MECH4240 – Spring 2014

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ABET Objectives

The **Program Outcomes** for the Mechanical Engineering Undergraduate degree are as follows.

Graduates will have:

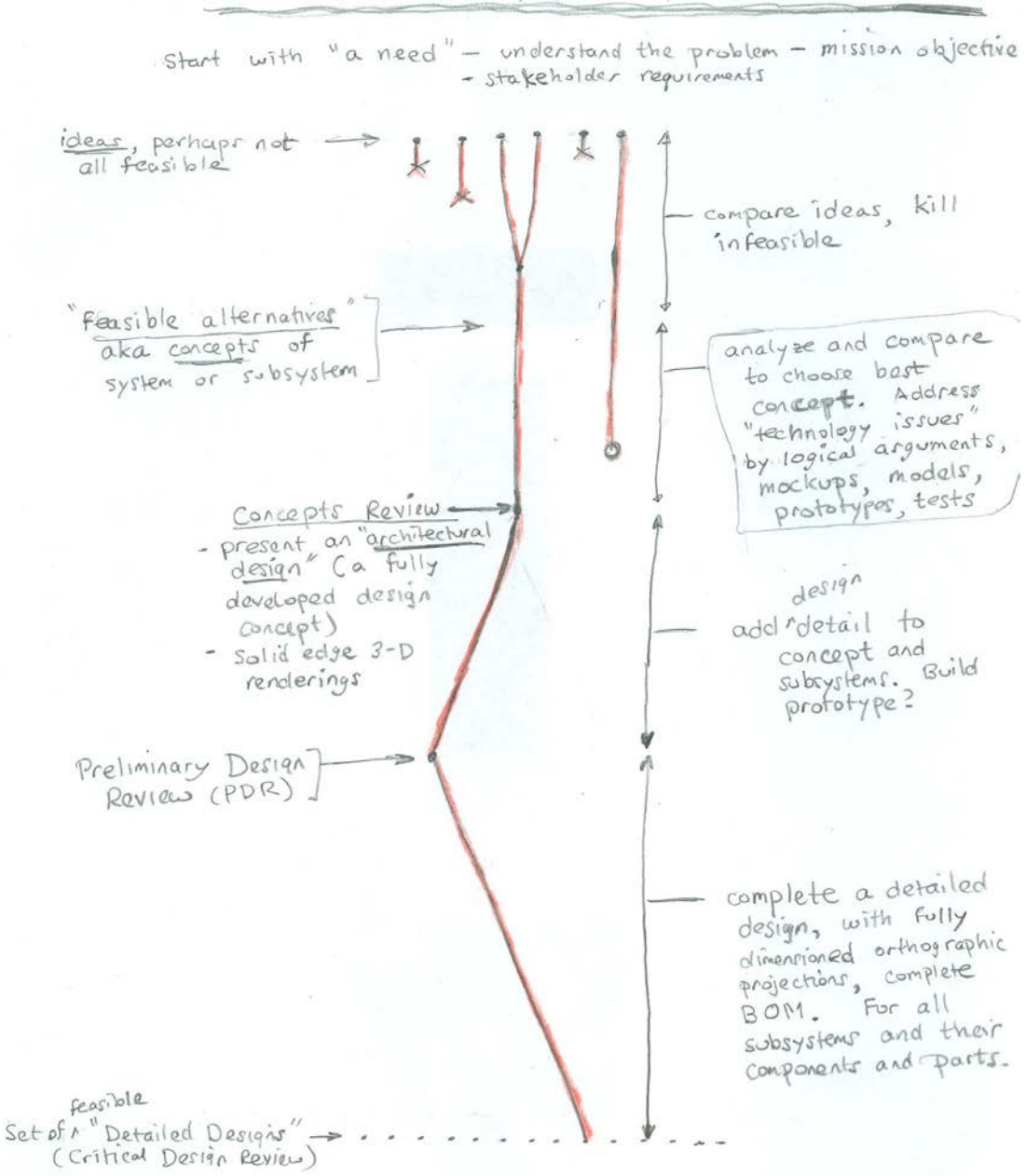
- (a) an ability to apply knowledge of mathematics, science, and engineering
- (b) an ability to design and conduct experiments, as well as to analyze and interpret data
- (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- (d) an ability to function on multidisciplinary teams
- (e) an ability to identify, formulate, and solve engineering problems
- (f) an understanding of professional and ethical responsibility
- (g) an ability to communicate effectively
- (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- (i) a recognition of the need for, and an ability to engage in life-long learning
- (j) a knowledge of contemporary issues
- (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- (p1) an ability to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations) to model, analyze, design, and realize physical systems, components or processes.
- (p2) an ability to work professionally in both thermal and mechanical systems areas

