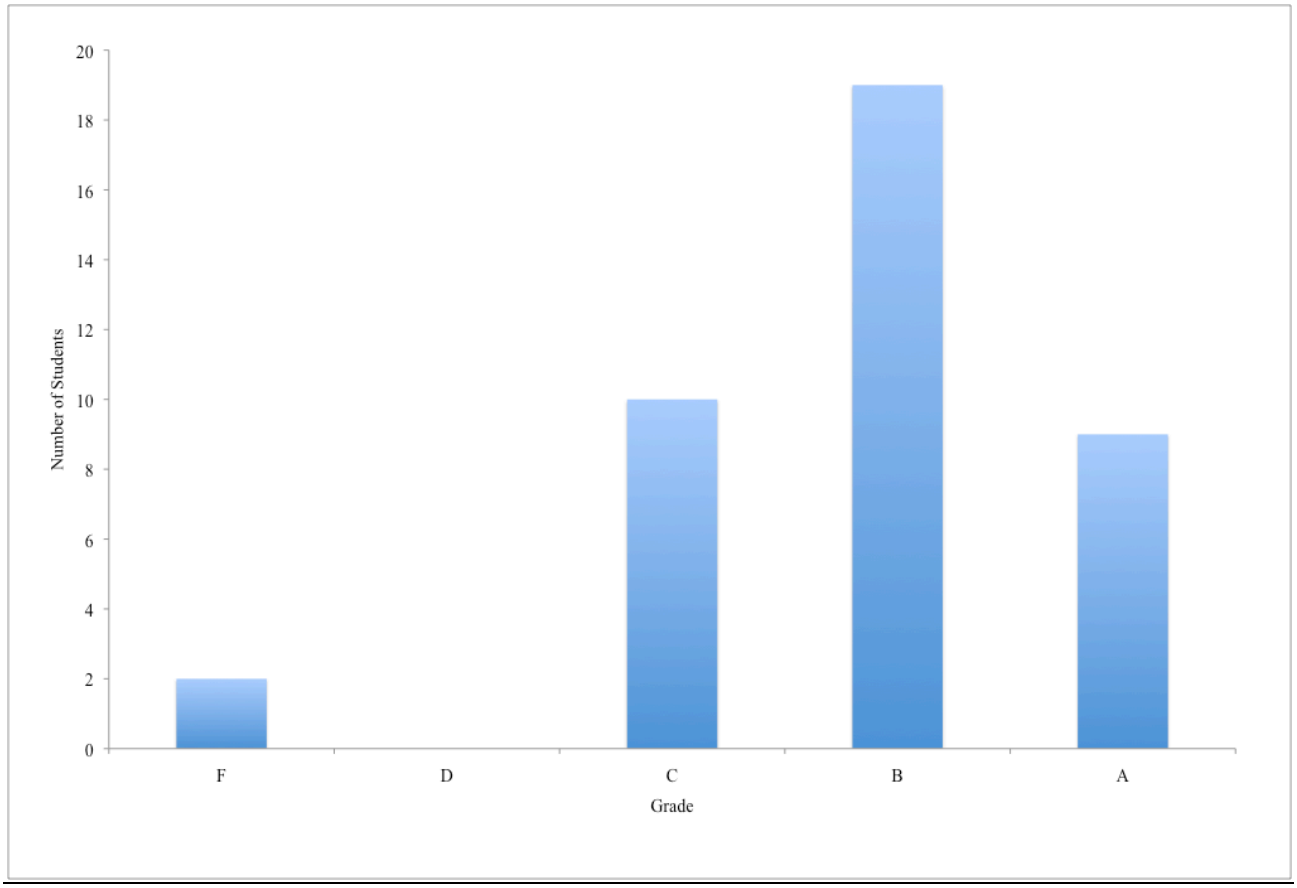
Course: Thermal / Fluid Sciences I
Number of Student's Surveyed: 38
Date: Fall 2012

Question	Rating System (1 to 5 Scale)	Average
1. Were your class sessions characterized by a clearly presented lecture and/or learning activity?	1=Never, 5=Frequently	**4.97**
2. Was your understanding of course concepts enhanced by your professor's presentation of the material?	1=Not at all, 5=Very Well	**5.00**
3. Did your professor encourage questions and comments during the class?	1=Did not encourage, 5=Frequently encouraged	**4.92**
4. Was your professor responsive to students' questions and ideas?	1=Not responsive, 5=Very Responsive	**4.89**
5. Was your professor's evaluation of students' work impartial and unbiased?	1=Partial/Biased, 5=Impartial/Unbiased	**4.84**
6. Did your professor stimulate thinking in this course?	1=Not stimulating, 5=Very Stimulating	**4.92**
7. Did your professor require a high level of student performance in this course?	1=Not at all, 5=Usually	**4.82**
8. Overall, how would you rate your professor in this course?	1=Poor, 5=Excellent	**5.00**

