Introduction to Engineering & Engineering Design

Fall Quarter 2018

What is Engineering?

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What is Engineering?

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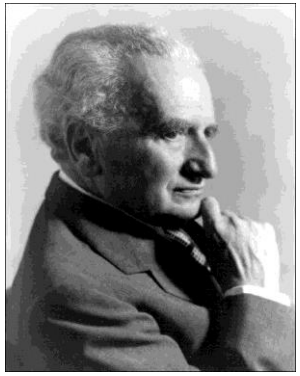
Engineering is

- Application of science and mathematics
- Design and build practical products - structures, machines, devices, systems, materials and processes
- Towards the improvement of the human condition

Scientists discover the world that exists;
engineers create the world that never was



Theodore von Karman
The Father of Supersonic Flight, he made fundamental contributions to the theory and practice of aerodynamics.

What is Engineering?

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"Engineering will challenge you to turn dreams into realities, while giving you the chance to travel, work with inspiring people and give back to your community."

http://www.engineeryourlife.org/

"From Research to Practice: The First-Year Engineering Program" by Prof. Teri Reed-Rhoads, Assistant Vice Chancellor of Academic Affairs, Texas A&M

Sample Projects @ UC I
Winter Design Reviews
https://www.youtube.com/watch?v=HJvs9cTI620
Engineers Without Borders
http://youtu.be/-sYLQAI7_aE?list=PLzRjdViBCgbx5tAECBdn-B6mSKSVgNKUD
HyperXite
https://youtu.be/yHYQa07Js3E?list=PLzRjdViBCgbzAsgxmfMeipoRDEV8xouIQ

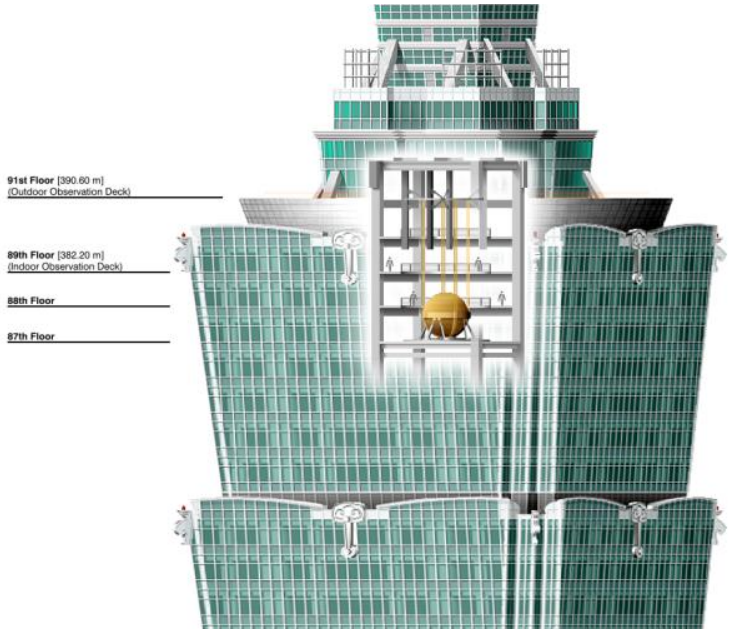
Engineered Structure

- Burj Khalifa
  - Tallest building in the world
  - 2,722.52 ft tall
  - Built in 2010
  - Country : United Arab Emirates
  - City: Dubai

Engineered Structure

- Akashi-Kaikyō (Pearl Bridge)
  - Longest Suspension Bridge in the world (6,532ft)
  - Built 1998
  - Country : Japan
  - City: Kobe

Engineered Structure



- Taipei 101
  - World's biggest tuned mass damper
  - Built 2004
  - Country : Taiwan (Republic of China)
  - City: Taipei

Engineered Structure

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- All of the machines you find in your hospital are produced by engineers. Even some that you don't see.
  - Medicine delivery
  - MRI Machines
  - CT Scan Machines
  - EKG
  - Thermometer

