Before We start

You feel more bright today?

Fill in the matrix.

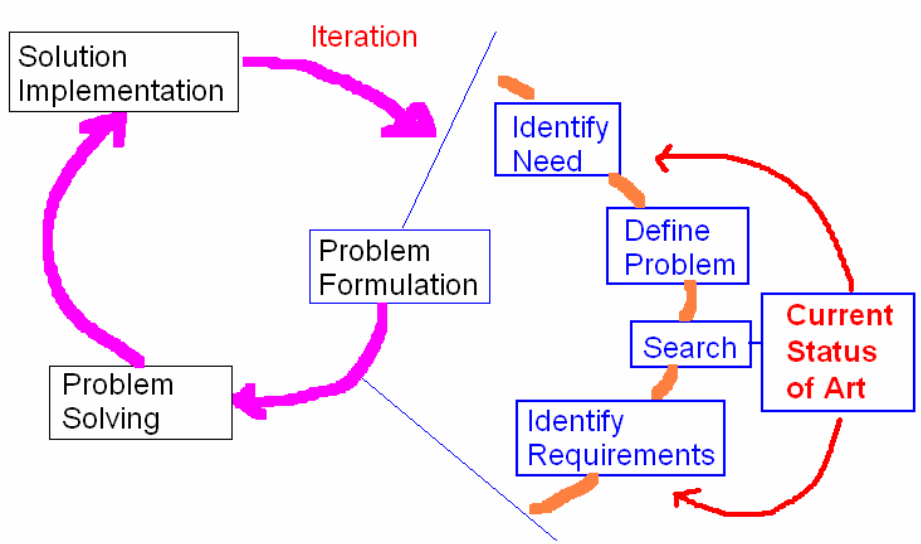
1	2	3	1	1	8
2	2	6	2	2	14
3	4		3	1	20
4	4				23
					31
6			3	2	

Search

- To gather customer needs
- To establish requirements for problem
- Requires the most work
- Three primary activities
  - Working with customers/users to get information
    - Interviews, Concept Maps, Observation
  - Discussing the problem with each other
    - Clarification within a group
  - Researching Information
    - Libraries and online sites
      - Be careful:
        - » Accuracy and Authority
        - » Objectivity
        - » Currency
    - Existing products
      - Benchmarking
    - Experts
      - Consulting Experts
      - Advisors

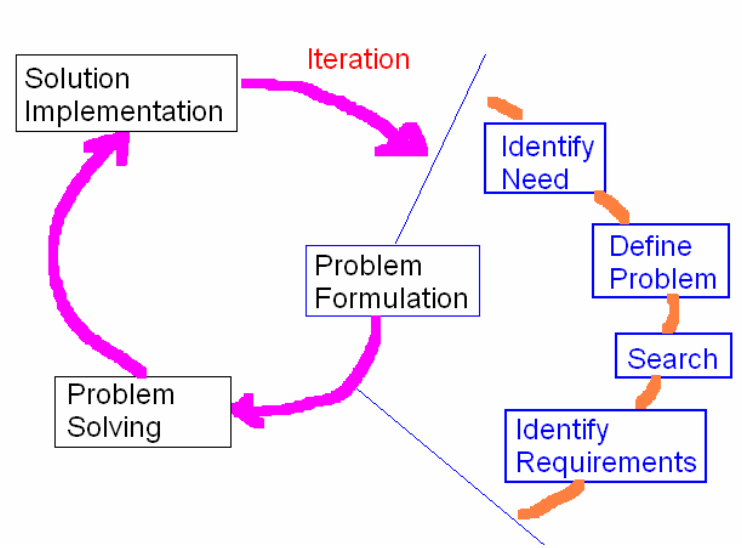
Current Status of Art

- Problem Already Solved?
- Any improvement you can make?
- How does change the Needs and Problem Identified?
- This is the starting point you jump up from



Identifying Requirements

- Identifying Needs & Defining Problems & Searching are for establishment of clear set of requirements
- Clear, unambiguous description of the problem
- Two Elements frequently incorporated:
  - Functional Requirements – Core functions
  - Design Requirements – Technical guide



Functional Requirements

- Exercise – What are the Fundamental Functions of the follow
  - 2-liter soda container
  - Dolly
  - Towel Rack
  - Wireless guitar amplifi
- **Formation of Functi**
  Rules
  - R1: Define the widest area while remaining true to the problem
  - R2: Word the functional requirements so as not to imply a specific solution
  - R3: Things a design will do, not things a customer will do.

Functional Requirements Formation Rule 1

- Rule 1: Define a Wide Area
  - Abstraction of the problem being addressed
  - Do not pin down a problem to a narrowly-defined scope
  - Define the problem as broadly as possible
    - To examine all possible solutions before selecting the one to pursue
  - Soda Container example:
    - **“Hold pressurized soda & provide access to soda”**
    - Anything that can do these things
    - Bladder, syringe, keg, tube, hard plastic container, aerosol can, etc

Functional Requirements Formation Rule 1 - conti

- Design Space
  - Range of options available to a designer
  - Start from huge, later reduced to a single design
- Design Freedom
  - How many choices available to designers
- Point of Rule 1: Define the design space as large as it can be to allow for a much design freedom as possible
- Soda Container Example—Do not say
  - “cost less than 15 cents”
  - “be small enough to fit in a refrigerator door”
  - “be made of clear material”
  - “be light”
- Wireless Guitar Amplification System – Do not say
  - “ _____ “