A Structured Design Approach Based on Systems Engineering

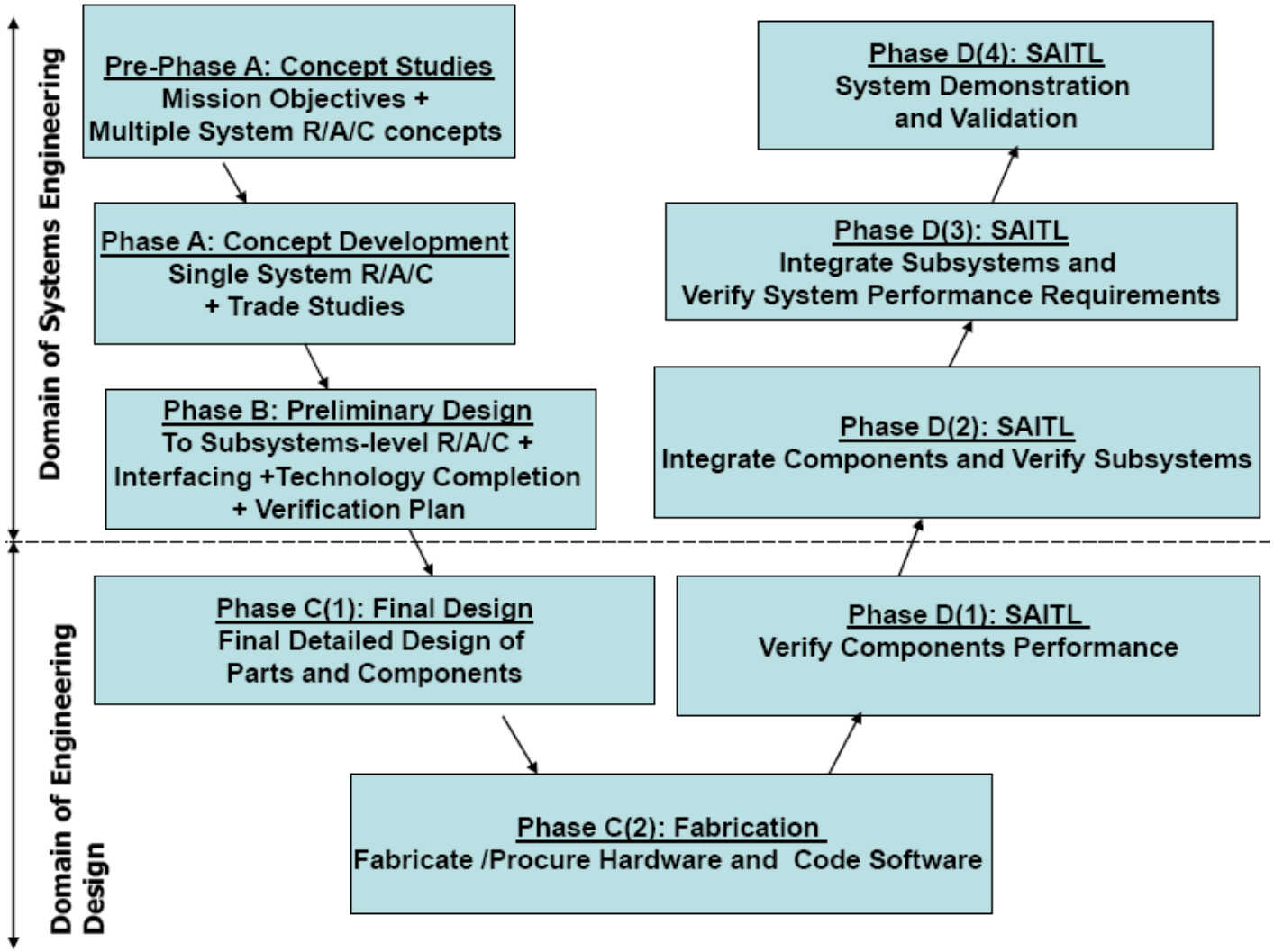
- The Design Space Pathway
- The Vee Chart
- There are two kinds of designs in this course:
  - An **architectural design** or "architecture", and
  - An architecture reveals the subsystems and their interfaces, and engineering specifications for each, with requirements that are fed to subsystem engineering design teams. It is a "big picture" design.
  - **detailed design** (which includes fully dimensioned CAD drawings created by subsystem engineering teams)
- Websites
- http://www.eng.auburn.edu/users/bealedg/MECH4240-50/

http://education.ksc.nasa.gov/esmdspacegrant/LunarRegolithExcavatorCourse/index.htm