New Emerging Fields

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Example: ENGRGY

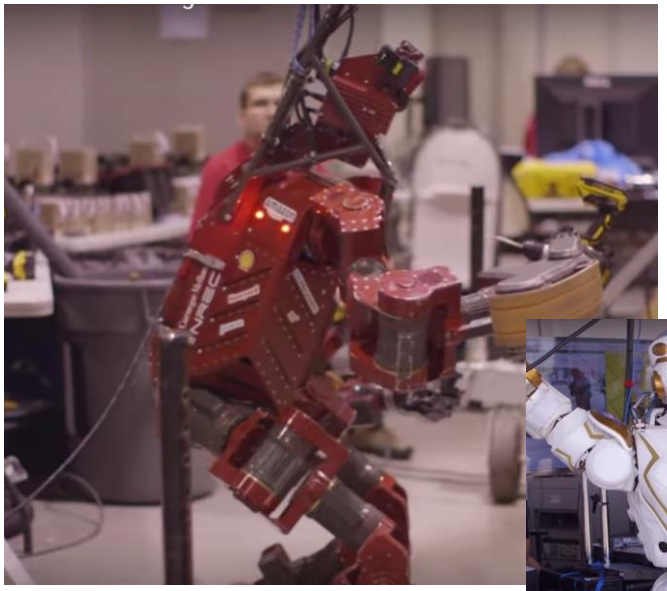
Engineered Systems - Nellis Solar Power Plant, Las Vegas

- Power
  - **14 MW**
- Site area
  - **140 acres**
- Equipment
  - **72,416 solar modules**
  - **54 inverters**
  - **18 transformers**
- Solar Tracking Technology
  - **5,394 tilted single-axis trackers**
  - **641 horizontal single-axis trackers**
- Energy Production
  - **30,100 MWh annually**
  - **~25% of the NAFB's load**
- Cost/Time
  - **Over 100 million in 26 WEEKS!**
  - **Largest Solar PV Power Plant in the US**

This solar power system will reduce CO2 emissions by 24,000 tons annually, equivalent to planting 260,000 trees or removing 185,000 cars from the roadways.

New Emerging Fields

- **Example: Humanoid, Human-Machine Interface**
  - DARPA Robotics Challenge, Human-Machine Interface



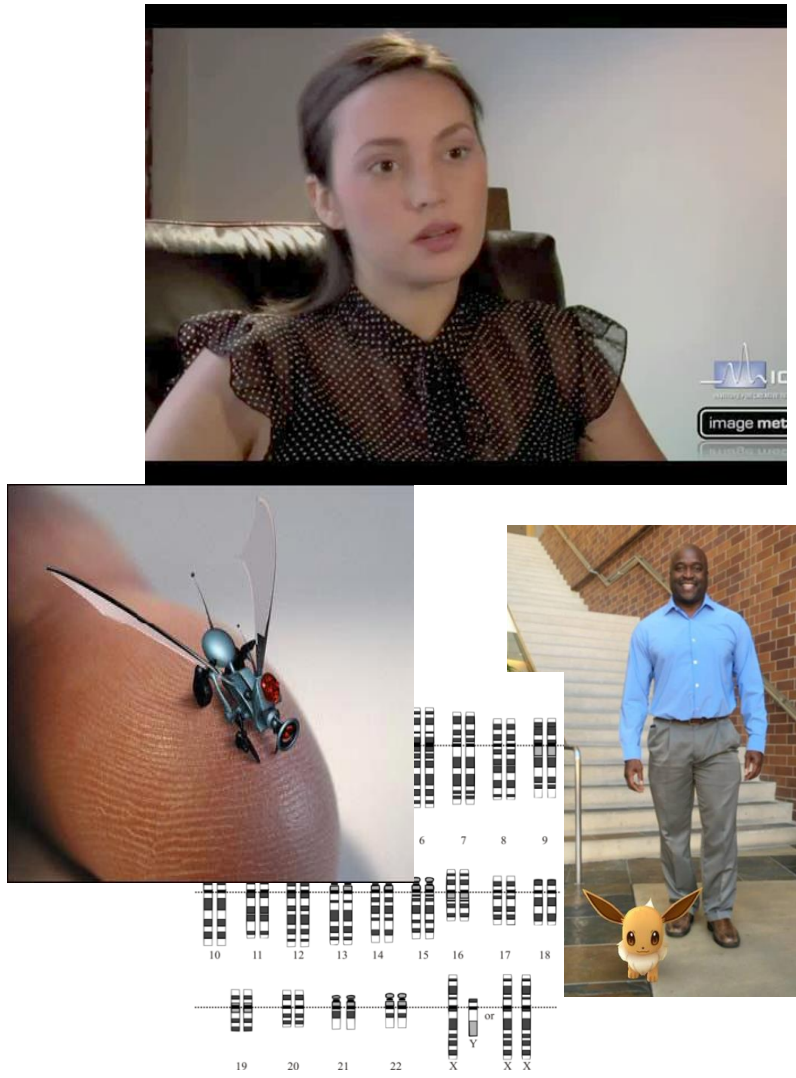
https://www.youtube.com/watch?v=8P9geWwi9e0

https://www.youtube.com/watch?v=g0TaYhjp0fo

https://www.youtube.com/watch?v=-Ly2r8hedBI

New Emerging Fields

- **More Examples!**
  - In April 2003, Human Genome (3 Billion DNA sequenced and encoded on 25K genes).
  - By 2023 computers will eclipse humans in Computational Capacity. Laptops by 2029.
  - Communications Bandwidth has increased by 100K since 2000.
  - Rise of Nanotechnology as a Discipline
  - Augmented Reality



