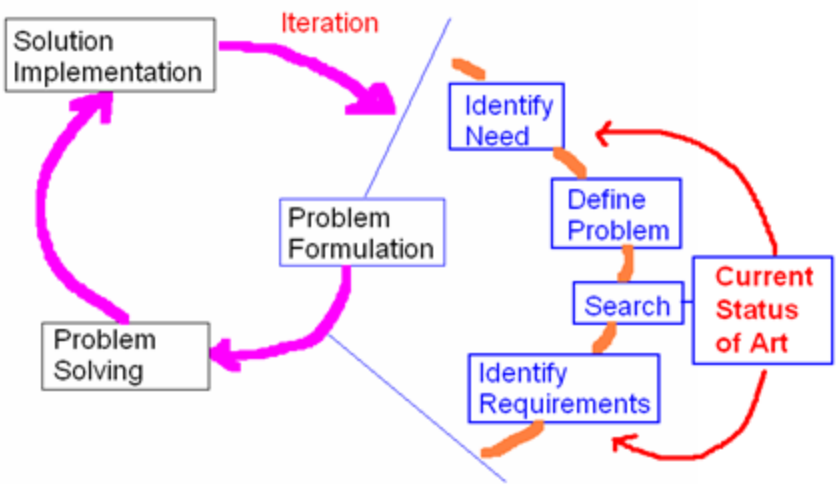
Design Requirements



EECE401 Senior Design I

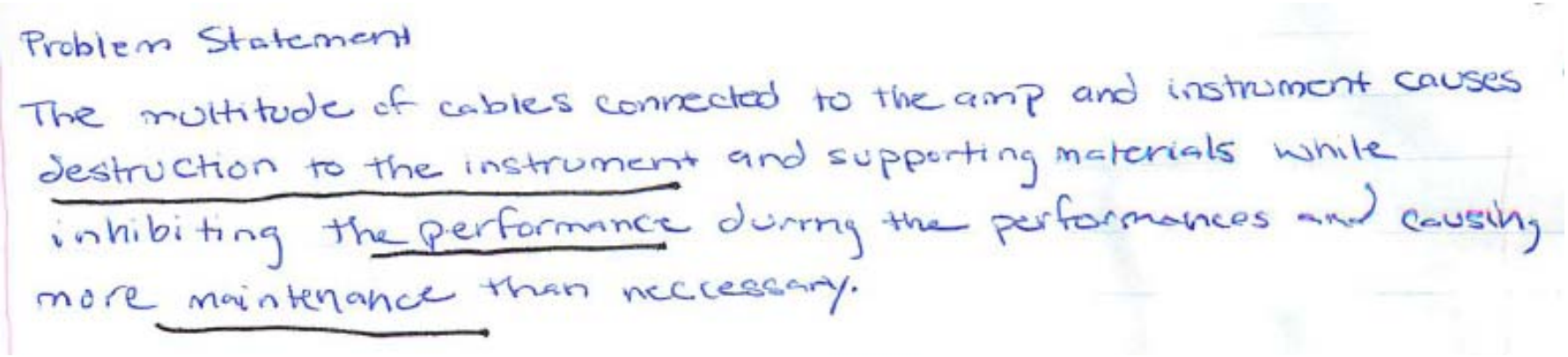
Dr. Charles Kim

Electrical and Computer Engineering
Howard University
Washington, DC

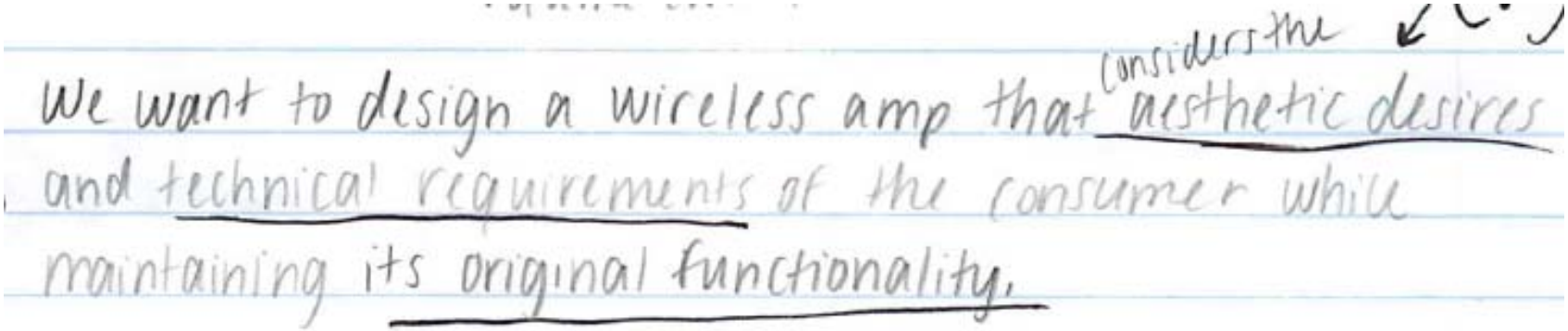
www.mwftr.com/SD1415.html

Before We Proceed

- Problem Statement for Jimi Hendrix and Eric Clapton → **"Complete Set of Customer Needs"**

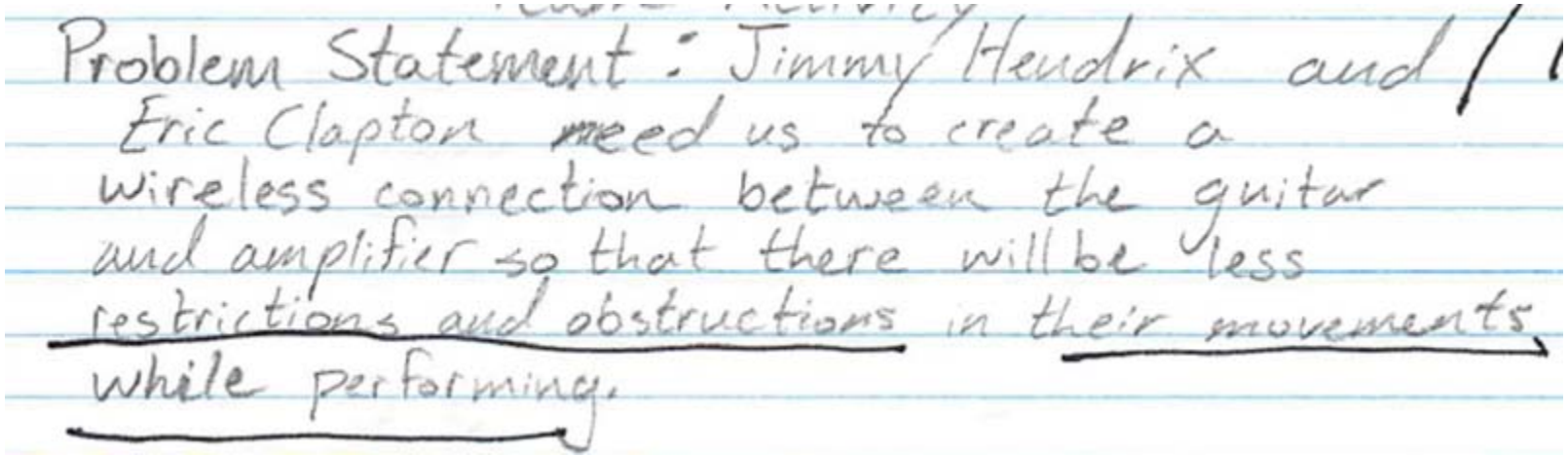

Problem Statement

The multitude of cables connected to the amp and instrument causes destruction to the instrument and supporting materials while inhibiting the performance during the performances and causing more maintenance than necessary.