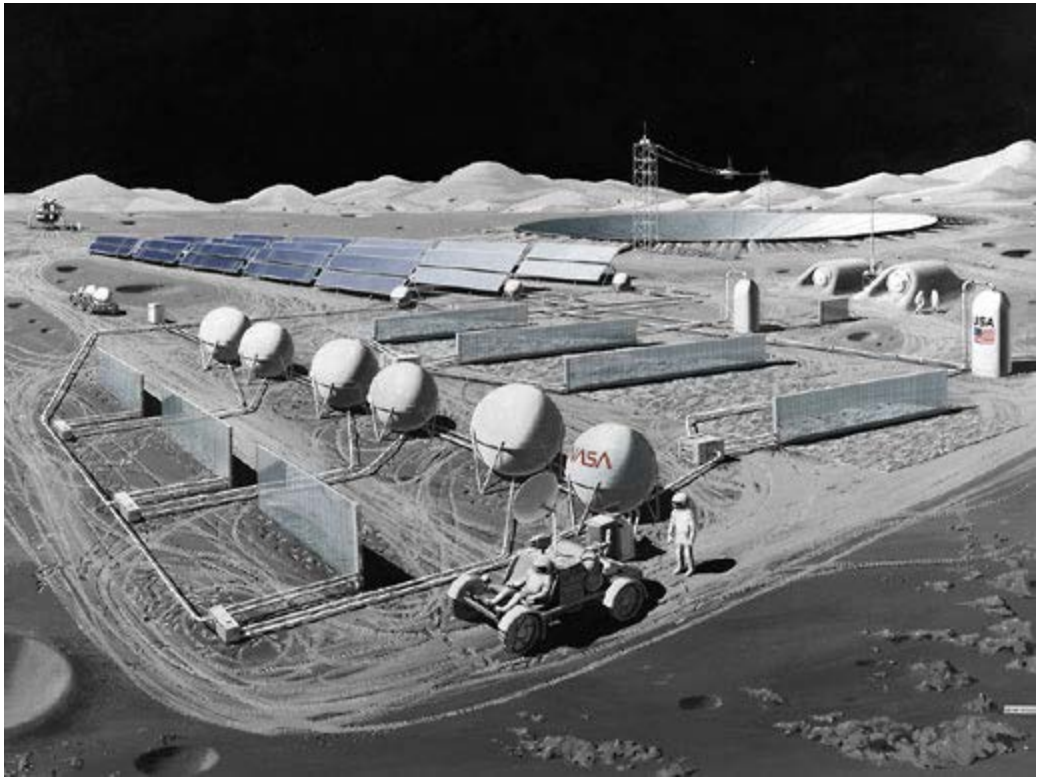
Design Space Pathway Toward a Detailed Design