Engineering is Lucrative

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	Profession	Average Starting Salary
1.	Pharmacy	$111,782
2.	Petroleum Engineering	$83,121
3.	Chemical Engineering	$64,902
4.	Mining & Mineral Engineering	$64,404
5.	Computer Engineering	$61,738
6.	Computer Science	$61,407
7.	Electrical Engineering	$60,125
8.	Mechanical Engineering	$58,766
9.	Industrial/Manufacturing Engineering	$58,358
10.	Systems Engineering	$57,438
11.	Engineering Technology	$56,447
12.	Aerospace/Aeronautical Engineering	$56,311
13.	Construction Science/Management	$53,199
14.	Information Sciences & Systems	$52,089
15.	Civil Engineering	$52,000

Source: cnbc.com

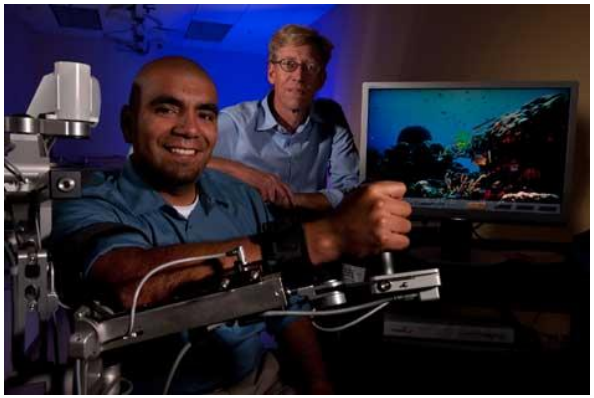
- 85% of US growth is attributable to advancements from Engineering and technology. Only 4% of our Workforce

Engineering is Fun

- Today you have learned some of the aspects of engineering
  - Design
  - Build
  - Test
  - Re-design
  - Re-evaluate

UCI Senior Design Project: HyperXite
https://youtu.be/yHYQa07Js3E?list=PLzRjdViBCgbzAsgxmfMeipoRDEV8xoulQ

Popsicle Stick Bridge



Rehabilitation Robots

ENGR Environment in 2020

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- The pace of technological innovation will continue to be rapid (most likely accelerating)
- The world in which technology will be deployed will be intensely globally interconnected.
- The population of individuals who are involved with or affected by technology (e.g., designers, manufacturers, distributors, users) will be increasingly diverse and multidisciplinary.
- Social, cultural, political, and economic forces will continue to shape and affect the success of technological innovation.
- The presence of technology in our everyday lives will be seamless, transparent, and more significant than ever.

The Engineer of 2020

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- Strong analytical skills.
- Practical ingenuity, creativity; innovator.
- Good communication skills.
- Business, management skills.
- High ethical standards, professionalism.
- Dynamic/agile/resilient/flexible
- Lifelong learner.
- Able to put problems in their socio-technical and operational context.
- Adaptive leader.
- Global engineer!

The Solar Decathlon Competition

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Juried Contests

- Architecture
- Market Appeal
- Engineering
- Communications
- Affordability
- Home Entertainment
- Comfort Zone
- Hot Water
- Appliances
- Energy Balance

Engineering Design

- *Engineering design is the set of decision-making processes and activities used to determine the form of an object given the functions desired by the customer. (Gov of MA)*

- *Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic science and mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing and evaluation. (ABET)*

Engineering Design

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- Creative process
- Problem solving – the big picture
- No single "correct" solution
- Technical aspects only a small part

