Engineering Education:
It really should be about human transformation

Srinivas Garimella
Hightower Chair in Engineering and Director
Sustainable Thermal Systems Laboratory
GWW School of Mechanical Engineering
Phone: (404) 894-7479; E-mail: sgarimella@gatech.edu

Zeigler Outstanding Educator Award Lecture
April 17, 2013
Guru is Brahma, Guru is Vishnu, Guru is Shiva;
He is the All-pervasive Supreme Being;
This is why I pray to Guru

The secret to education:
Teacher is God! Enough Said. Bye Bye
Guru, Nietzsche, and the Mirror

- If you want to be a Guru, and play God, you had better assume the responsibilities of God, and keep looking at the mirror, because it does not lie.
- It is not just a job, it is a tall order and a lifelong challenge.
Who decides what one is worth

http://www.youtube.com/watch?v=jLo7tHDHgOc
Outline of this talk

• Really, not much of an outline
• I have taken the liberty to not get confused by the facts, and instead taken the easier way of spouting unsubstantiated opinions
• And thank you, Mr. Zeigler, for:
  – being such a champion of GT
  – demonstrating what relevant engineering education is without the need for labels, programs, and box checking

• **Dedication:**
  – To my parents, wife, son, and countless defenseless students at three schools who have had to put up with a tyrant like me
Who Am I?

• Core undergraduate courses in which I did **NOT** get an A at IIT Kanpur:
  – Intro to Engineering Design
  – Thermodynamics
  – Fluid Mechanics
  – Heat Transfer
  – And several others......

• I “specialize” in the Thermal Sciences!

• What gives me the right to opine about education?

• Better find the exit doors now rather than waste an hour of your time
What is Education?
Synthesis: Where are my “Givens”? 

Condenser: 
- $P_{\text{sat}} = 1150 \text{ kPa}$

Evaporator: 
- $P_{\text{sat}} = 430 \text{ kPa}$

Condenser:
- $T_{\text{air}} = 35^\circ \text{C}$
- $V_{\text{air}} = 2.36 \text{ m}^3/\text{s}$

Evaporator:
- $T_{\text{air}} = 25^\circ \text{C}$
- $V_{\text{air}} = 0.64 \text{ m}^3/\text{s}$
Synthesis: Thermal System Instead of Component

- Bite-sized digested nuggets syndrome prevents students from making connections
- Few components in real life act in isolation
- A more insidious problem:
  - *Students lulled into thinking anything that can’t be solved in 10 minutes is just too hard and too much to expect*
The Engineering Education “Problem”

• Unfortunately, it is NOT a conventional “problem” looking for a “solution.”

• And yet, plethora of analysis:
  – Box students into visual learners, auditory learners, kinesthetic learners, youtube learners, facebook learners, wikipedia learners, strategic learners
  – **Analogy:** Lebron James scores **22.06 points**, catches **7 rebounds**, dishes out **6.43 assists**, travels **2.1** times, and steals **3.26** times on games played on the **first Tuesdays** of each month on nights that are the **second nights of back-to-back games** on the **road** when **Dwayne Wade is playing** *(Have computer, analysis tools, will analyze)*

• So, what do we do with all this?
The Engineering Education “Problem”

- **Programmatic solutions**: The obligatory official mantra, offices, VPs: learning, not teaching
- One teaching enhancement course instructed engineering faculty to read to students in class, so they understand the importance of reading
- Check boxes on student evaluations
- NSF mandates “Broader Impact” statement in even 2-page graduate student fellowship proposals – *I will remove poverty and world hunger in destitute children in sub-Saharan Africa, and drag them into the 21st century, whether they want it or not*

- Facebook page, twitter feed, web “presence”
  - Never mind whether there is anything of substance on the site

- All of the above is good, but just partial “framework” steps

- How about just chatting with the students, looking at them, knowing who they are, **caring for** who they **should become**?
“Massive” Undergraduate Education