The Vee Chart

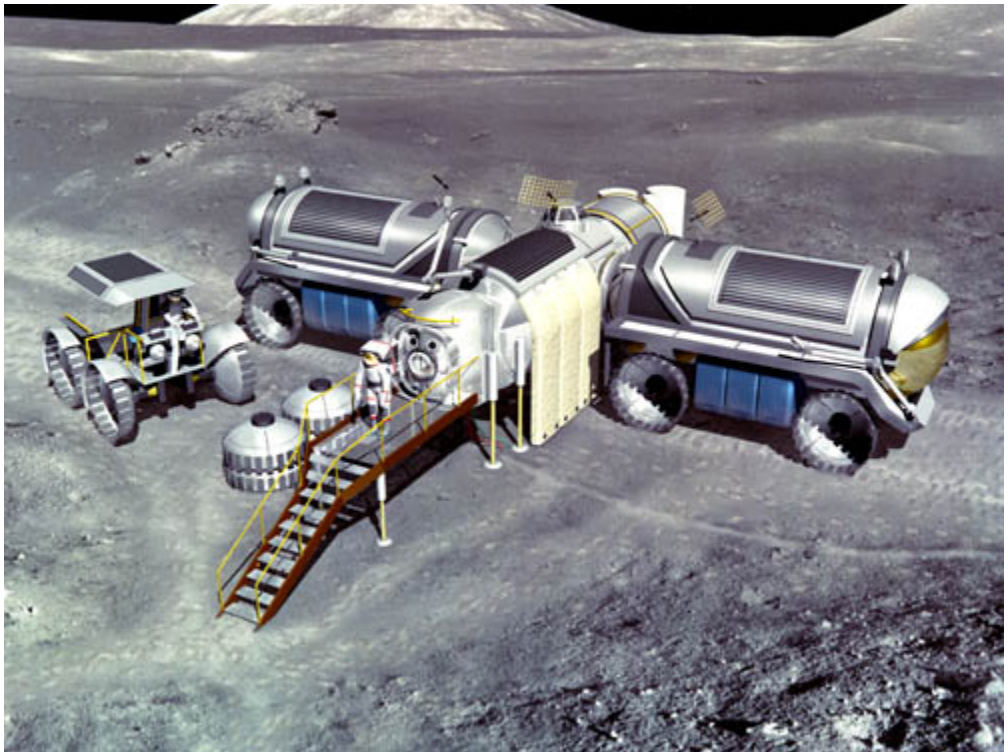


Examples of Architectures



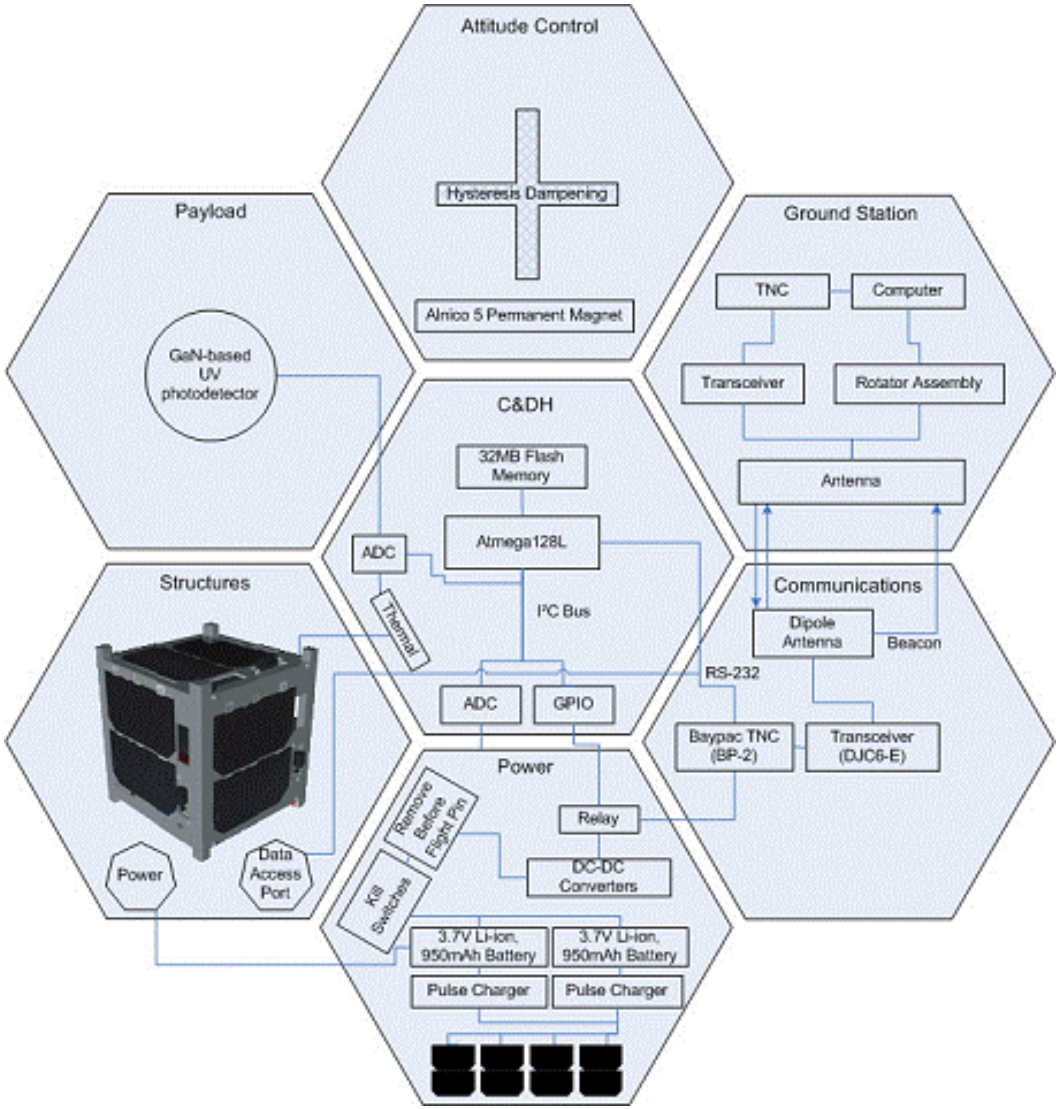
Architectural Design of a Lunar Base

LUNOX Outpost Architecture

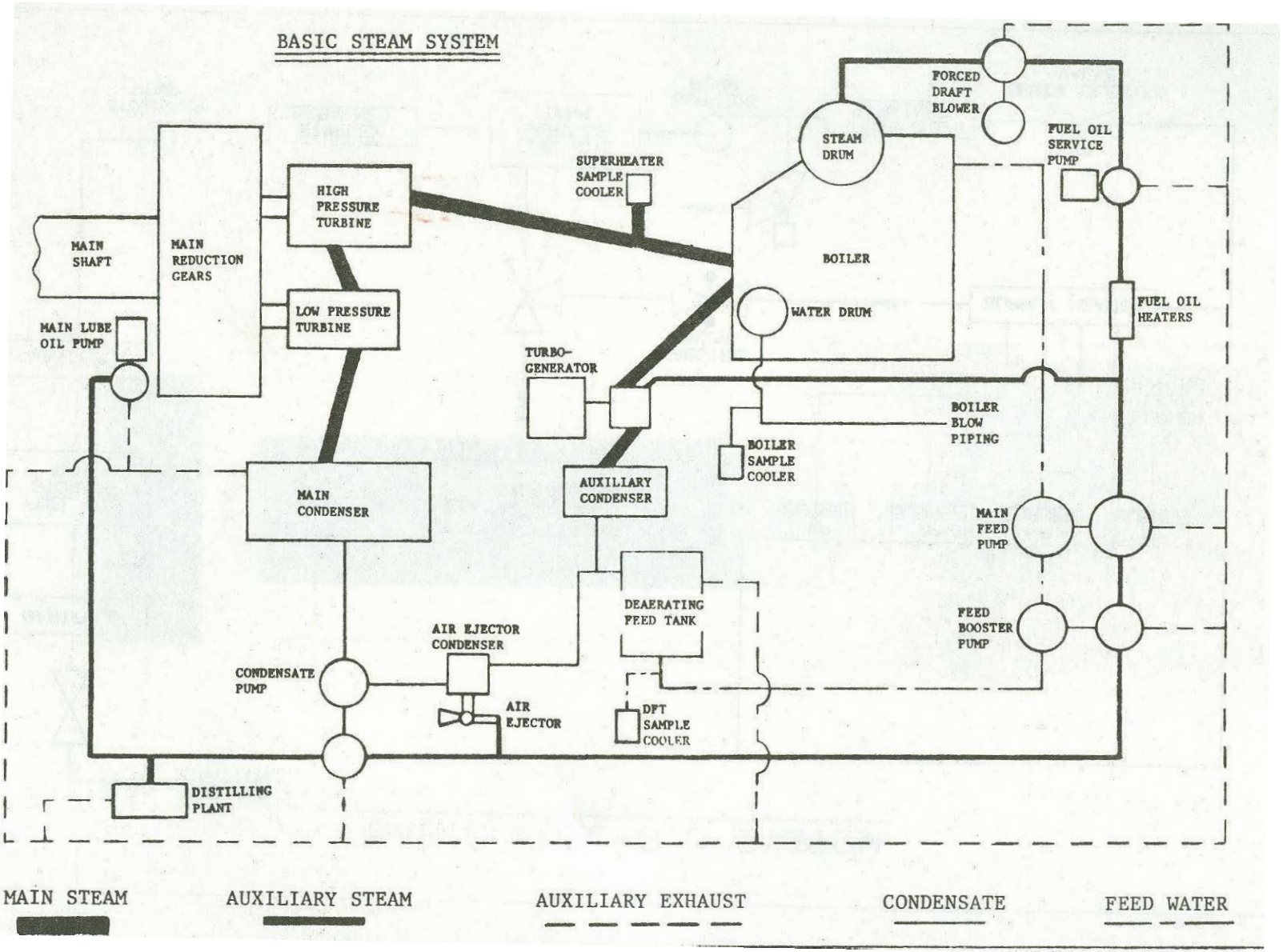


Like NASA's "First Lunar Outpost" study, LUNOX would only employ expendable spacecraft and rockets although the lunar surface infrastructure is reused. The first mission would deliver enough consumables for a 2-crew, 14-day mission to accomplish setup, repair or maintenance of the surface infrastructure. Future 4-crew missions of up to 45 days would also be feasible, although the required supplies (crew consumables, experiments, liquid hydrogen for the LUNOX system and fuel cells) must be delivered by a separate unmanned cargo flight.

CubeSat Architecture



Steam Power System Architecture


BASIC STEAM SYSTEM
FORCED DRAFT BLOWER
STEAM DRUM
FUEL OIL SERVICE PUMP
SUPERHEATER SAMPLE COOLER
HIGH PRESSURE TURBINE
MAIN SHAFT
MAIN REDUCTION GEARS
BOILER
WATER DRUM
FUEL OIL HEATERS
LOW PRESSURE TURBINE
MAIN LUBE OIL PUMP
TURBO-GENERATOR
BOILER BLOW PIPING
BOILER SAMPLE COOLER
AUXILIARY CONDENSER
MAIN CONDENSER
MAIN FEED PUMP
DEAERATING FEED TANK
FEED BOOSTER PUMP
AIR EJECTOR CONDENSER
CONDENSATE PUMP
AIR EJECTOR
DFT SAMPLE COOLER
DISTILLING PLANT
MAIN STEAM
AUXILIARY STEAM
AUXILIARY EXHAUST
CONDENSATE
FEED WATER

The Key Contributors Who Impact the Process

Sponsor	Technical Advisor	"Overlord"
• The primary stakeholder	• Assists the team • Monitors progress	• Assures that accreditation objectives are being met

Usually a contributor is a single person.
Sometimes the same person can serve as more than one contributor
Sometimes two people can work together and serve as a single contributor
Expect all three contributors to be present at your midterm and final presentations in MECH4240