Student Survey Comments on Professor

- Dr. Bhatia was a great professor. He made the class enjoyable and taught on our level so we were able to learn a lot. I look forward to having him next semester
- GREAT CLASS
- This was one of the best professors I've had. Lectures were always very clear in terms of material to learn and expectations of performance were fair.
- One of the best professors I've ever had
- One of the best instructors I've had at Rowan. Very good at relating problems to situations everyone is familiar with.
- These were the most helpful lecture periods I have had in my time at Rowan. The examples were clear and very helpful.
- Top professor of college career thus far.
- Professor Bhatia was one of the best professors I've had at Rowan. He knew exactly how to explain the material to get everyone to understand. I actually enjoyed learning in this class
- Excellent professor. Challenged students & provided comprehensive lectures & fair exams.
- Loved the history. Gave everything perspective & inspiration.
- Dr. Bhatia is fantastic.
- Professor Bhatia is excellent at explaining difficult concepts and fielding questions. I hold him in high regard.
- Very good. I understood much to most of what I was doing. Gave very useful examples to clarify and explain material. I enjoyed this class overall
- This professor is the best teacher I know
- Dr. B is one of the best professors I've had. His ability to explain new topics with examples is unmatched by any other professor I've had
- Above and beyond all expectations
- Great Professor Keep Bhatia teaching this class.
- One of the best I've taken :) The background/history was a big help to understanding and ??? The material
- Instructor really cares about this topic. He is very eager to share this knowledge with everyone. I really enjoyed this course.
- Best I've ever had

- Dr. B. is the perfect person for this job. He really pushed me to learn the material and provided great guidance along the way. Thanks for doing an amazing job. Looking forward to Thermo 2.
- The professor frequently involved the students in a variety of discussions pertaining to the class/other historical backgrounds about the course. His downfall was his availability and sometimes responsiveness to students outside of the class period.
- Great teacher, always helpful, great lectures
- Great teacher
- One of the two best teachers I've had at Rowan. Amazing pep talks. Actually makes history interesting
- One of the best professors in the department
- Bhatia is best engineering professor I've had at Rowan, keep up the awesome lectures
- More time for steam engine design and fabrication - more homework
- Course was extremely difficult and felt somewhat rushed
- Dr. Bhatia is a great instructor, looking forward to having him for Thermal Fluids 2
- Loved the class! Fantastic Lecturer! 1 suggestion more homework, quizzes where I scored the least were ones where I had the least practice (i.e. otto cycle) Also not a fan of losing a letter grade on a quiz for a calculator error
- Best professor I've had at Rowan for teaching
- Dr. Bhatia is quite helpful and his lectures are quite engaging than lectures for other courses.



Reflection: Thermal-Fluid Sciences 1 is a beast of a class. It is a 6-credit lecture & lab monster combining what at most schools is typically 3 separate courses (Thermodynamics 1, Fluid Mechanics 1, and Heat Transfer). I felt the grade distribution turned out acceptable. I did have 2 students fail, which was upsetting, but also not uncommon in such a tough class. Both went on to re-take the course and passed the following year. The material is very challenging and the topics often abstract. It was my first time teaching the course, and I think it went very well. I tried to make the material less intimidating by introducing the history of the science behind it at every opportunity. The project was the course's biggest focus, and examples of student built air engines can be found in section 9. This very hands-on project really helped drive home lecture material. Their engines were loud, sprayed oil everywhere, vibrated like crazy, but did the intended job. One student joked with me that he loved his air engine more than anything else in his life. Now, if I can get a student to do a bunch of engineering calculations, spend hours on a computer doing design, build that air engine, test it till it breaks, and end up loving a lifeless pile of metal on the lab floor, I think I did my job. Overall, I was extremely pleased with the outcome and humbled by all the very positive student evaluation comments. Since then, this course has become my second favorite to teach (after the above mentioned Automotive Engineering).