Engineering Design

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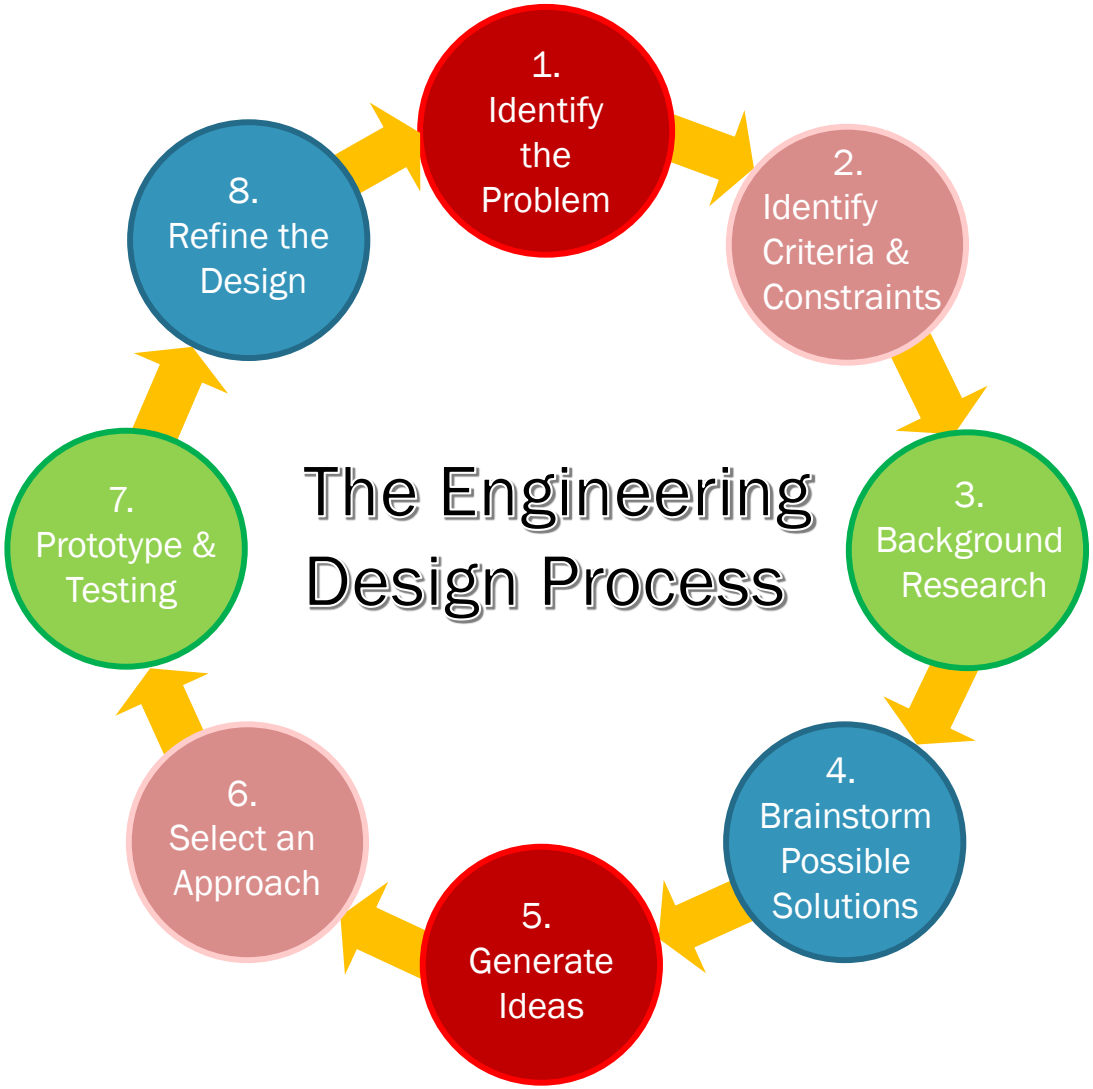