We want to design a wireless amp that considers the aesthetic desires and technical requirements of the consumer while maintaining its original functionality.

Before We Proceed

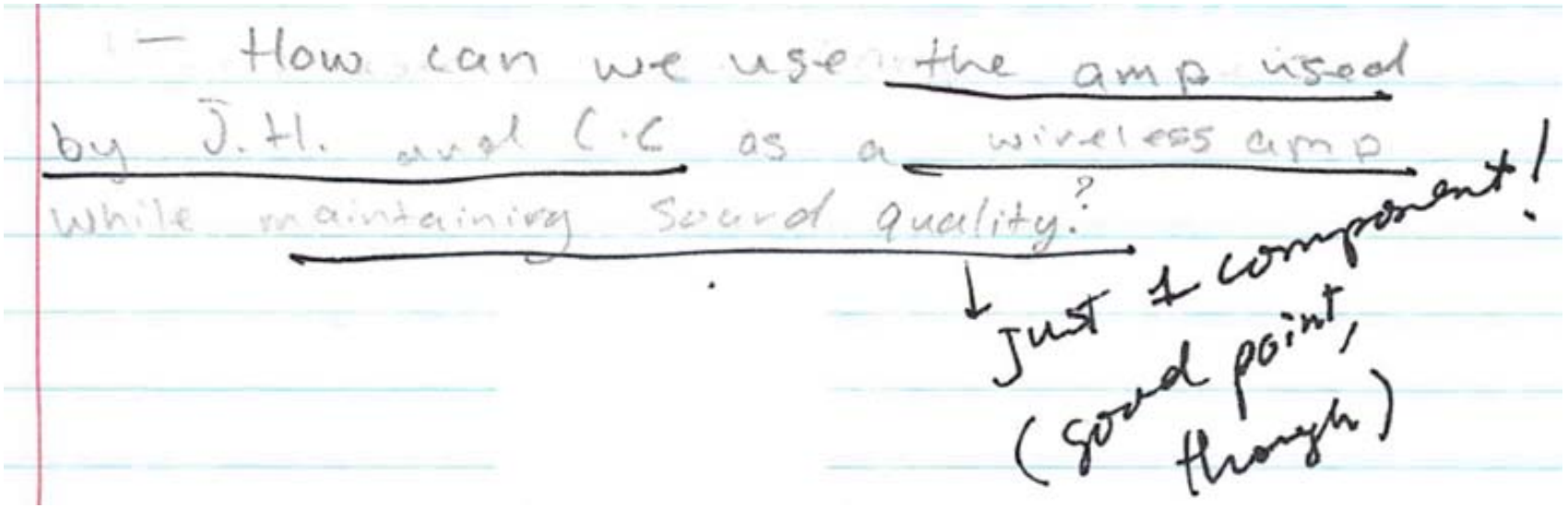
- Problem Statement for Jimi Hendrix and Eric Clapton → **"Complete Set of Customer Needs"**


Problem Statement: Jimmy Hendrix and Eric Clapton need us to create a wireless connection between the guitar and amplifier so that there will be less restrictions and obstructions in their movements while performing.

The goal is to create a wireless connection between the guitarist and amplifier because the wires limit the showmanship of the musician and create a danger hazard of having many wires on stage.

Before We Proceed

- Problem Statement for Jimi Hendrix and Eric Clapton → **"Complete Set of Customer Needs"**



Before We Proceed

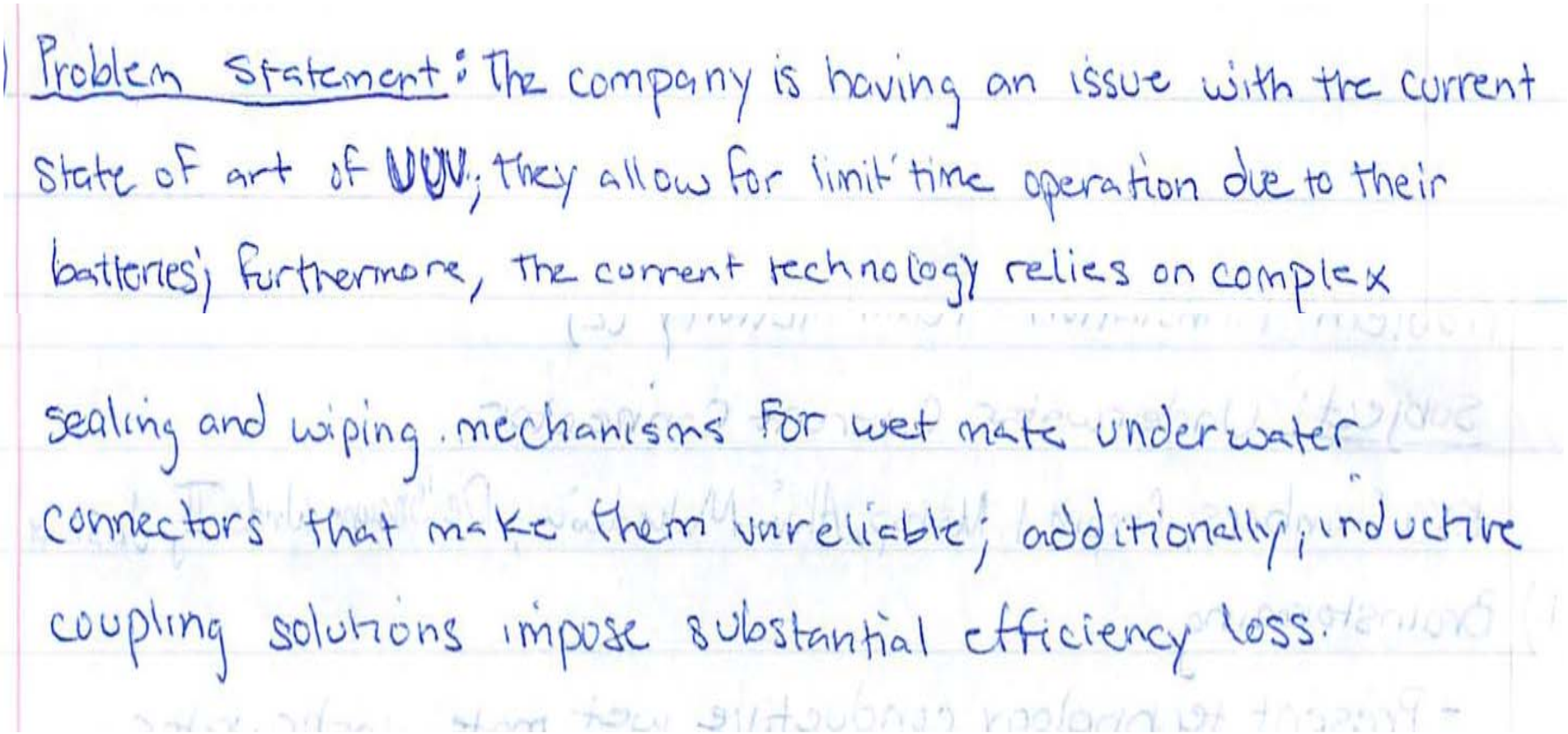
- Problem Statement for a **Project**

Security systems are in constant danger of being breached. Customers need an easy and more secure method of security systems. Voice recognition software already exists, but if someone pre-records your voice, they can breach the system. Our solution is a new voice encryption method to better secure a security system.