• Lure of automation
• Central theme in all enhancements:
  – removing person (teacher/taught) from the process
• Gains in “efficiency” mistaken as, portrayed as, gains in effectiveness
• Hurtling toward homogenized, average education of the masses, may be even achieving it
• But what about the individual, the brilliant and the not so bright
Quality

• Instant coffee commercials tout their ability to be *almost as good as* brewed coffee, the real thing
• The best Frozen Pizza
• Kraft “cheese” slices
• Big Box store DIY furniture or hand crafted?
• What is the difference:
  – Individualized attention
  – At least the product here is a product, in Engineering Education, the *product* is a *person*, and we want to achieve this by removing the person from the equation
Inspiration and Individual Transformation

• When was the last time a graduation speech or an Oscar speech thanked a viral video for inspiration, instead of a high school teacher or a drama coach?

• Is it all just content consumption?

• Who do you call when you want:
  – A glare at a student who arrives late to class?
  – A note on HW that says “expected better from you”
  – That was 100% right, but do you want to settle just for that?
  – “That was a well thought out, perfectly formulated and delivered response, but it was nonsense”
  – “Is everything OK, you look a little lost today”
  – Just for a previous Zeigler Award winner’s benefit:
    • “I think you can do better at a place like mid-western values school like The OSU, rather than an Applied Math department masquerading as engineering, like Hopkins”

• Bottom line:
  – Hard to transform an individual without individual interactions between individuals
Transformations in Graduate Students

• This is even more about the individual than undergraduate education is

• So many teaching advancement techniques, programs, few on advising grad students, developing a group

• GT one of the best research institutes, yet few programs to help advise graduate students, focus almost exclusively on undergrads
Pat Riley

• A **bench player** on stellar World Champion Laker teams
• And yet, Pat Riley effectively coached:
  – Kareem Abdul-Jabbar, Magic Johnson, James Worthy, Patrick Ewing, Alonso Mourning, Tim Hardaway, Shaquille O’Neal, Dwayne Wade, many others
• What makes him a great coach?
  – While emphasizing the person, instilled spirit of subsuming ego to achieve intensely felt team goal
  – Accepted nothing but excellence:
    • **Practice habits** more important than game day
• Who is an adviser?
  – Player?
  – Coach?
  – Research adviser?
  – Boss?
  – Friend?
  – Manager?
• All of the above except player + **Mentor**
• **It is about them, not you**
You might be a bad adviser if.....

• You are just looking for a finished product to cash in on
• Students are just your tools for your career advancement
• “Here is the problem, work hard, get me results and don’t ask me stupid questions”
• “Will fire you if no results by this date”
• “When I was a student, I knew everything”
DON’Ts

• **DON’T** treat all students equally
• Graduate student does not change because he/she was screamed at
• Focusing on weaknesses simply reinforces it, makes the person comfortable with the concept of failure
• **There are no students with no redeeming qualities,** find the best in every student and enhance it
• Whose responsibility is it if a student does not work out?
• Firing a student is an extreme measure
Simple, High Payoff, Too Often Ignored Habits to engender for Transformation

- Rigid framework, flexible content (allows focus on intellectual matters)
- On time (to the minute) to meetings, expect strict adherence
- Adviser who does not point out flaws is no adviser, not a popularity contest
- Honesty and integrity indispensable, but mere entry level passes – you don’t get a medal for this
- The output standard for all PhDs from your lab same, starting points differ
- No such thing as a “draft” effort; upper bound on PhD dissertation quality
- Needs “recurring fees” of steady high quality effort; lump sum at the end rarely, if ever, works.

**Tools:**
- Elevator pitch
- Career goals
- Core beliefs
- Weekly reports
- Travel forms
- Semester review and guidance
Clarify Expectations from Student to Enable Transformation

• PhD: ability to conduct large quanta of research on your own, not simply at adviser’s direction – you are the engine of research progress, not the adviser.

• If you are uncomfortable in your current abilities, either strive and work hard to improve them, or lose the illusion that it will happen on its own.