Sponsor Involvement

- The Sponsor is the Primary Stakeholder – i.e. the person who has the most interest in the success of the project
- Duties of the Industrial Sponsor
  - Evaluates (i.e. grades) the technical content and product at midterm and final presentations . The grade is conveyed to the technical advisor to give to the team.
  - Sometimes the Sponsor will effect the design direction if the project does not appear to be meeting their objectives.
  - Establishes the “need”, which begins the design process
  - Pays for the project
- Often the Sponsor is a very experienced engineer who KNOWS what is needed from your design and product!

Technical Advisor Involvement

- Monitors your progress and meets with the group, biweekly or as needed or requested by the team. Grades design notebook. Manages and may contribute to peer reviews.
- Serves like a "senior engineer" i.e. someone who has had previous design experience, can answer some technical questions or else guide the student team toward resources to get their questions answered. In some situations the technical advisor may assign task(s) so that the student(s) answer their own question.
- Breaks down "walls" (impediments to progress when a team or student is stuck).
- The Technical Advisor does not lead the team's design effort or make assignments – that is the duty of the team manager.
- May offer ***design suggestions*** (but should not be the source of ***design innovation***).
- The technical advisor allows students to explore their own creative ideas, and to perhaps fail should those ideas not pan out (i.e. a "successful failure").
- However, if the student team is not proceeding with a workable solution or is "off on a tangent", the technical advisor may intercede and redirect the effort.