- No solution, please! This is a problem statement question.
- Focus on the problem – and logically structure the problem.

Before We Proceed

- Problem Statement for a **Project**


Problem Statement: The company is having an issue with the current state of art of UUV; they allow for limit time operation due to their batteries; furthermore, the current technology relies on complex sealing and wiping mechanisms for wet mate underwater connectors that make them unreliable; additionally, inductive coupling solutions impose substantial efficiency loss.

- Not very neat 1 sentence statement – not logically structured

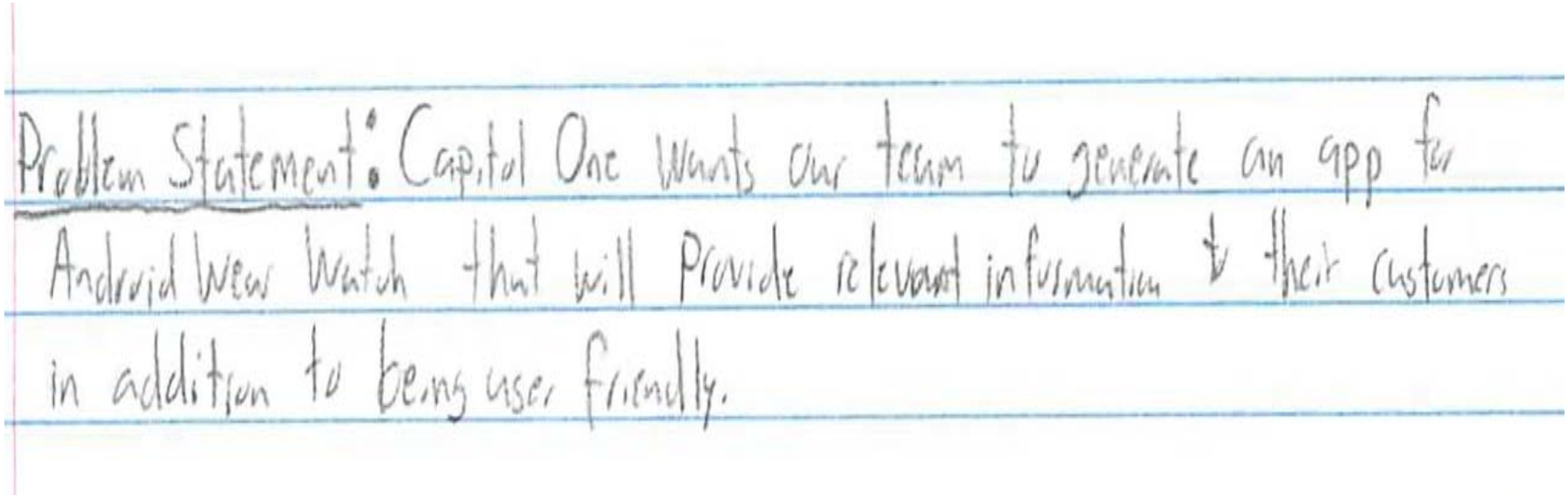
Before We Proceed

- Problem Statement for a **Project**

- What do deaf people need? Not what you think they need.
- Communication may include reading, hearing, talking, writing, etc.
- Who are your customers? Deaf people who do not know ASL? Regular people who want to learn ASL?
- Do you include deaf people in Japan, for example?

Before We Proceed

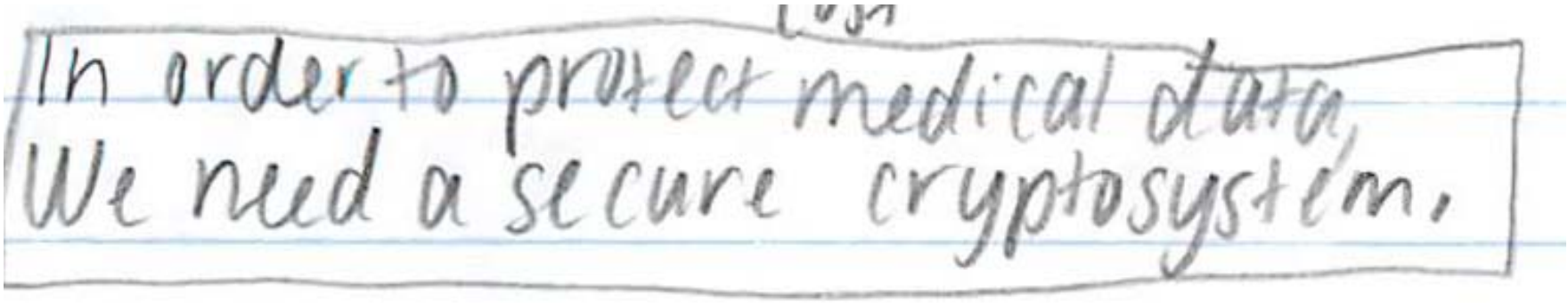
- Problem Statement for a **Project**



- All information available?
- Where is the information physically located?
- What intermediate means or medium are involved in data transfer?

Before We Proceed

- Problem Statement for a **Project**



- Even though it may pose a long and inconvenient process?
- Why not turning to a paper system?
- With $10M investment?

Side Bar

Project

Problem Statement

Refinement

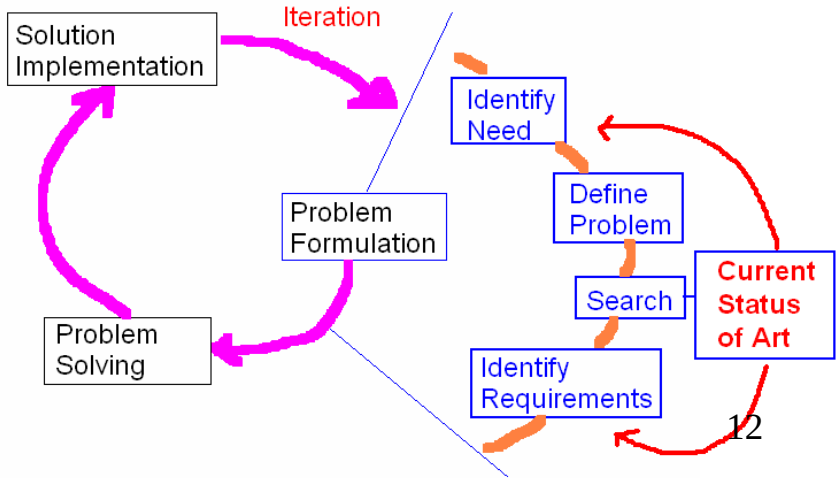
- Rework on the project problem statement
- Consider suggestions and further thoughts (and some more information gained from team meetings)
- Make out a final 1-sentence problem statement which is
  - Considered on comprehensive needs of the customer
  - Focused on problem, need, or demand.
  - Logically structured
- Take 15 minutes --- Type into an email or Word format or Hardcopy (*No hand-writing, please*)

The Next Step

- We now have Problem Statements
- Next Step
  - Want to know the **current status** of the solution (product), if any, to the needs and problems
  - Once we are confident that the needs, with the current solution/product, cannot be met, we take up the problem, and establish **design requirements** for the needs and the problems
    - Conversion from the **Needs** to the Design **Requirement**
- If applicable:
  - Intel-Cornell Cup 2015 Competition Teams
    - Topic and Title and Summary →Registration by Oct 13

Current Status of Art

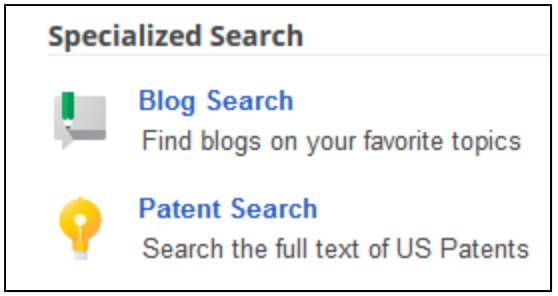
- Study and understanding of the field knowledge around the needs and problems – core principle and technology, theory, etc ← Basic Theory Focus
- The current status of the field related to the needs and problems -- products, patents, research and development, etc ← Product Focus
- Main Focus:
  - Is the “problem” already solved?
  - What are the currently available, similar products ?
  - Is there any room for improvement or addition?

