# Introduction to Engineering Teamwork

High School Course Proposal

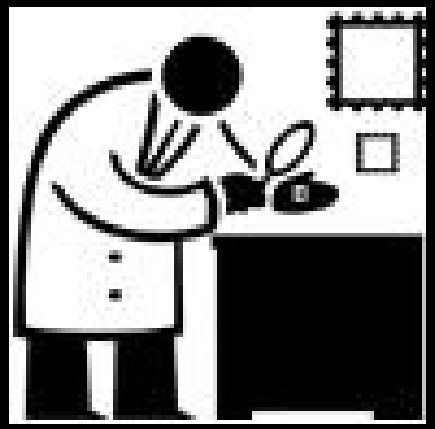
2010

# Most People Do Not Know What An Engineer Really Does.

- Thus often high school students do not know if they wish to pursue engineering to the college level.
- However, when some get a good glimpse, it inspires them to strive to build the proper background.

# Often Student are Able to See One of Two Extremes of Professional Science. Either…

- Projects that are very realistic as to what an entry-level scientist may perform, but usually do not motivate students to continue in that direction.



- Exciting demonstrations that do inspire the students but offer little realistic direction.

# We Prefer: Project-Based with Customized Levels of Differentiation, Including Key Elements:

- Split the Class into two or more Teams.
- Find Clients (outside of the school) for whom to provide engineering skills.
- Clients are only chosen who have very feasible tasks.
- Team members each develop their own Specialty.

# Specialties

- Allowing Students to chose their Specialty fosters Differentiation by helping each Student find both the Level and the Discipline that most motivates them.
- Some Specialties are chosen to draw women into this male-comfortable field.
- Some students may wish to adopt one than one (lighter-duty) Specialty to fully contribute.

# Some Specialties Include:

- Brainstorming & Concept Selection Facilitator
- Computer Modeling Designers (using engineering software such as AutoCad or SolidWorks)
- Bill of Materials (BoM) Manager using a spreadsheet like Excel
- Theoretical Analysis Manager
- Experimental Analysis Manager
- Prototype Design & Construction (with various sub-specialties)
- Prototype Testing
- Manual, Brochure & Press Release Writers

# Client and Task Example #1:

- Cristina from Rio de Janeiro has requested the development of a device that will cool people at beaches or by hotel pools, either including or in conjunction with an umbrella.
- If the device is a fan, it must not ruin a user's nice hairstyle.
- The device must be affordable for her to make or buy so that she can start selling them with a very low investment.

# The Client Feeds Marketing Info.

- For example, Cris photographs a popular billboard which offers cooling mist to joggers and bikers. This tells the team that the humidity is not too high for a mist to be effective.

# Initial Team Steps

- Start by identifying existing solutions.
- At a Team Meeting, existing solutions are categorized and trimmed.
- Each team member is assigned a category upon which to perform more in-depth research (via Internet, Patents & Libraries).
- At a Team Meeting, research is presented & discussed.
- The next meeting brainstorms for unique concepts to compete against the existing concepts.