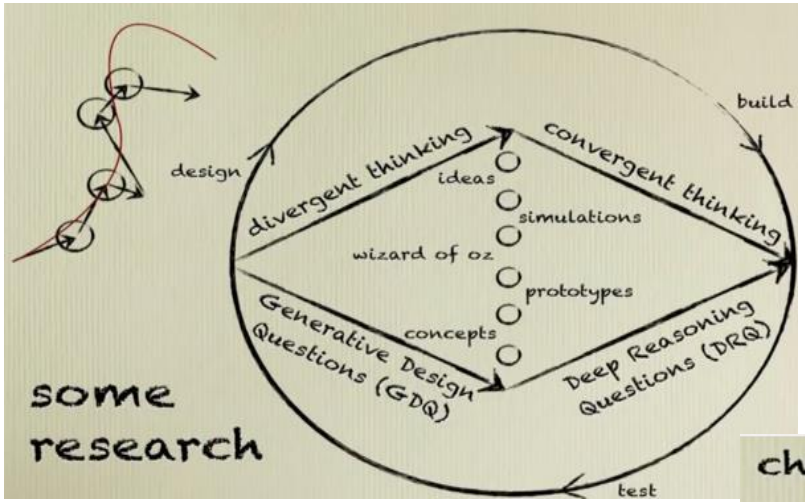
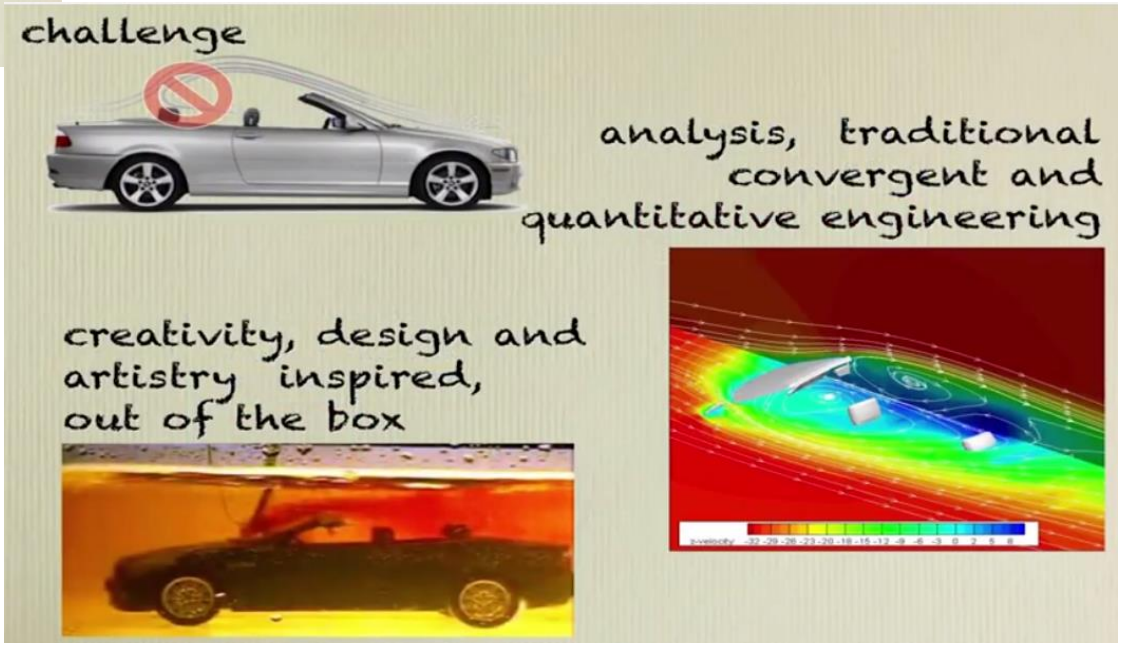