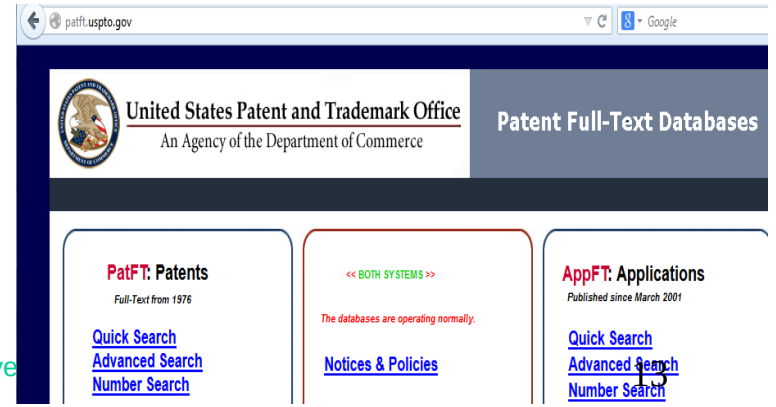


Charles Kim – How

How to know/investigate the current status of art

- **Three primary activities**
  - 1 Working with customers to get information
  - 2 Research/Study for Information
    - **Patent Search ---** Google Patent Site, USPTO patent search site, and General Web search
    - **Online search**
      - Technical articles on product/technology introduction
      - Be careful:
        - » Accuracy and Authority
        - » Objectivity
        - » Currency
      - Existing products for benchmarking
    - Experts
      - Professors, engineers, etc
      - Advisors
  - 3 Discussion within the team





What is the eventual goal for “the current status of art” Investigation

- Focus:
  - Is the problem already solved?
  - Are the customer needs can be met by a product or a combination of multiple existing products?
  - Difference between the existing technology/product and the problem/needs?
  - Any room for improvement? How to improve?
  - How to define the new product to be developed considering overall current status of art in the field?
  - If there is no invention nor technology (principle or theory) nor product in the market, how to proceed to develop the technology?

Team Assignment #2 – Current Status of Art (1)

- The current status of the **product** and **the technology** related to your team project

- A. Should answer the following questions:
  - 1. What is the core principle or theory of the technology involved in the team project? (← Basic Theory Focus)
  - 2. What kind of products (for the same desired functions) are out there in the market, if there are any? (← Product Focus)
  - 3. **Fundamental Questions and Answers**
    - What's the relevant technology (principle or theory)
    - What are their advantages and disadvantages against the needs?
    - What and how would improve the products and meet the needs?

Team Assignment #2 – Current Status of Art
Study Suggestions -- *just suggestions, so add more*

Project	Technology/Principle/Theory	Product	Comparison against the Needs
UCC	Element (Niobium, Nb) characteristics, RF over conductor	Dry Mate, Wet Mate, RF over conductor	Summarize
Intruder	Encryption, Hardware malware, Hardware malware detection methods	Hardware malware detector, Hardware Trojan detection system	Summarize
SLATE8	Sign language interpretation, Robot, text/voice recognition and/or generation	ASL to Text/Voice system, Text to ASL/Vice system	Summarize
Watch Me Now	Android OS, Watch and Wear Application S/W	Google Watch, Samsun Watch, LG Watch, Capital One prototype	Summarize
Funktioneers	Sound/Audio Encryption, circuit bending	Voice encryption system	Summarize

Team Assignment #2 – Current Status of Art (2)

- B. Report (**hardcopy only**) **Email submission not accepted**
  - Concise, technical, professional, with your own words
  - Letter size, 1" margin all sides, 12 pt. Times New Roman font. Single space. Left justified. 2 – 3 pages.
  - No cover page;
    - line 1 (Project title);
    - line 2-3; names and IDs; l
    - line 4; Date;
    - line 5: space;
    - line 6: First line of your first paragraph.
    - Then, the rest of the report body follows.
      - Divide into 2 sections:
        - » Status of Relevant Technology (Principle or Theory)
        - » Status of the Relevant Products
  - **First paragraph ("summary of the summaries") -- the most important piece in the report .**
    - First paragraph should answer the questions in a concise manner, and subsequent paragraphs should explore more and expand.
  - Submission Due: October 15, 2014

Design Requirement

- What is “Design Requirements” ?
  - Technical Guide
    - Plain English description of problem statement→ Technical terms for concept design
    - **Specifications**
      - Size
      - Weight
      - Current and Voltage and Power consumption
      - Reach
      - Response Time
    - “It has to be all down to numbers”
    - **Regulations**
      - FCC
      - NEC
      - IEEE Standards
      - FAA (San Diego building Case)

Importance of Compliance

FCC approves iPhone for sale; set to hit stores in late June

By Troy WolvertonMercury News

POSTED: 05/17/2007 02:04:34 PM PDT | UPDATED: 7 YEARS AGO

0 COMMENTS

Apple's iPhone took one step closer to store shelves Thursday as regulators gave their stamp of approval to the forthcoming handset.

The Federal Communications Commission issued a "grant of equipment authorization" for the device. Although expected, the approval from the FCC is necessary before a manufacturer can begin selling a handset to consumers.

The approval means that the device is on track for scheduled release next month, said Mark Siegel, a spokesman with Cingular, which will be the only U.S. wireless carrier that will offer the iPhone when it launches.

"The device is going to be available, as we and Apple have been saying all along, in late June," Siegel said.

Apple representatives did not immediately return calls seeking comment.

Importance of Compliance

FreedomPop for iPhone is delayed, awaits FCC certification

Posted: 09 Jan 2013, 14:11, by Nick T.

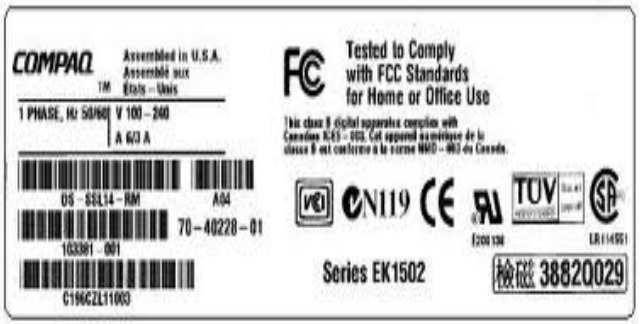
Tags: Accessories + Apple + Wireless service +

Several months ago, FreedomPop opened its doors to customers hungry for free mobile data. For those who have never heard of it, the service provides internet access with the use of a WiMAX-enabled Wi-Fi hotspot that doubles as an iPhone or iPod touch case. The first 500MB you consume are free, but additional data can be purchased for $10 per gigabyte or $35 for 5 gigs.