# Example of Existing Concepts:

- Umbrella Fan

- Cooling Vest Using Super Water Absorbing Polymers

- Handheld Misting Fan

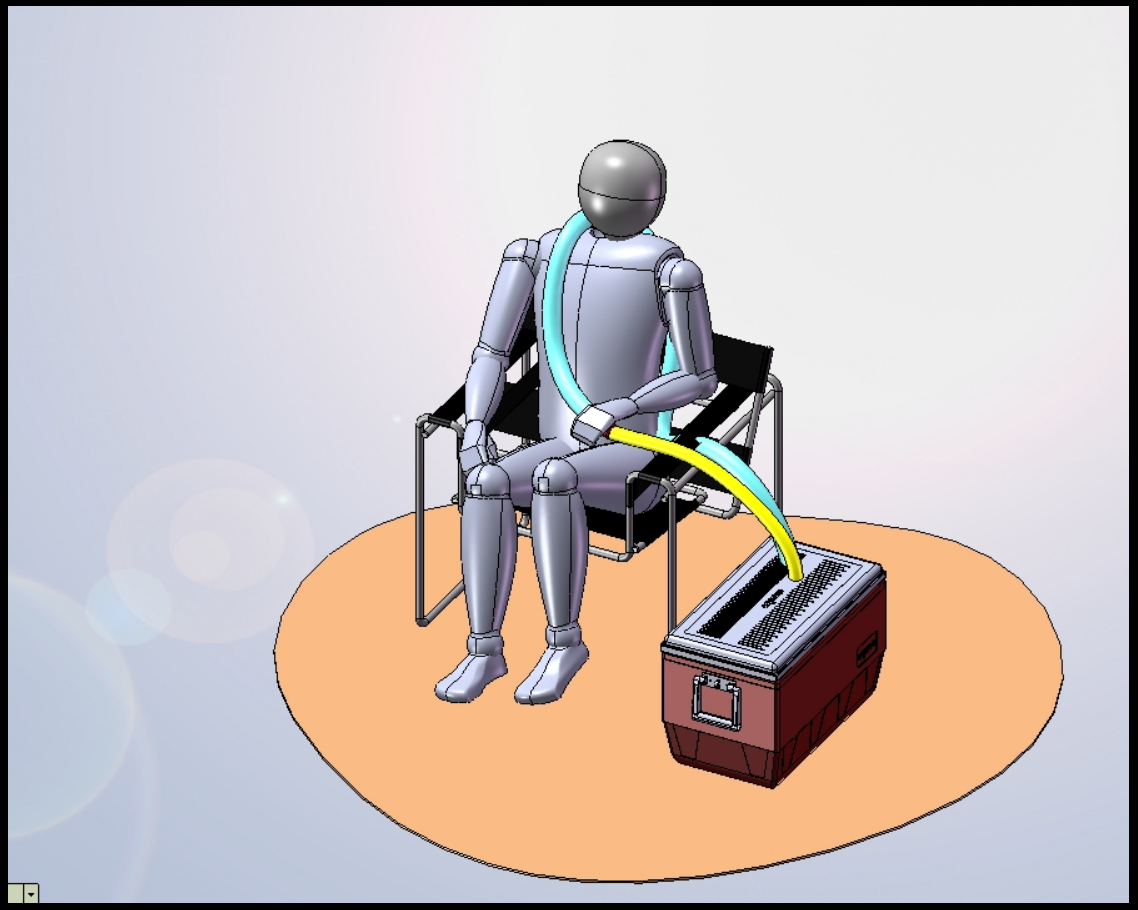
# Team Performs Concept Evaluation:

| \ Concept | Cools | Preserves Hairstyle | Inexpensive to Produce/Buy | Works when humid | People/Hotels will buy | Sum |
|---|---|---|---|---|---|---|
| Umbrella Fan | 5 | 0 | 3 | 8 | 4 | **20** |
| Cooling Vest (Polymers) | 4 | 10 | 8 | 2 | 5 | **29** |
| Handheld Misting Fan | 7 | 8 | 8 | 2 | 9 | **34** |
| Body Cooler | 8 | 10 | 9 | 10 | 5 | **44** |
| Hose Fan | 8 | 10 | 5 | 8 | 7 | **38** |