8. Course Syllabi

Below are syllabi from two of my recent courses as well as a short reflection/commentary on each:

0910.444 and 544: Automotive Engineering
Professor: Dr. Krishan Kumar Bhatia
T 4:45 – 7:15pm
bhatia@rowan.edu
135 Rowan Hall, Phone x-5346

Course Description:

This course will emphasize thermodynamic, fluid, heat transfer, dynamics, and machine design fundamentals, and their application to automotive design. Topics covered in automotive engineering will vehicle propulsion, braking, road loads, internal combustion engines, electric motors, batteries, powertrain design, vehicle handling and lateral dynamics.

Textbook: None

How to get a hold of me:

I get about million emails (bhatia@rowan.edu) and messages on my office phone (856.256.5346) a day from the folks at Rowan. Due to the high volume, I am really slow and bad at email and responding to my office phone messages. So, don't email me or leave me a message on my office phone unless you can wait 2 weeks for a response.

However, the university administration doesn't know my cell phone number! That is only for my students since you folks are special to me. So, for your questions/concerns, it is best to call me at **302.740.1386**. Leave a message if I miss your call. Also, please don't text me (**I have a dumb phone, can't read text messages, and don't know how to write back)**. You can also find me in my office (135 Rowan Hall) anytime you like.

Grading:

Exams – 3 x 25 pts each

Three examinations will be given. The exam must be taken on the scheduled date. Make-up exams will be given, but only with a valid reason (illness, emergency, etc.) and prior approval from the professor. Without prior approval, a grade of "0" will be given for any student who misses the mid-term exam.

Project – 25 pts

One team project will be assigned.

Grading System:

- A Range (Excellent) – 93 pts, Well above standards. No deficiencies in calculation or conceptual understanding.
- B Range (Good) – 86 pts, Above the standard. No deficiency in conceptual understanding but with calculation or mathematical errors.
- C Range (Fair) – 79 pts, Generally good work with the standard met. However, minor conceptual deficiency or multiple math errors.
- D Range (Poor) – 72 pts, Standards met. Multiple minor conceptual deficiencies or a major conceptual deficiency.
- F (Fail) – Below 72 pts, Standard not met. Multiple major conceptual deficiencies.

Rowan University Accommodation Statement

Your academic success is important. If you have a documented disability that may have an impact upon your work in this class, please contact me. Students must provide documentation of their disability to the Academic Success Center in order to receive official University services and accommodations. The Academic Success Center can be reached at 856-256-4234. The Center is located on the 3rd floor of Savitz Hall. The staff is available to answer questions regarding accommodations or assist you in your pursuit of accommodations. We look forward to working with you to meet your learning goals.

Automotive Engineering Syllabus Reflection – This cross-listed course is both a senior level elective and graduate section in a single lecture. As you can see, I try hard to keep my syllabi short and sweet. The class covers a wide range of automotive related topics and the course description in the syllabus reflects this. I am notoriously bad on email, so I provide my cell phone number in the syllabus. As mentioned before, I prefer this more personal communication method to email. I have found in the past that this is a much easier and faster communication method with the students. I say specifically in the syllabus "you folks are special to me." It is much easier for me to help someone with a tough homework problem or give advice over the phone than to have a long email exchange. I also try to make my grading system as transparent as possible, so I have laid out a simple point system and total point cut-offs for each grade range. I think the student's really appreciate this transparency. I assign homework throughout the course, but do not grade it. Instead, my grading system is based on exam performance and a course project. I've gotten feedback in the past from students who like this ability to exactly know and track their grade throughout the term. Most students don't like final grade surprises, and this simple point system eliminates that possibility. Furthermore, since there is no grade curving, there is no grade competition among students. As such, I think this grading system where everyone is judged to a standard rather than to each other encourages team studying and team learning.

Thermal Fluid Sciences 1
Professor: Dr. Krishan Kumar Bhatia
T 10:50 – 12:05, James 3091A
R 9:25 – 12:05, James 2103
F 8 – 10:40, Rowan 104

How to get a hold of me:
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Course Description:
This course will emphasis the fundamental physics of thermodynamics, heat transfer, and fluid flow. Its fun.