However, while that iPod touch version of FreedomPop case is already on the market, the iPhone variant is taking longer than expected. That's because the accessory is still stuck at the FCC awaiting its approval. Apparently, its design is causing all the trouble since the FreedomPop 4G radio is positioned close to the iPhone's radio, which could potentially cause trouble.

At this time it is early to tell when the FreedomPop case for the iPhone 4 and iPhone 4S will be released. Their maker has confirmed that it has 5,000 pieces ready to ship once they get the thumbs up from the FCC.

Importance of Compliance



Electromagnetic Compatibility

Dell products are designed, tested, and classified for their intended electromagnetic environment (domestic/residential environment or business/industrial environment). Electromagnetic Compatibility (EMC) is the ability of items of electronic equipment to function properly together in the electronic environment. While all Dell computer systems have been designed and determined to be compliant with regulatory agency limits for EMC, there is no guarantee that interference will not occur in a particular installation.

Required statements for the international EMC specifications, marks and approvals, as obtained and documented on the product specific Product Safety, EMC and Environmental Datasheet, are provided in applicable agency/country language(s). Examples of EMC specifications include, but are not limited to, CISPR 22 and FCC Part 15.

Electrostatic Discharge

Dell products that have the CE marking are designed and tested for immunity to Electrostatic Discharge (ESD) to IEC standard 61000-4-2, CISPR 22, and CISPR 24. While these products have been designed and determined to be compliant with standard levels for ESD, there may be situations, such as low humidity levels, that can exacerbate ESD event occurrence. Users are encouraged to read and follow the ESD protection guidance provided within the Protecting Against Electrostatic Discharge section of this website.

Title 47 CFR Part 15

Code of Federal Regulations, Title 47, Part 15 (47 CFR 15) is an oft-quoted part of Federal Communications Commission (FCC) rules and regulations regarding unlicensed transmissions. It is a part of Title 47 of the Code of Federal Regulations (CFR), and regulates everything from spurious emissions to unlicensed low-power broadcasting. Nearly every electronics device sold inside the United States radiates unintentional emissions, and must be reviewed to comply with Part 15 before it can be advertised or sold in the US market.

Importance of Compliance

- Common Uses of Part 15 Transmitters
  - 802.11 Wireless LANs (WiFi): 2.4 GHz, 5 GHz
  - 802.15 PANs (Bluetooth, ZigBee): 2.4 GHz
  - Cordless Phones: 900 MHz, 1.9 GHz, 2.4 GHz, 5 GHz
  - Walkie Talkies, Baby monitors, etc
  - Remote controllers such as garage door openers (27MHz, 315-433 MHz, with limited duty cycle and 100-200 meter distance)

No Wonder

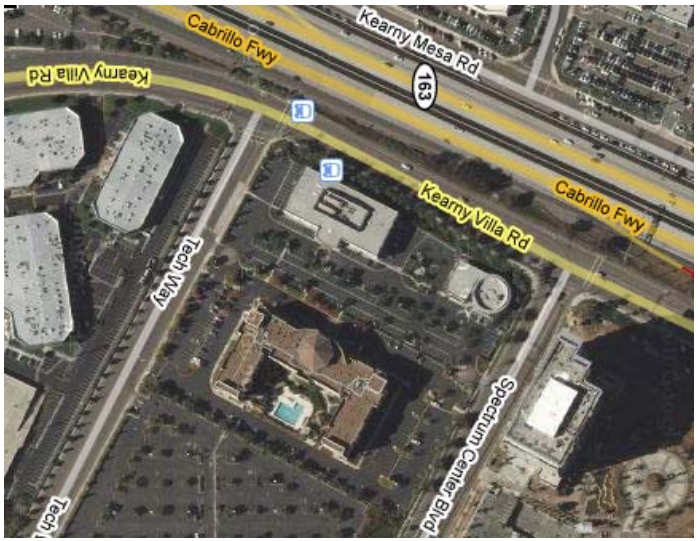
- Cellphone Booster

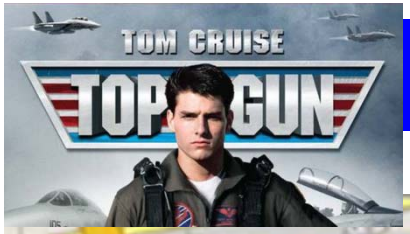
- FCC says “Turn it off” – why?

[Got a Cell Phone Booster? FCC Says You Have To Turn It Off]