A Creative Process

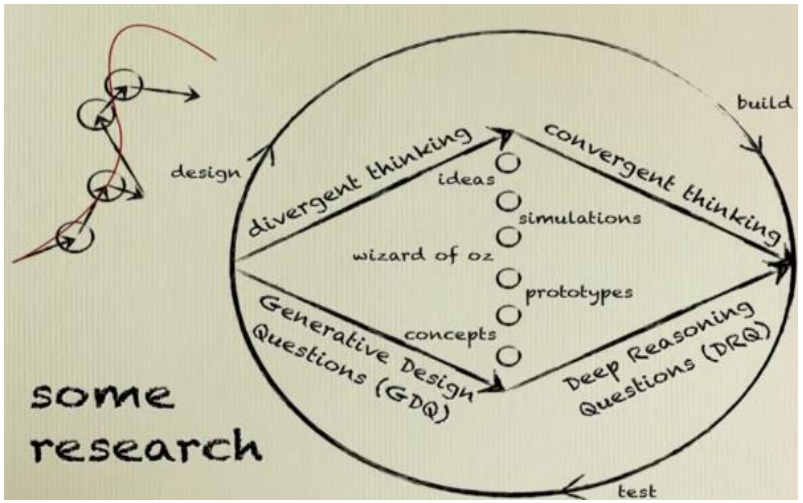


Prof. Martin Steinert,
Center for Design Research

Solving Backdraft problem of a convertible



A Creative Process



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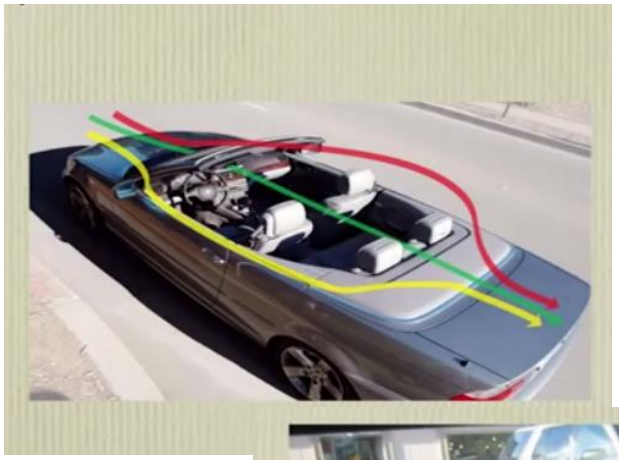
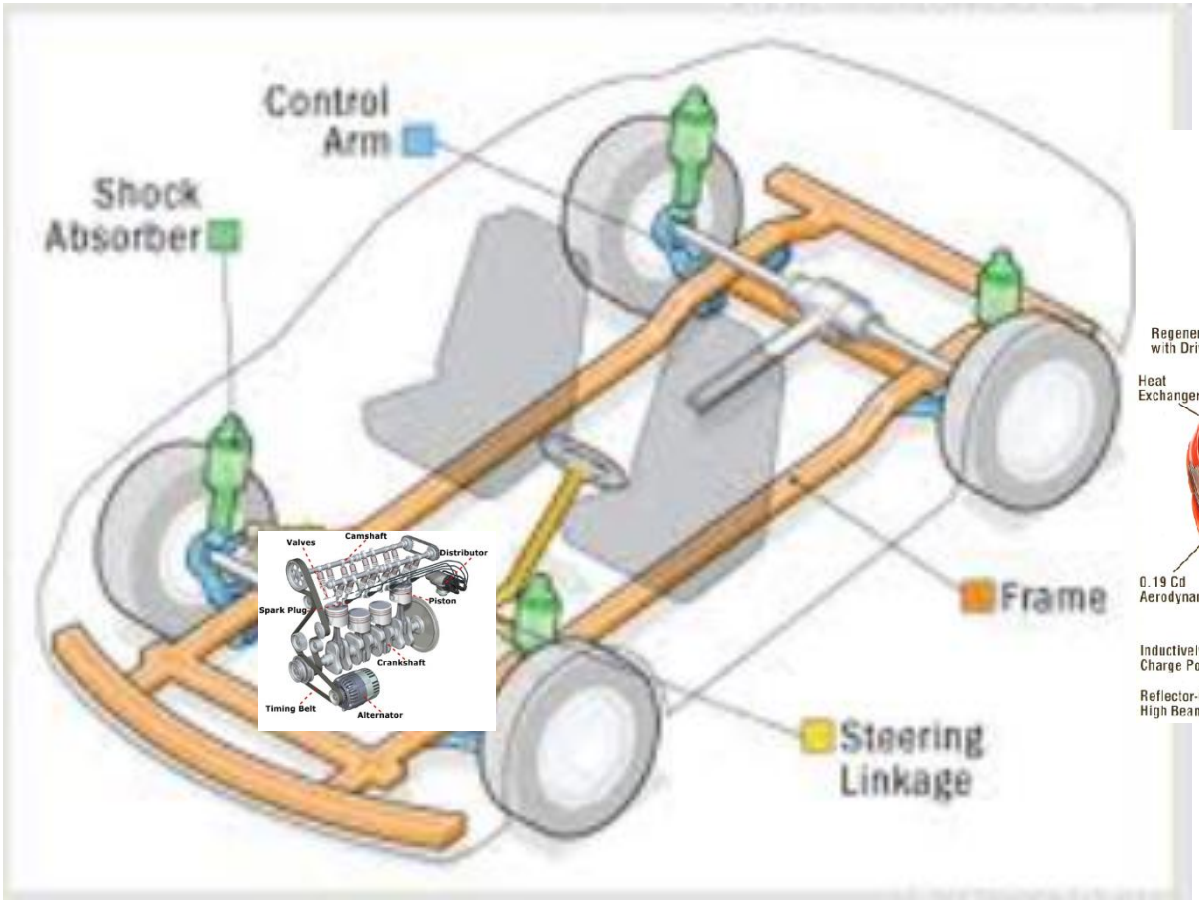
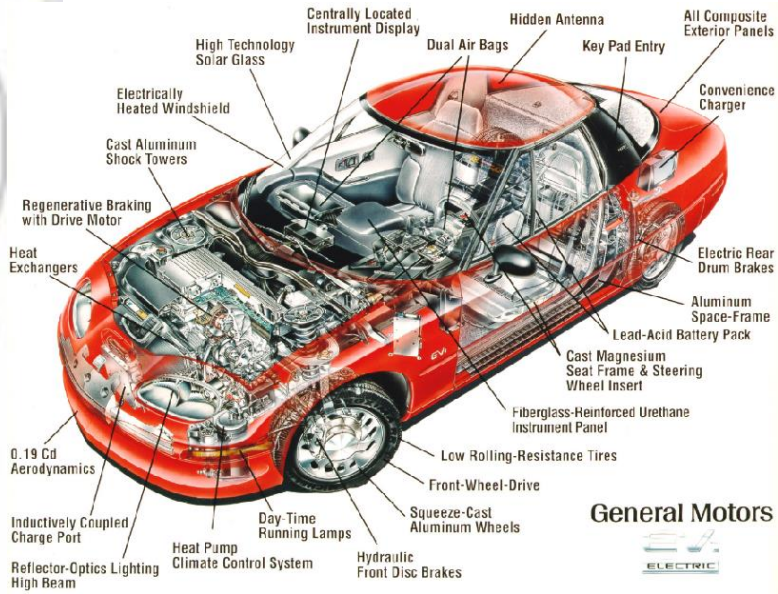