Textbook: Thermal-Fluid Sciences, Stephan Turns

Grading: There are 100 pts in the course, with 60 for quizzes and 40 for practicum. There will be 6 quizzes throughout the term, each 10 points. Quizzes will cover material from the lecture, homework, textbook and practicum. Quizzes are closed book, but you can use a calculator and a hard copy of the FE Exam Reference Manual (8th Edition, 2nd Revision) during the quiz: http://www.ncees.org/exams/study_materials/download_fe_supplied-reference_handbook.php

Don't print out the whole 264 page manual. You'll only need 41 pages of it (pages 19-20, 62-90, and 239-248). Make-up quizzes will be given, but only with a valid reason (illness, emergency, etc.).

Grading System:

- A Range (Excellent) – 93 pts, Well above standards. No deficiencies in calculation or conceptual understanding.
- B Range (Good) – 86 pts, Above the standard. No deficiency in conceptual understanding but with calculation or mathematical errors.
- C Range (Fair) – 79 pts, Generally good work with the standard met. However, minor conceptual deficiency or multiple math errors.
- D Range (Poor) – 72 pts, Standards met. Multiple minor conceptual deficiencies or a major conceptual deficiency.
- F (Fail) – Below 72 pts, Standard not met. Multiple major conceptual deficiencies.

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Your academic success is important. If you have a documented disability that may have an impact upon your work in this class, please contact me. Students must provide documentation of their disability to the Academic Success Center in order to receive official University services and accommodations. The Academic Success Center can be reached at 856-256-4234. The Center is located on the 3rd floor of Savitz Hall. The staff is available to answer questions regarding accommodations or assist you in your pursuit of accommodations. We look forward to working with you to meet your learning goals.

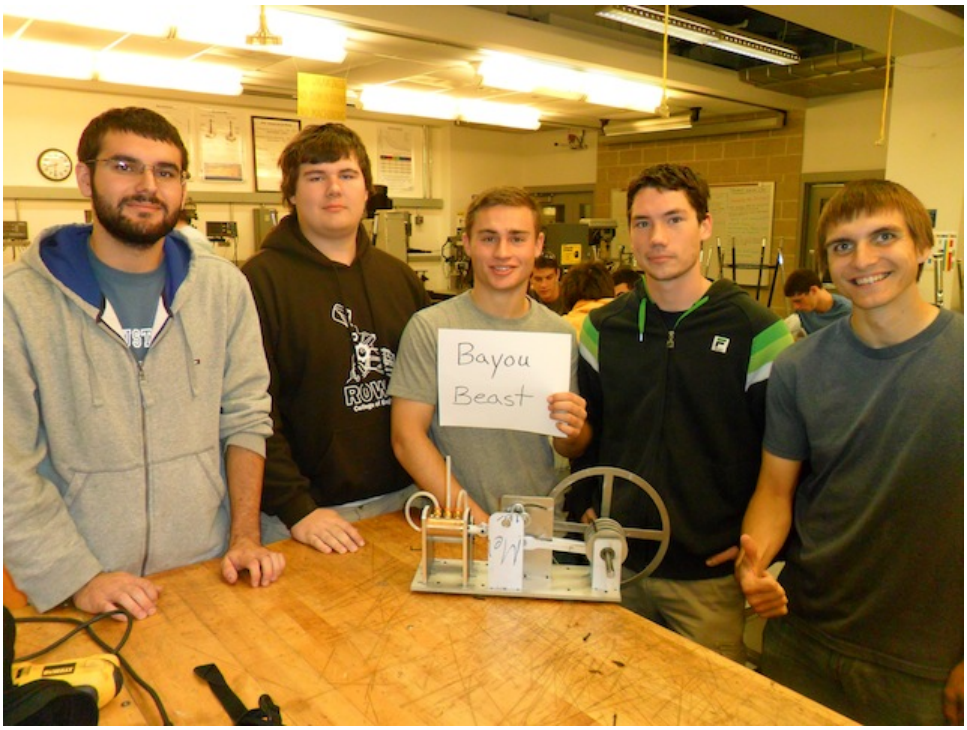
Thermal-Fluids Sciences 1 Syllabus Reflection – My syllabus for Thermal-Fluid Sciences 1 is very similar to that of Automotive Engineering (very short, simple grading system, phone number to contact me, etc). The only major difference is in the breakdown of course points. For this class, instead of a few heavy exams, the assessment method is several shorter quizzes. I do this because Thermal-Fluid Sciences 1 is a 6-credit course and covers an extremely broad range of topics. As such, it is nice to have several shorter exams on each big topic as opposed to say just a mid-term and final exam that would each span many different topics. The students really seemed to like this approach, and it helped to relieve the stress of "big exams" that carry 30 or 40% of the course grade with them (each of my many quizzes were only 10% of course weight). One question I often get from colleagues is "Why don't you grade homework?" For this course, I assign a lot of homework, but don't grade it. Instead of the traditional homework process, I give all the answers to problems when I assign the homework. For me, homework is about studying and learning, not about assessing performance. I tell students that if you do the homework, you don't have to study for the quizzes. For me, the homework is another hands-on way to learn the material, and I want them to focus on understanding the problem they are doing rather than if they are on the right track to getting a correct answer and good homework grade. So, students often come to me with homework question like "Dr. B, help me understand this problem" as opposed to "Dr. B, help me solve this problem."