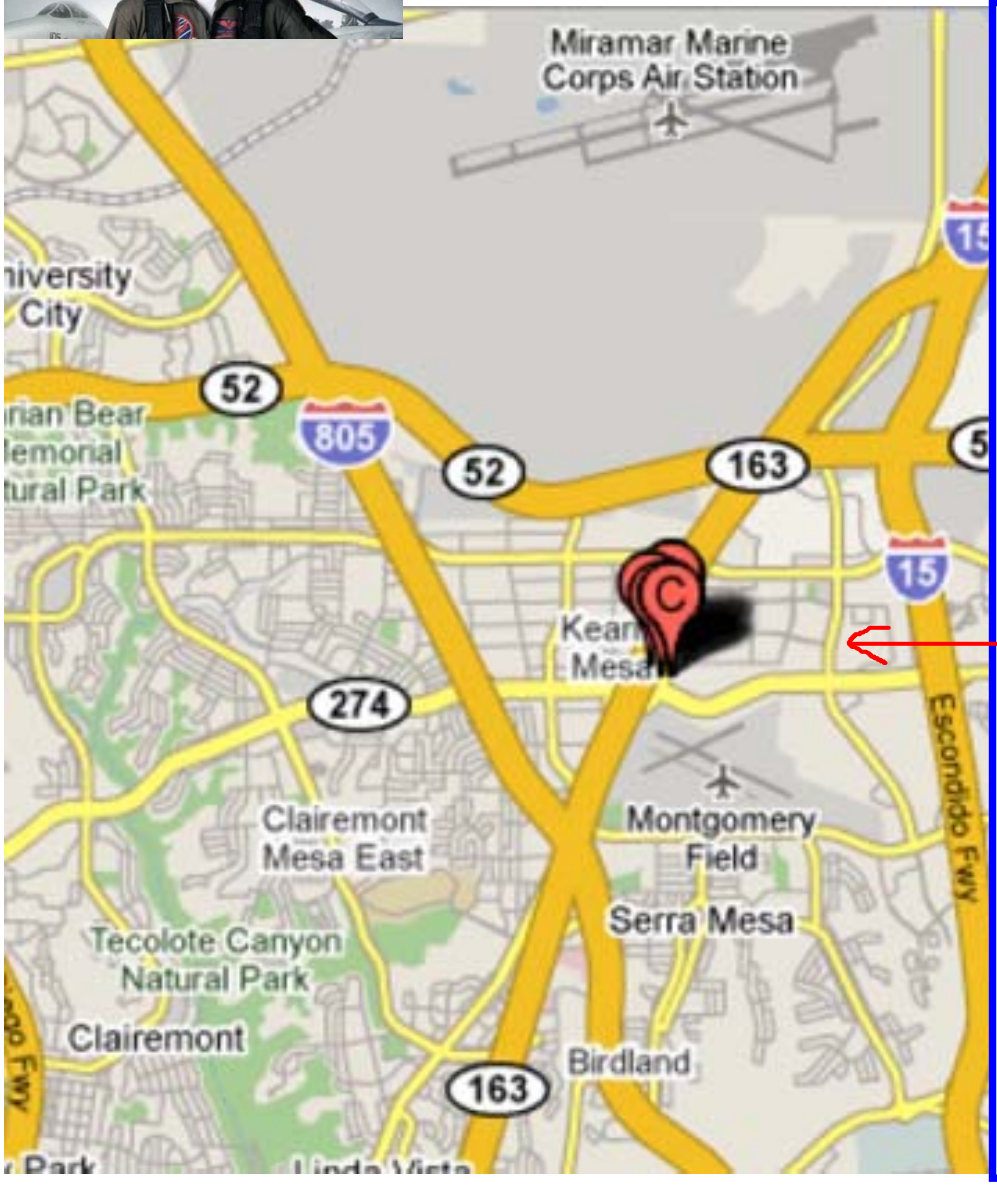
Importance of Compliance

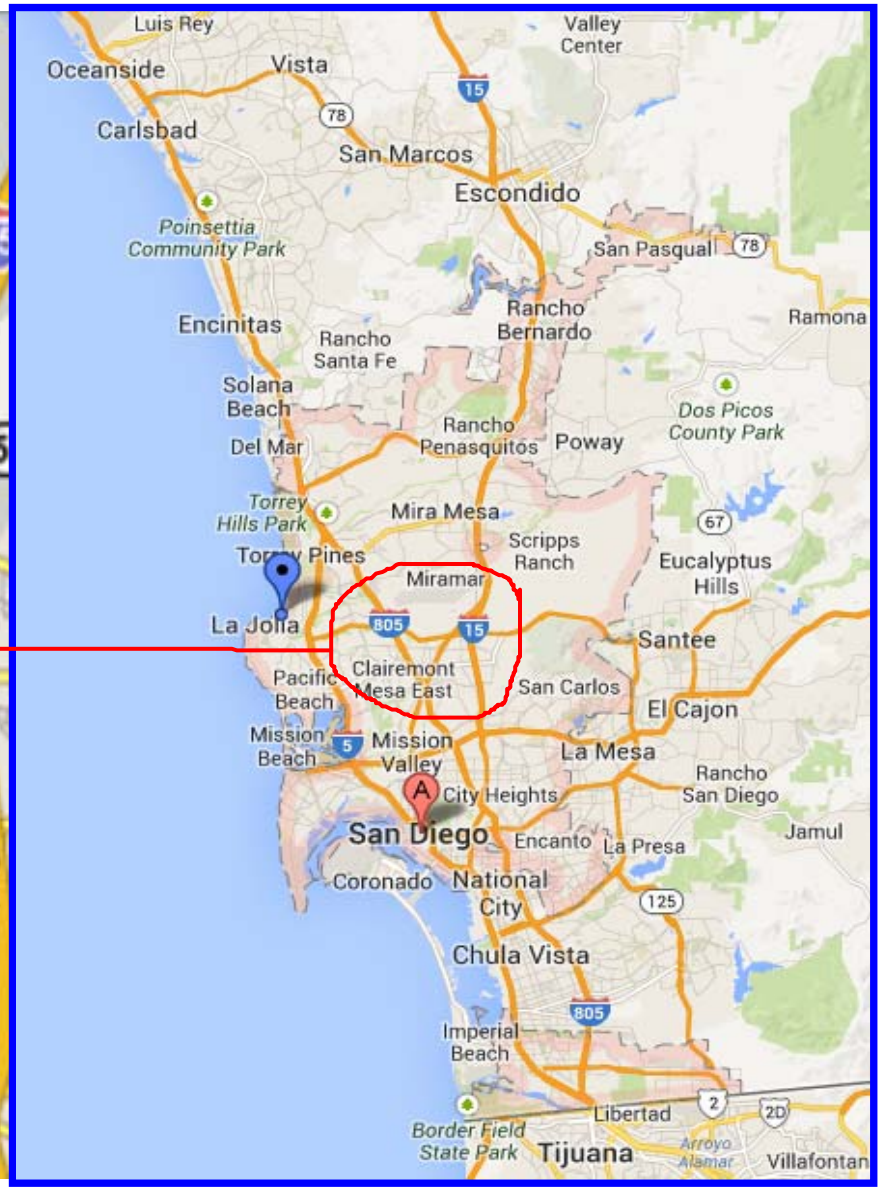
- A building on 8620 Spectrum Center Blvd, San Diego, CA (“Sunroad Spectrum 12 Office Tower”) – Now (2012) Ashford University
- Difference between two photos of the same building is about $20M.
- Left (summer 2008). Right (Summer 2009)





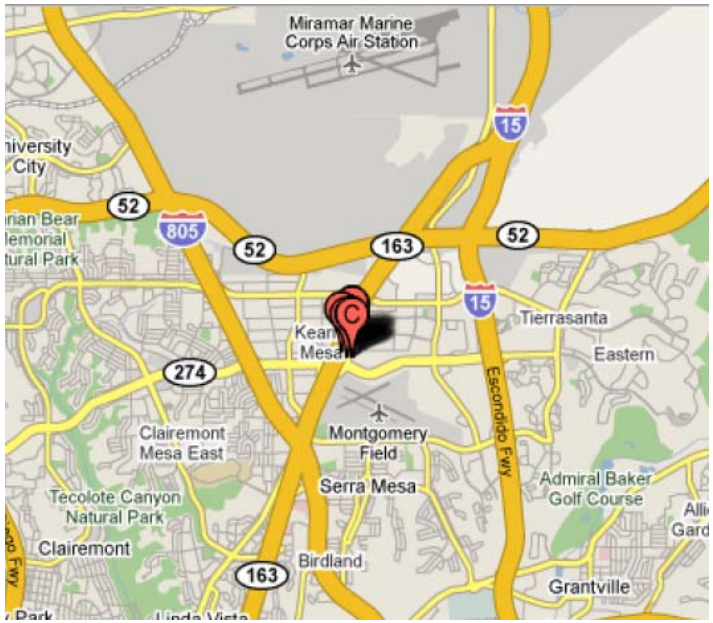
General Location of the Building

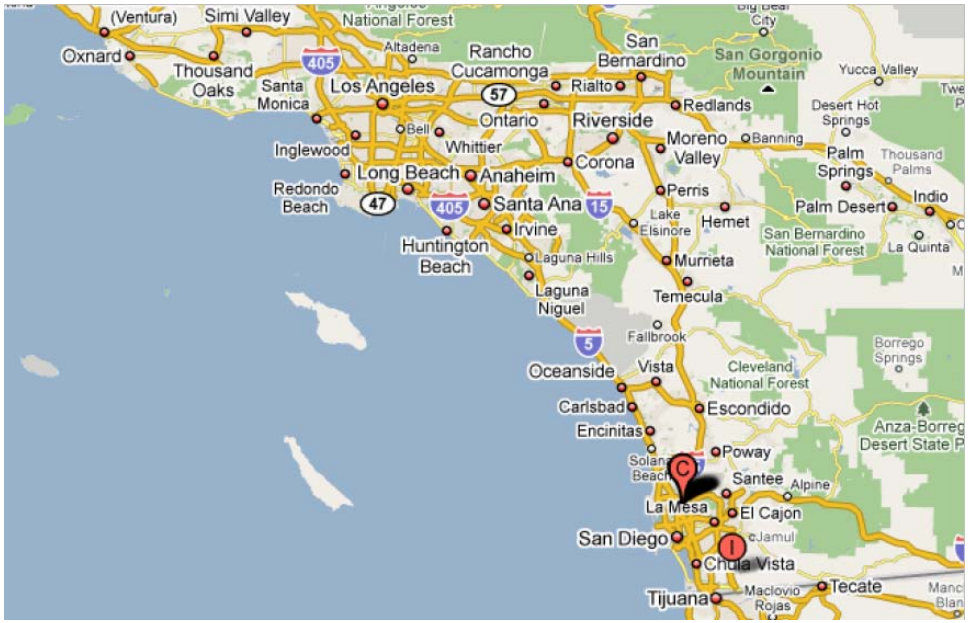




FAA Regulation

- 20 ft too tall under FAA regulation for instrument approach (ILS) (180 ft vs. 160 ft)





AGL: Above Ground Level

AMSL: Above Mean Sea Level

You are hereby ordered, pursuant to San Diego Municipal Code Section 121.0312, to restore and mitigate the *structure* and *premises* at 8620 Spectrum Center Boulevard to their lawful and prior condition where all buildings, *structures*, towers and projections on the *premises* remain below 160 feet (160 feet AGL/576 feet AMSL), in compliance with the Federal Aviation Administration ("FAA") No Hazard Determination, which was issued to Mr. Craig Bachman, Sunroad Enterprises, on June 27, 2006. (Copy enclosed with this order.)