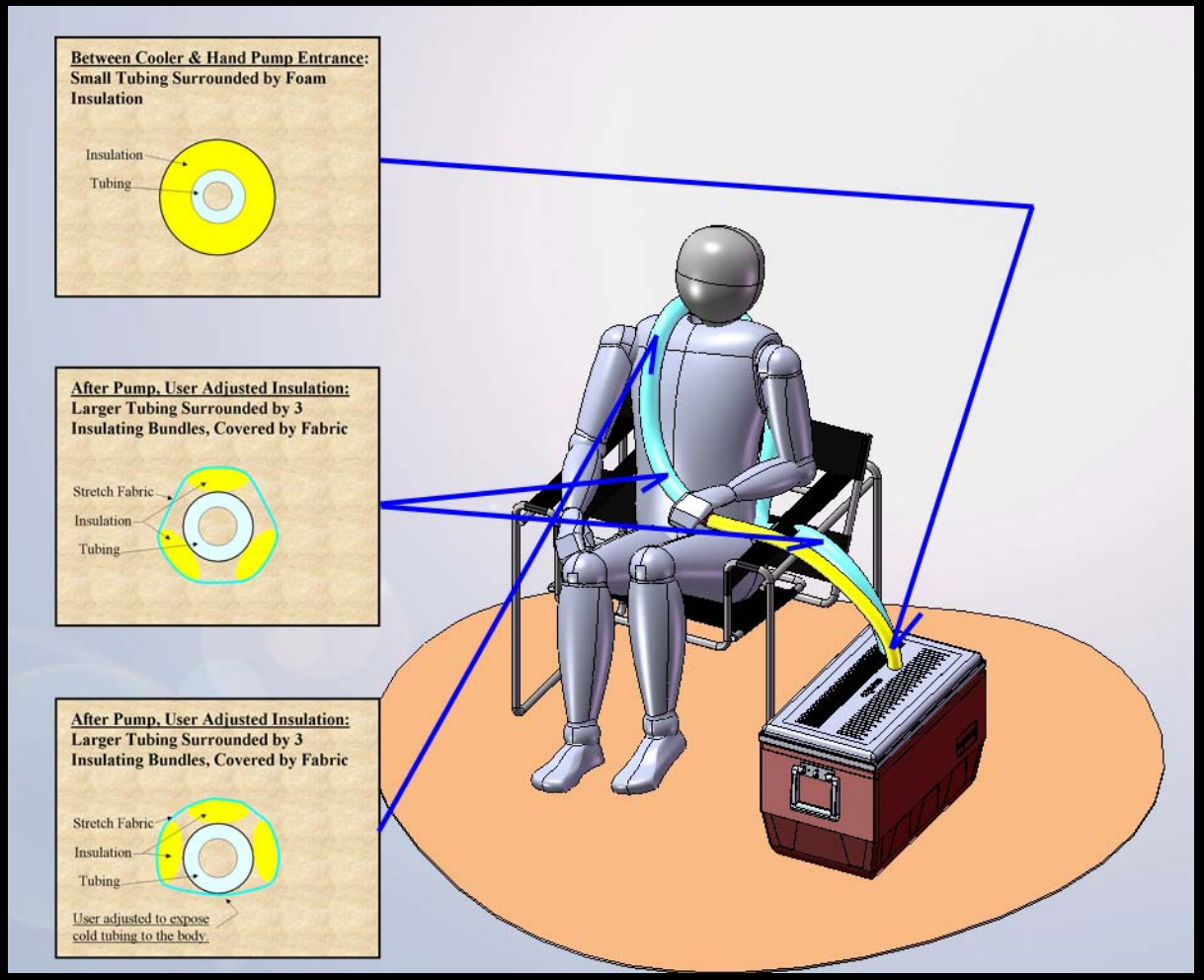
Exiting Concepts in Pink  New Concepts in Orange

(This quick example is not weighted.)

# Computer Modeling Specialists Create Parts, Assemblies & Models



# Theoretical & Experimental Specialists Refine the Design:



# The Level of Differentiation can be Adjusted for the Class

- For example, specialists only can perform the heat transfer analysis (a key discipline in used by most of engineers) or the whole class can learn key principles driven by the motivation to improve their product.

- Examples of leading questions related to this product are….

# Heat Transfer Question #1:

- It's a hot day and you are given only one of two choices to cool-off,… either:
  1. Eating an ice cube made from 70 ml of water & at -4 $^{o}$C.
  2. Drinking an 350 ml glass of water that is cooled to 10 $^{o}$C.

- Decide which is will cool you more.
- This question introduces
  - The difference between temperature and heat capacity.
  - The concept of latent heat.
  - Setting up an enclosed system model.
  - Calculations for determining equilibrium temperatures.

# Heat Transfer Question #2:

- Our Body Cooler is installed in a cooler with an internal volume of 12 Liters. Of that useable space,
  - 4 liters are taken up with cold soda cans;
  - 4 liters are accounted for by only ice at -2 $^{o}$C; and
  - 4 liters are accounted for by cold water that surrounds the soda and ice and that will circulate in your Body Cooler.

- How many Joules can you take out of this system that will cause only ½ the ice to convert to water at 0 $^{o}$C? Assume that the temperatures of the soda, water and cooler does not change.

# Heat Transfer Question #2 Teaches:

- Concepts continued from Question #1.
- How to make assumptions to set up for quick "ballpark" calculations rather than starting off analyzing all the details of a proposed system.
- Follow up by asking what impact the assumptions will have on the analysis.

- Possibly a follow-up experiment to determine what it feels like to have that many Joules removed from your body on a hot day and over a 20 minute time span. Is it a valuable feeling?

# Heat Transfer Question #3:

- Same as question #2, but this time replace ice with freezable material. What are the Joules now?
- Can the manufacturers be right when they say that this material is “Colder than Ice”?


# Prototype Developing Specialists Get to Work

# The Students Finish the Course with Documentation, Including:

- Documentation of the solutions developed (i.e. brochures, photos of prototypes, etc.)
- Thank you letter from the client, whom is encouraged to describe how the team has helped.
- Letter from the course leaders acknowledging how they have effectively learned and used their specialty to advance their team.

- A list of classes to take in High School to prepare for majoring in engineering in College.
- A list of suggestions for ways to find clients (or employers) (both pro bono and paying) in order to continue to develop as a viable resource.