Overlord Involvement

- The Overlord makes sure that the ABET (Accreditation Board for Engineering and Technology) objectives are being met. This is primarily achieved by midterm and final reports that follow a specified format and is a well-written technical document.
- The Overlord will grade your midterm and final reports, and also individual student presentations

Other People

- Vicki Nelms is the administrative assistant who is responsible for billing and Purchase Orders (see technical advisor when ready to order something)
- Dr. Payton for manufacturing help and drawing approval.
- Other on-campus experts that I can send you to.
- Karen Clark for reserving conference room for presentations, key to lockers in new project room in Wiggins Hall…..
- Teaching Assistant – fabrication help, FEA help, CAD help, maintain the project room
- Your Professors!
- The wonderful marketplace.... With all the technical expertise of businesses that sell AND KNOW their product

Teaching Assistant Responsibilities

- Keeping grades up to date in CANVAS
- Tabulating peer reviews
- Assisting with ordering materials and purchase orders
- When assistance is needed for Finite Element Analysis, as directed by instructor
- CAD and fabrication assistance as needed and directed by instructor
- Project room management

Early Team Tasks

- Get a cabinet with key from Karen Clark
- Get a design notebook after form teams
- Start thinking about who will be manager, scribe
- Meet with your technical advisor and establish meeting schedule

Grading

- 25% Peer Review
  - Groups of 2 or 3: “Top Level Peer Review” by Technical Advisor
  - Groups of 4 or more: 1) Each student peer reviewed by their colleagues, and Technical Advisor will be encouraged to also peer review and/or 2) “Top Level Peer Review” by team manager.
- Industrial Sponsor Grade - They may not say much, but they know.

Want a COTS Part? E.g. "servo motor"

- A servo motor is a motor (often DC) for closed loop control purposes, often purchased with an encoder.
- **Check the industrial parts suppliers first:**
  - http://www.grainger.com/Grainger/static/products.html Grainger is a leading provider of top-quality industrial supplies worldwide. NONE HERE
  - http://www.mcmaster.com/ NONE HERE
  - http://us.misumi-ec.com/ factory automation supplier, NONE HERE
- **How about an electrical suppliers:**
  - www.mouser.com motors manufactured by Applied Motion only.
  - http://www.alliedelec.com/ manufactured by Pittman only.
  - http://www.newark.com/ - Maxon, Lin Engineering
  - MINIMAL CHOICES, also check the aforementioned manufacturers websites….
- **Let's also hunt for other manufacturers websites:**
  - Off the top of my head: Baldor, Dayton, Parker (www.parker.com), Danaher (http://www.danahermotion.com), Pittman. Call and talk to an engineer!
- **Perhaps call a local supplier of motion products** – Motion Industries in Columbus or Montgomery: (http://www.motionindustries.com/motion3/jsp/mii/index.html)
- **Look at a site that has listings of motor manufacturers.**
  - www.globalspec.com, www.thomasnet.com.
- **Check out the neat general engineering knowledge sites:**
  - www.efunda.com, www.machinedesign.com , Dr. Beale's catalog collection

Now When You Order, the Process Is:

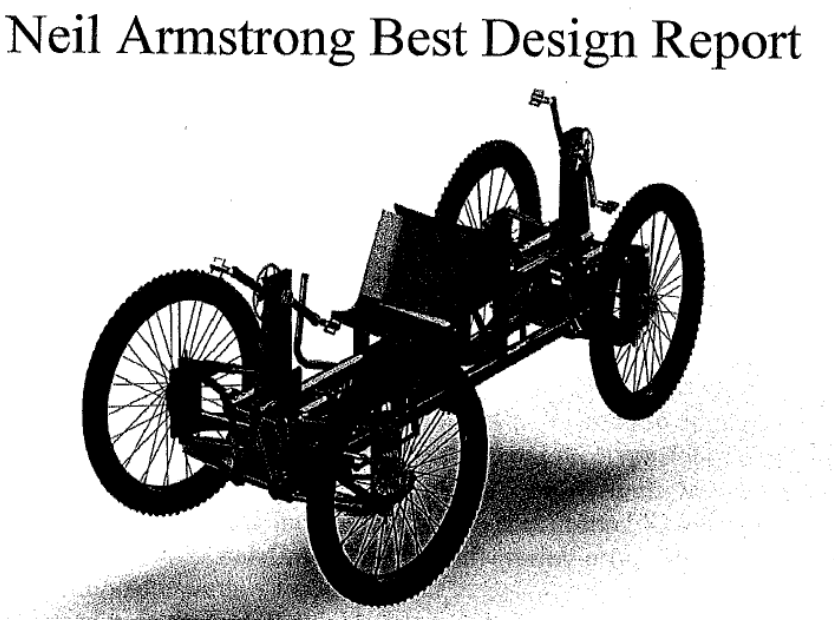
- See webpage

THIS NEXT SECTION IS DRAFT AND WILL BE UPDATED AFTER SPONSOR PRESENTATIONS!!!!!