FAA FAR (federal aviation regulation) Part 77 Section 13

§77.13 Construction or alteration requiring notice.

(a) Except as provided in §77.15, each sponsor who proposes any of the following construction or alteration shall notify the Administrator in the form and manner prescribed in §77.17.

(1) Any construction or alteration of more than 200 feet in height above the ground level at its site.

(2) Any construction or alteration of greater height than imaginary surface extending outward and upward at one of the following slopes:

(i) 1 00 to 1 for horizontal distance of 20,000 feet from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) or this section with at least one runway more than 3,200 feet in actual length, excluding heliports.

(ii) 50 to 1 for horizontal distance of 10,000 feet from the nearest point of the nearest runway of each airport specified in paragraph (a)(5) of this section with its longest runway no more than 3,200 feet in actual length, excluding heliports.

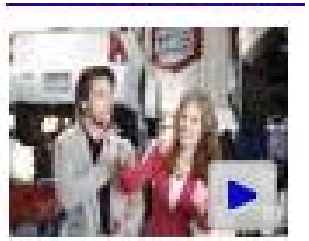
(iii) 25 to 1 for a horizontal distance of 5,000 feet from the nearest point of the nearest landing and takeoff area of each heliport specified in paragraph (a)(5) of this section.

(3) Any highway, railroad, or other traverse way for mobile objects, of a height which, if adjusted upward 17 feet for an Interstate Highway that is part of the National System of Military and Interstate Highways where overcrossings are designed for a minimum of 17 feet vertical distance, 16 feet for any other public roadway, 10 feet or the height of the highest mobile object that would normally traverse the road, whichever is greater, for a private road, 23 feet for a railroad, and for a waterway or any other traverse way not previously mentioned, an amount equal to the height of the highest mobile object that would normally traverse it, would exceed a standard of paragraph (a)(1) or (2) of this section.

(4) When requested by the FAA, any construction or alteration that would be in an instrument approach area (defined in the FAA standards governing instrument approach procedures) and available information indicates it might exceed a standard of Subpart C of this part.

Problem vs. Requirement (or Spec)

- A more precise (technical) description of the Problem (Needs):
  - should not imply a particular architecture/solution;
  - provides **input** to **concept design/solution** process.
- Difference between Problems (Needs) and Specification
  - Layman's term → Technical terms
  - Aamco Commercials
  - Description → **Specification** (Example)



Replacement Dell Latitude E6500 AC Adapter 90Watt 19.5V 4.62A

Replacement Dell Latitude E6500 AC Adapter 90Watt 19.5V 4.62A

Email to a Friend

Be the first to review this product

Availability: In stock

$19.99

Qty: 1 Add to Cart OR Add to Wishlist
Add to Compare

Quick Overview

Specification:

Replacement Dell Latitude E6500 AC Adapter 90Watt 19.5V 4.62A

Manufacturer: 3rd Party

Input: AC100-240V (worldwide use)
Output: DC19.5V 4.62A
Power: 90W Max

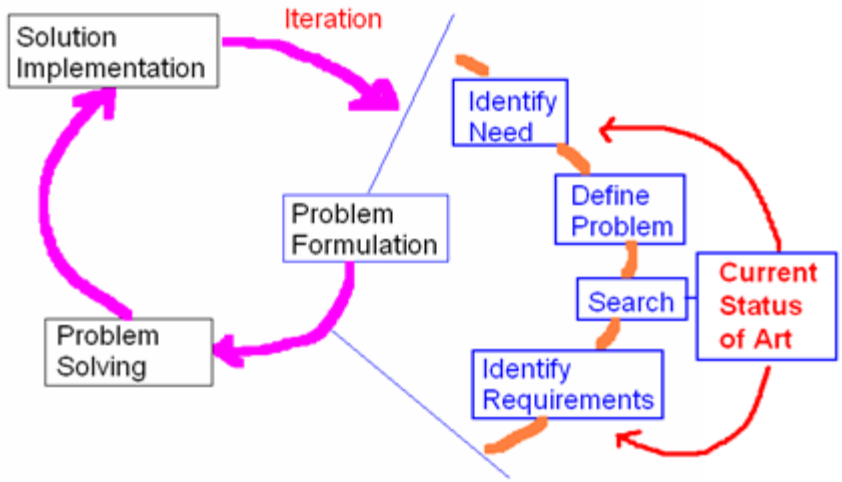
Outlet: 3-Prong

DC Connecter (Barrel) size:
Internal Diameter: 5.0mm
External Diameter: 7.4mm
With central smart-pin

Item Includes: AC Adapter and Power Cord.

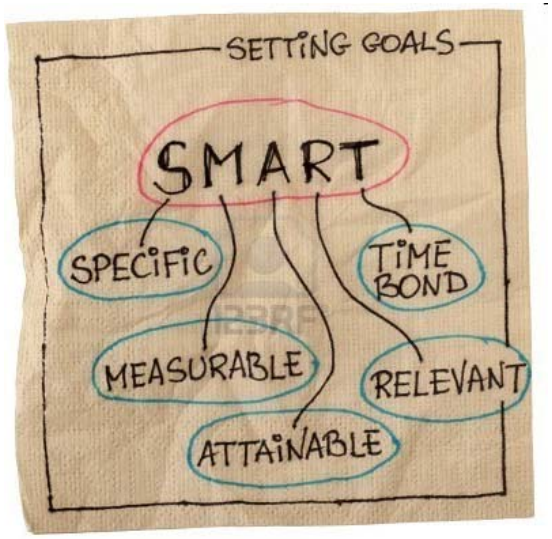
Design Requirement Identification

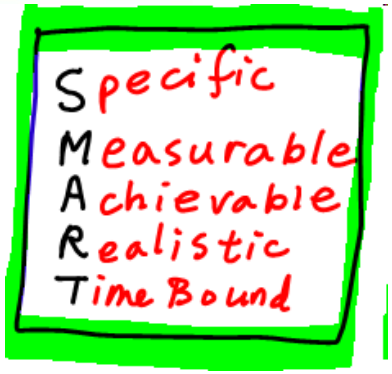
- Step 1:
  - Clear, unambiguous description of the problem
  - **DONE!!**
- Step 2: Focus of the class
  - Establishment of **clear set of Design Requirements**