One solution to the backdraft problem

A Creative Process



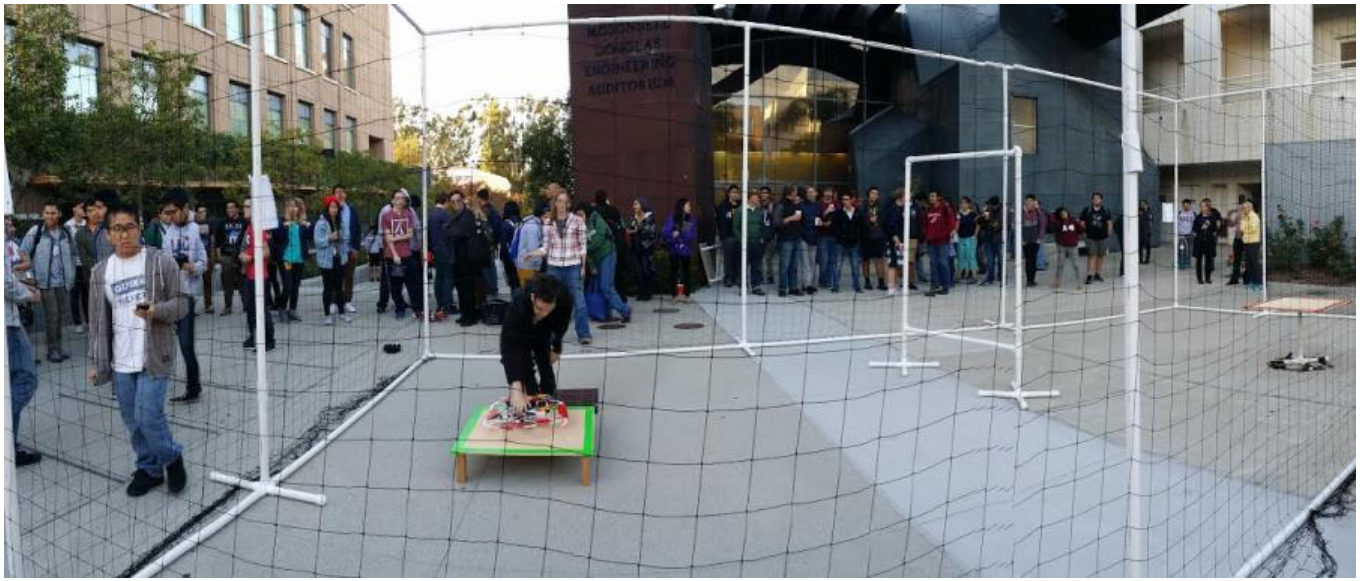
Example: Car Design



Final Product

Problem Needs Identification

- What is the “Problem”?
  - Collect information
  - Interpret information
  - Determine relative importance of needs
  - Review outcomes and process



course for quadcopter competition, 30’x15’x10’

Other Criteria/Constraints

- Economic
- Environmental
- Ethical and Legal
- Health and Safety
- Manufacturability
- Political and Social – FDA, language?
- Sustainability
- Example: Remote Control Quadcopter

Background Research

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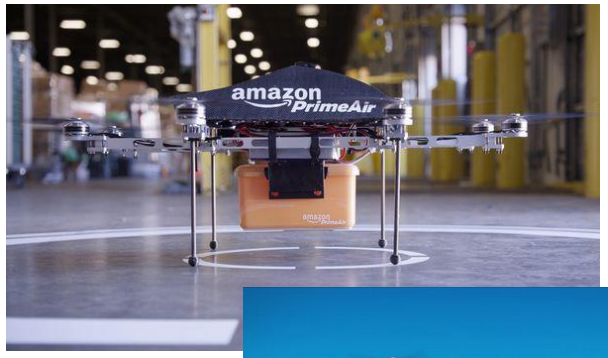
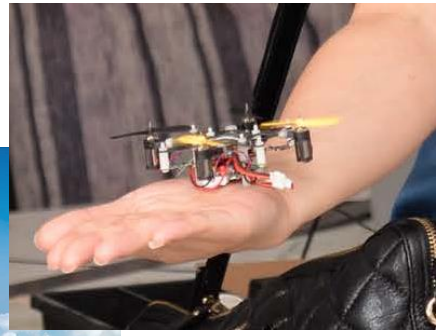
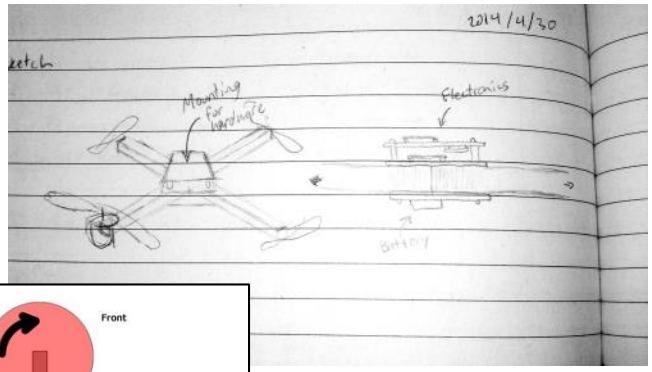
- What have been done in this field?
- What are the capability of existing products?
- What issues do current products have?
- What can I design to improve the current products?