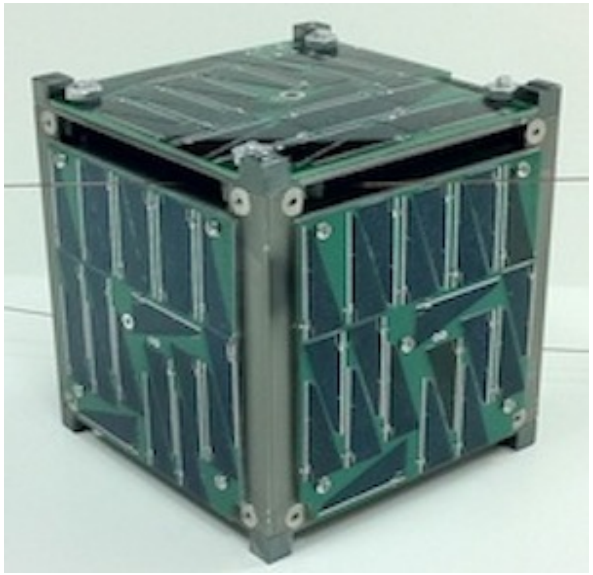
Overview of Projects and Project Choices This Semester (tentative)

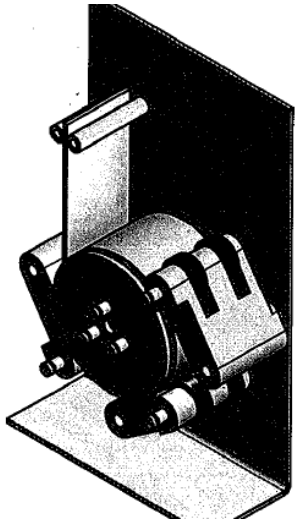
NASA Human Exploration Rover Challenge (#1 NASA Rover)

- http://www.nasa.gov/roverchallenge/home/index.html#.Us7TFPQSjPo
- Competition late April in Huntsville
- A 4250 team is preparing for the competition in April. You will also attend.
- RW will discuss the needs for a student team.
- First semester tasks TBD (tire?, joining team??, begin redesign??)
- Second semester: Evaluate competition performance and incremental improvement??
- Lots of vehicle dynamics, manufacturing



Cube Satellite Project (#2 CubeSat)





- Mechanical Engineering Issues:
- Vibrations, structures, deployable (antennas and mechanisms), attitude determination and control, thermal control
- Spring 2014: Largely ADACS, work with NASA folks and Dr. W. A highly analytical, computer simulation, dynamics and controls project. Will need to meet outside of classtime with Dr. W.

Air Force Heavy Lift (#3 Air Force)

- Competition among 20 universities
- Shortened timeline
- Internal competition?
- Trip to competition sight in April
- Possible patents
- Very challenging problem http://www.atlasdevices.com/

#4 Johnson Controls

- In our Row 1 metals kitting area there are 3 workstations for track prep that have a pretty archaic design. It is nothing more than a fixed, metal table that the team member sets the track on. At this station they put end caps, the wire harness, and the flex mat on the track. To do this requires the team member to flip and rotate the ~30 lb track. This design has resulted in an ergonomic and 5S nightmare. We would like a design team to come up with a height adjustable fixture capable of securing the track while still allowing the team member access to everywhere they need on the track. Each operator you watch moves the track in a different way, so part of the project would be to determine what sort of table rotation would be best for the operation.
- An excellent manufacturing project. Challenging, with mechanisms, actuators, sensors and sequential control (PLC, for which training is expected).

Johnson Controls Track Stand Senior Design Project

January 2014

The Part

Johnson Controls

The Workstation

Johnson Controls

#5 USDA Project

- Carroll has a well-used KMC peanut digger that he's using in his organic farming research. KMC is Kelley Manufacturing Co. and they are at Tifton, GA. I show some photos of KMC peanut diggers below. Carroll isn't using the digger for its intended use - instead, he's using it to remove weeds from the soil before the crop has been planted, and maybe even after the crop is growing. He's using it for various crops, so he's not necessarily using it for peanuts. So far, when he uses the machine, he's just letting the uprooted weeds get deposited out the rear of the digger, back on the soil surface. A problem with this is that the weeds have the opportunity to take root again and start growing again. He's interested in developing a hopper or box to be at the rear of the digger, to receive the weeds so they can then be transported away from the field and dumped "in the woods." He thinks a useful feature of the design would be to have a means of shaking the weeds, before they land in the hopper, to shake the soil from the weeds and let that soil drop down onto the soil right there in the field, while the digger is running. I suggested to Carroll that this would be a good design project for one of your student design teams and Carroll is quite eager to pursue this. I wasn't sure when your next group of students starts your senior design course, so I said it might be a year or 1.5 years before the student group would have their prototype completed. He said this is OK - he said they've been using their digger as it is for about 4 or 5 years, so if it takes a year or 1.5 years before this new prototype would be developed, that's fine.
-
- The machine that Carroll has is the "2 row model" shown in Fig. 1 below, but on his, much of the extra stuff has been removed, so the main working mechanism is the inclined chain that's between the two whitish (light green) guiding walls that are shown in Fig. 1.
- http://www.caes.uga.edu/topics/sustainag/programs/peanut.html
- Wiley C. Johnson III (Carroll)
- USDA - ARS Crop Protection and Management Research Unit
- Research Agronomist - Weed Science Room 133 2747 Davis Road Tifton, GA, 31793-0748
- Phone: 229/387-2347 E-Mail: Carroll.Johnson@ars.usda.gov
- Photos here are from http://www.kelleymfg.com/products/peanut/digger.aspx

Points: Will work with Dr. Way and technicians at USDA facility on campus at corner of Donahue and Samford. Excellent access to a machine shop there and other equipment.
-

USDA Project

Peanut Digger/Shaker/Inverter

Fig. 1. 2 Row Model Front view is shown above.