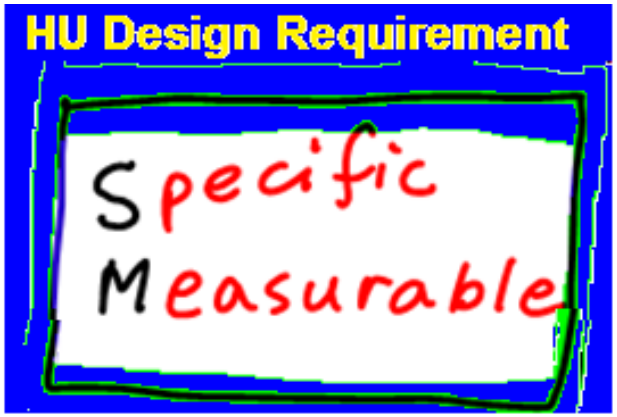


Good Design Requirements

- Design Requirements should:
  - Be as quantitative, measurable, and precise as possible
  - Describe the Need, not the solution
  - Be Comprehensive
  - Be presented in an easy to understand format.
  - "SMART" Requirement?
    - No. They are for GOALS
  - **"SM" Requirement**







Requirements – Be Measurable

- **If you cannot test if a "requirement" is met or not, then it is not a requirement**
- Testable → Measurable → Quantitative
- Example:
  - UCC
    - Bad: "Connect underwater"
    - Good:
  - Slate8
    - Bad: "Sign is quickly displayed in text"
    - Good:
  - Intruder
    - Bad: "Secure the medical record"
    - Good:

Requirements – Need is described

- **Should not limit the <u>range of solutions</u> unnecessarily**
- Ex. Safer and Stronger 2-liter soda holder
  - Bad: “bottle”
  - Good: “container”
- Funktioneers
  - Bad: “Use an FM radio to bend”
  - Good:
- Ex. Wireless Guitar Amplification System
  - Bad: “Use Bluetooth technology”
  - Good:
  - Bad: “must have wheels to move around”
  - Good:
- Ex. Slate8
  - Bad: “Use Wired Communication System to avoid interference between Sign Robot and Display/Audio”
  - Good:

Requirements – Be Comprehensive

- How to be comprehensive?
  - Include a team in the formulation of requirement
  - Keep the customers (or stakeholders) in the loop
  - Checklist
    - Spur Ideas
    - Identify gaps
  - “Soft hard skill”

Practice for GOOD Requirements

- Remember this?

- And these good problem statements ?

There are six females living in a small dorm room and they would like our help in figuring out how to pack their belongings in the room as efficiently as possible. while maintaing their comfort and security for everyone.

The fundamental problem is to find the most efficient way to use a given space as our living quarters while maintaing comfort, organization, and moveable space.

Practice for GOOD Requirements

- **Conversion to quantifiable requirement**

There are six females living in a small dorm room and they would like our help in figuring out how to pack their belongings in the room as efficiently as possible. while maintaing thier comfort and security for everyone.

- Efficiently?
- Maintaining comfort?
- Maintaining security?

Practice for GOOD Requirements - Example

There are six females living in a small dorm room and they would like our help in figuring out how to pack their belongings in the room as efficiently as possible. while maintaing their comfort and security for everyone.

- Efficiently?
  - One's belongings are to be placed within 1 meter of her bed/desk.
- Maintaining comfort?
  - Each person has own space of radius 2 meters with no clutters
- Maintaining security?
  - All occupants under emergency should be able to evacuate within 10 seconds.
  - No belongs are to be placed within 1 meter from the front door.

Sample requirement items (1)

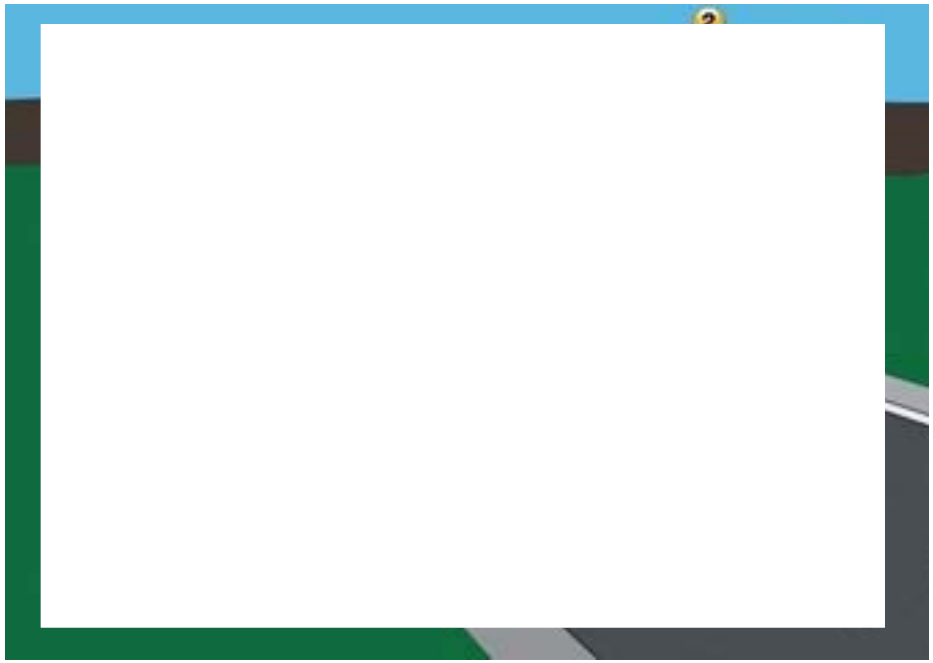
- **Aesthetics**: “70% of target guitarists indicate that the appearance of the system will encourage purchasing it” --- cf. iPad vs. Galaxy Tab
- **Cost**: “Each container must cost less than $0.10 to manufacture given a production of 2 million per year”
- **Dimensions**: “It must fit within 10”x6”15”
- **Easy of use**: “must not require more than 1 minute to set up the system”
- **Energy Use**: “The maximum power demand must be less than 20W and lasts at least 2 hours with standard audio system emergency power source”
- **Environment**: “The system should stand more than 4 hours in temperatures ranging from 40F to 130F.
- **Ergonomics**: “The system must be able to be lifted up with less than 10 pound force”
- **Interface with other systems**: “all connectors must fit on audio industry terminals”
- **Lifespan:** “The soda container must last for 2 years when filled with pressurized soda at 85F”

Sample requirement items (2)

- **Maintenance**: “Required annual maintenance should be minimized and must not exceed 10 minutes per 1 person”
- **Weight:** “The system must be less than 1 pound”
- **Noise Level:** “The noise level of the system should be less than 60dB at 2 feet from front of the device when operating”
- **Patents:** “Must not infringe on the following patents: (1), (2), etc”
- **Performance:** “Car must reach 110 mph”
- **Recycling**: “Container must be made of at least 33% post-consumer materials and must be 100% recyclable”
- **Safety:** “The system should not get in fire when dropped from 3 feet while in operation”
- **Standards:** “The EMC standards and FCC part 15 in particular must be complied”
- **Regulation**: Electric wiring must meet and satisfy 2010 NEC code

Sample Design Requirement

- Lane Departure Warning System



Design Requirements Form F2010.xls
Microsoft Excel Worksheet
36 KB

Design Requirements – Team Assignment #3

- Project Design Requirements
- Use the forms available in the note webpage
- Be comprehensive
- Submission: October 22. 2014

Summary of "Problem Formulation"

- The most important first step in design process
- Is focused on identifying the requirements of the needs and problems
- Involves activities of
  - gathering information about **needs → Problem Definition**
  - know the **current status of art**
  - Formulate (quantify) **Design Requirements**
- Will be used throughout the design process as Guideline for
  - **Concept development and exploration**
  - **Basis for testing**