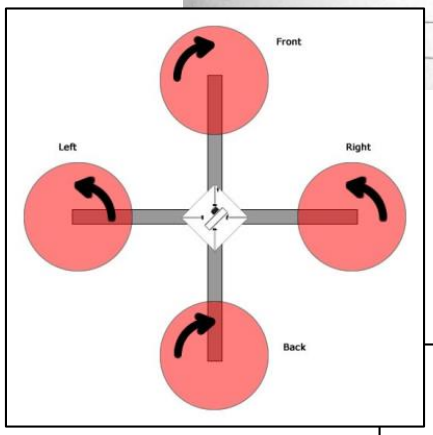


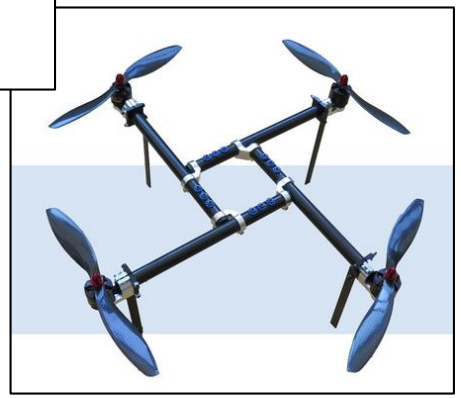


Concept Generation/Brainstorm

- Explore many solutions
  - Brainstorm
- Select the best solution
  - Based on needs and constraints
- Creativity
  - Development of new ideas
- Innovation
  - Bringing creative ideas to reality







Design Considerations

- WORST CASE DESIGN (Conservative)
- RELIABILITY
  - Measured by Mean Time Between Failure

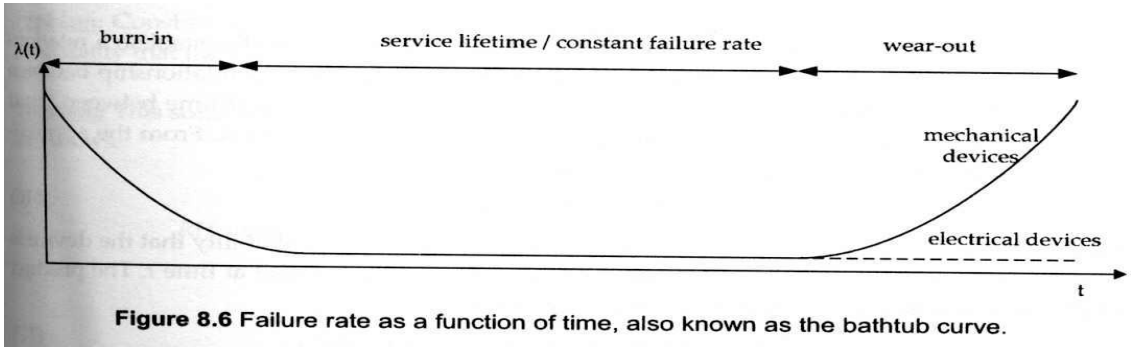


Figure 8.6 Failure rate as a function of time, also known as the bathtub curve.

  - Mechanical parts fail first
  - Build design redundancy into system
  - Simple system/fewer parts = more reliable

Design Considerations (cont.)

- SAFETY
  - Identify failure modes
  - Provide protection
- TEST
  - Design for ease of testing
- PRODUCTION/MANUFACTURING
  - Consider ease of assembly

Reading Assignment for Weeks 1 and 2

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"Introduction to Engineering Design" Book 11

Engineering Skills and Quadcopter Missions 4th Edition 2017

Chapter 1 "Introduction"

Chapter 2 "Product Development and Quadcopter Missions"

Chapter 7 "Development Teams"

Chapter 8 "The Engineering Profession"

Chapter 20 "Engineering and Society"