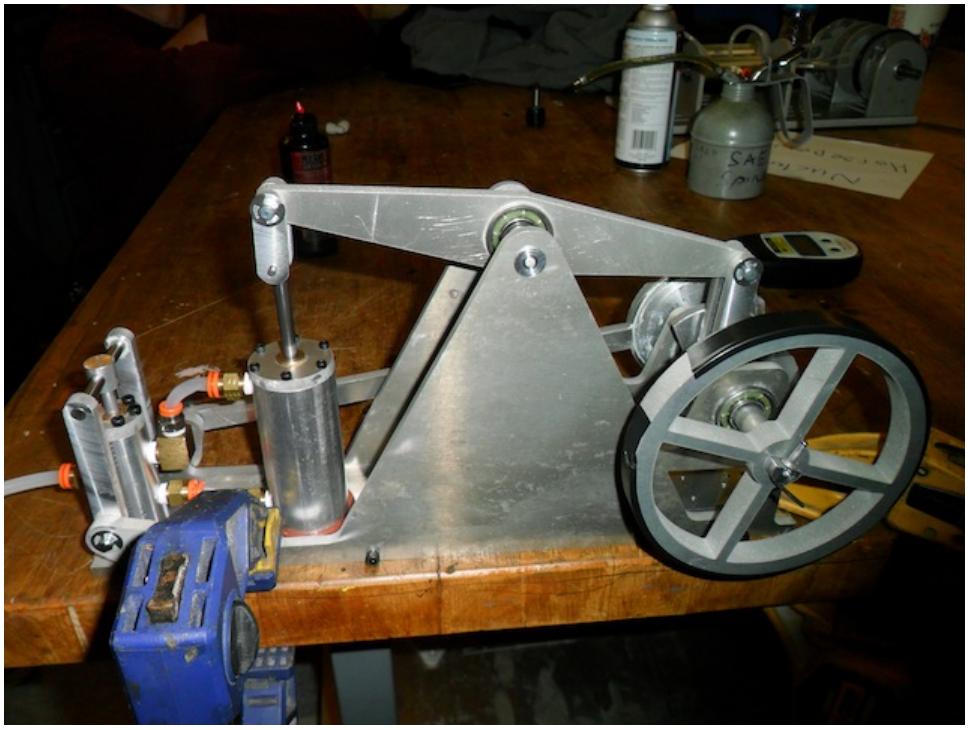
9. Additional Materials

Below are some pictures of my happy students at the culmination of their Thermal-Fluid Sciences 1 project. Each student team is holding an air engine that they designed, analyzed, built, and tested over the course's term. These engines are full of the students' blood, sweat, and tears. I also included a close up picture of one team's engine to give an appreciation for the complexity involved.


NAVY
TEAM
CARPARTS


the Ladies


Bayou
Beast



10. Biographical Sketch

I was born into a large and loving family in Wilmington, Delaware. My father got me into vehicles and all things mechanical at a young age. I earned my undergraduate degree in Mechanical Engineering from the University of Delaware in 2000. After UD, I got my MS and eventually PhD in Mechanical Engineering from Penn State in 2004, along the way engineering and building two diesel hybrid-electric SUVs and a 100% electric Ponitac Fiero.

For the past 10 years, I have been a professor at Rowan University teaching everything under the sun, but my favorite classes to teach are Thermal-Fluid Sciences, Advanced Heat Transfer, and of course Automotive Engineering. My area of specialization and research is hybrid and electric vehicle powertrain design and vehicle aerodynamics. Away from Rowan, I'm usually found outside playing with my kids and working on one of my half-dozen cars and tractors. I also spend and unhealthy amount of time looking forward to my favorite day of the year, the 24 Hours of Le Mans. I owe everything to the love I got from my big extended family, wife, two children, and countless Rowan engineering students.