• Ambition supported by imagination, adaptability, and a constant search for new avenues.

• Someone is paying for the work: deliverables owed.

• Someone is depending on results of your work.
A Graduate Student is a Person

- GT students bright; can read book, solve equation, just point them in right direction: that is not where your most critical input is needed
- If all you give is orders to get the job done, you have “not added value”
- You have to reach the person
- Most common revelation of most new Asst. Profs: never thought I had to deal with so many and so different types of people
- Some true stories:
  - “Dr. G., my brother broke my leg on the soccer field”
  - “Dr. G., I broke my leg playing squash”
  - “Dr. G, I broke my leg just waiting for the light to turn green”
  - “Dr. G., my Dad underwent surgery on degenerative spine, can I spend a few weeks with him?”
  - From a sobbing student on the phone, “Dr. G., my girlfriend and I broke up”
  - “Dr. G., my parents are going through a rough patch”
  - “Dr. G., my wife and I are expecting twins”
  - “Dr. G., I am expecting”
- The first reaction should not be “Oh no! How will this affect my career”
- If 2-3 weeks out of 5-6 years to attend to a serious personal matter is unacceptable, your career was not on solid ground anyway
- If this happened to you, how much understanding would you expect from the chair?
A Supportive Relationship for Transformation

- Adviser-student in-person relationship almost as long as many US marriages
- Relationship is really generations long:
  - Fluid Mechanics faculty still strive to gain credibility by tracing their roots to Osborne Reynolds
  - This has to be earned by the “patriarch” adviser
- Trusting the adviser not optional - one cannot be guided without trust in the adviser
- Adviser's agenda never in conflict with, or orthogonal to, the student's agenda
- A champion for life
- Students part of adviser’s family
Building a Research Leader

• **If end point is capable research leader……**
  – Just do the experiments, you won’t understand why even if I explain it to you
  – I can’t risk having you present to a sponsor, your funding (and my career) is at stake
  – You don’t really think you can write a proposal, do you? There is a lot of deep thought involved
  – I can’t embarrass myself by having you present at a conference with the leaders in the field in attendance

• **Research leadership doesn’t just happen, you have to facilitate transformation**

• Far more rewarding to see student impress visitor, sponsor, audience than oneself
• Seek opinion, give decision making power, even veto power – you are building a leader, not a worker bee
• Help them decorate their CVs
• Earn a PhD because you are above normal, get comfortable with this – it is a responsibility to function at that exalted state
• Students should leave not just with “problem solved,” but with capabilities, a launching pad, and **comfort in intellectual leadership**
• Help them leave with, **I want to do this**, rather than **I can do this**
The Assistant Professor

• Muhammad Ali:
  – Float like a butterfly and sting like a bee
• Highly unlikely you are Muhammad Ali
• Even if you are:
  – Can you teach your student to be one?
  – And say it less
• What is my teaching load?
• School would be so great without students!
• Success comes one step at a time, in very small bits
• Don’t expect rewarding experience every day. Job can be 80% drudgery, 20% ecstasy; but drudgery is the struggle that leads to ecstasy
• Under ideal circumstances – life is not a theoretical problem - must excel under suboptimal conditions
• Function in ambiguity
• No long-term short cuts - excellence always trumps temporary undeserved success
• For the do-gooder senior faculty: Asst. Prof. is NOT a “tenure problem to solve”
  – Needs structured and unstructured help, not just proposal writing and class notes review
  – Not just a matter of reiterating tenure requirements
  – Not scaring the heck out of the junior faculty member (he or she is already plenty scared)
  – Often, it is just a friend with whom he/she can be genuine
• The best way to get tenure is to forget about it
An unending journey

- Seek people brighter than you, learn from them, revel in their success – that is your success and your legacy.

मातृ देवो भव
पितृ देवो भव
आचार्य देवो भव

mātī devo bhava
pitī devo bhava
ācārya devo bhava

Mother is God, Father is God, Teacher is God!

*We have a lot of work to do to keep trying to get there....*