#6 Southern Company

- Statement of Work
- *Development of a High Temperature Strain Gage*
- **Background**
- Characterization of high temperature power plant components is elusive, as often the harsh environments limit the type of instrumentation that can be used to do so. The ability to precisely and accurately monitor component state is often limited by the extreme temperatures encountered. Ironically, these components can dictate the useful life of their larger subsystem. Accurate prediction of remaining life via measurement, previously estimated via calculations or laboratory testing, has potential economic benefits.
- **Objective**
- High temperatures can degrade standard instrumentation rapidly, and some environments are accompanied by harsh chemical atmospheres. Durable and reliable instrumentation to characterize component loading is needed to more accurately characterize remaining life or component operation state regarding stress. This project should work toward developing such instrumentation, such as a high temperature strain gage.
- **Requirements**
- Low or comparable cost for instrumentation systems
- Compatibility with existing strain gage monitoring instrumentation
- Easy installation
- Low maintenance requirements
- Readily available componentry
- Ability to withstand sustained temperatures up to 1500°F without loss of accuracy or precision over time (both within 2%)
- Resistant to water
- **Deliverables**
- Report on state of the art stress/strain measurement instrumentation
- Design for novel, practical, and low cost high temperature strain gage that can withstand up to 1500°F sustained specimen temperatures and accurately measure loads at these temperatures and conforming to given specifications
- Successful demonstration and characterization of prototype strain gage instrumentation proving conformance to all design requirements.
- Analysis and critique of design, including operational limitations, resulting in a full instrument specification.
- Final report and presentation summarizing project effort

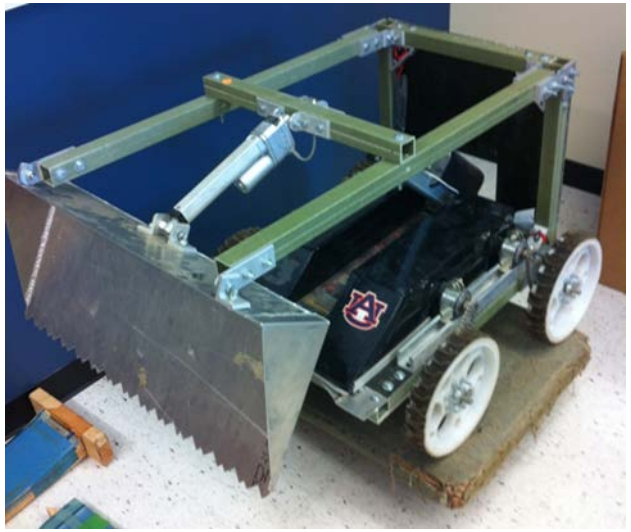
#7 Biomedical

- Garrett Thee project initially. Perhaps other projects as well, dependent upon the feasibility. Ronguers, locking screw possible.
- Patentability, claims, nondisclosure agreement.
- A smaller group here. A particular challenge will be manufacture of small parts.

#8 Dr. Payton

- A truly thermo-fluid systems project.
- Will work Dr. Payton

#9 NASA Robotics Mining Competition



Run as a senior project in ME, EE, with a new team each year. Competed at KSC in 2010-2012. Did well in digging contest (2^{nd} ,5^{th}), won Systems Engineering paper award 2010. 50 – 60 teams competing in 2012.

http://www.nasa.gov/offices/education/centers/kennedy/technology/nasarmc.html#.Us7UGfQSjPo

A new rover needs to be designed for the competition in May 2015. Team will concentrate on the mechanical design, including motor and actuators, mechanisms and structures, drive train and steering, simplified control, testing. The competition has changed, so the old rover is outdated but a useful learning device. EE and CSE students may join Summer.

Project Assignments

Project Type	Project	Industrial Sponsor (i.e. grading of product and ability to satisfy mission)	Technical Advisor	Overlord (i.e. grades report)
Competition	#1 NASA Rover	ASGC:Madsen/ Wersinger/Jones/Beale	Austin Gurley	Beale
Competition	#3 Air Force Heavy Lift	Cahill/Broughton/Beale	Beale/Broughton	Beale
Medical	#7 Biomedical	Garrett Thee/Dr. Warren?	Beale/Petersen	Beale
Gov't Lab	#5 USDA	USDA Laboratory: Dr. Way/Carroll Johnson	Way	Beale
Workforce Develpmnt	#2 CubeSat	Wersinger (Emeritus Professor)	McGinnis/Wersinger/Beale	Beale
Industry	#6 Southern Co. (strain gage)	Southern Co.: Josh Barron	Beale	Beale
Industry	#4 Johnson Controls (manufacturing device)	Johnson Control: Nate V.	Beale	Beale
Thermo-fluid	#8 Dr. Payton	Payton	Payton	Payton
Competition	#9 NASA Robotic Mining	ASGC: Madsen/Beale	Beale	Beale