Functional Requirements Formation Rules 2 & 3

- Rule 2:Should not Imply a Solution
  - Soda Container Example:
    - "Provide access to soda" –yes!
    - "Allow users to twist off cap" –no!
  - Use ***solution-independent*** **terms** and ways
- Rule 3: State what the design, not customer, must do.
  - Soda container example:
    - "empty soda" "open container" –customer (no)
    - "provide access to soda" – design (Yes)
  - Dolly example:
    - "move boxes" – customer (No)
    - "allow the use to move boxes" – design (Yes)
  - Wireless Guitar Amp Sys example:
    - Customer's point of view – "_____" (No)
    - Designer's point of view - "_____" (Yes)

Timeout: Where are we no

- Still in the Problem Formulation
- Identifying Needs – Pioneer, Changes, e
- Defining Problems – Brainstorming, cha
- Search – Information gathering activities
- Functional Requirements
  - Core functions
  - Design Freedom and Large Design Space
  - General Guidelines for Generating Designs
- What's the next step?
  - Selection of better designs (alternatives)
  - Any guideline for selection?
  - Any guideline to measure success?
  - Any guideline to evaluate?
  - Any guideline which we follow to the end?
  - **Yes, "Design Requirements"**

Design Requirements

- The process of reducing the size of design space.
- The guideline which guides all the way to the end.
- **Two Components of Design Requirements**
  - Constraints
  - Criteria
- **Constraints**
  - What a design solution must and must not do.
  - Key question: “Does the design meet the constraints?
  - Boundary of design space
    - Physical, social, ethical, corporate, or personal
  - Examples
    - 2-liter soda container
    - Wireless guitar amplification system
- **Criteria**
  - Differentiation tool between designs that pass the constraints
  - What “should” and “should not” the design do?
  - Key Question: “**How well** does the design meet the criteria?”
  - Example:10% gas mileage improvement from the stock vehicle

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

Requirements – Be Measurable

- If you cannot test whether a “requirement” is met, then it is not a requirement
- Testable → Measurable → Quantitative
- Example:
  - 2-liter soda container
    - Bad: “must be safe”
    - Good:
  - Wireless Guitar Amplification System
    - Bad: “lower power consumption”
    - Good:
    - Bad: “Sound quality should not be changed”
    - Good:
  - PV connection to Power Grid
    - Bad: “saving electricity bill”
    - Good:

Requirements – Need is described

- Should not limit the range of solutions unnecessarily
- 2-liter soda container
  - Good: “container”
  - Bad: “bottle”
  - Bad: “must be easy to twist off cap”
  - Good:
  - Bad: “Must be less than 6” in diameter”
  - Good:
- Wireless Guitar Amplification System
  - Bad: “Use Bluetooth technology”
  - Good:
  - Bad: “must have wheels to move around”
  - Good:
- Hybrid Vehicle
  - Bad: “Gasoline engine is minimally used”
  - 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

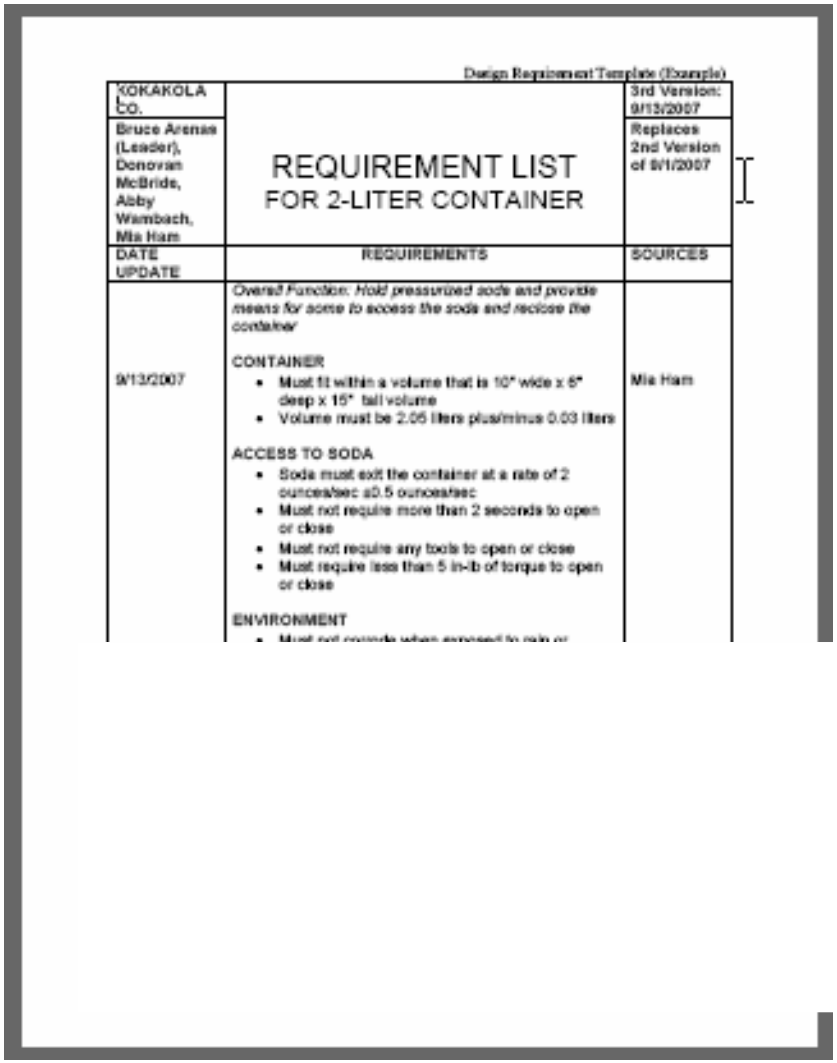
Checklist – sample requirements 1

- **Aesthetics**: “70% of target guitarists indicate that the appearance of the system will encourage purchasing it”
- **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”

Checklist – sample requirements 2

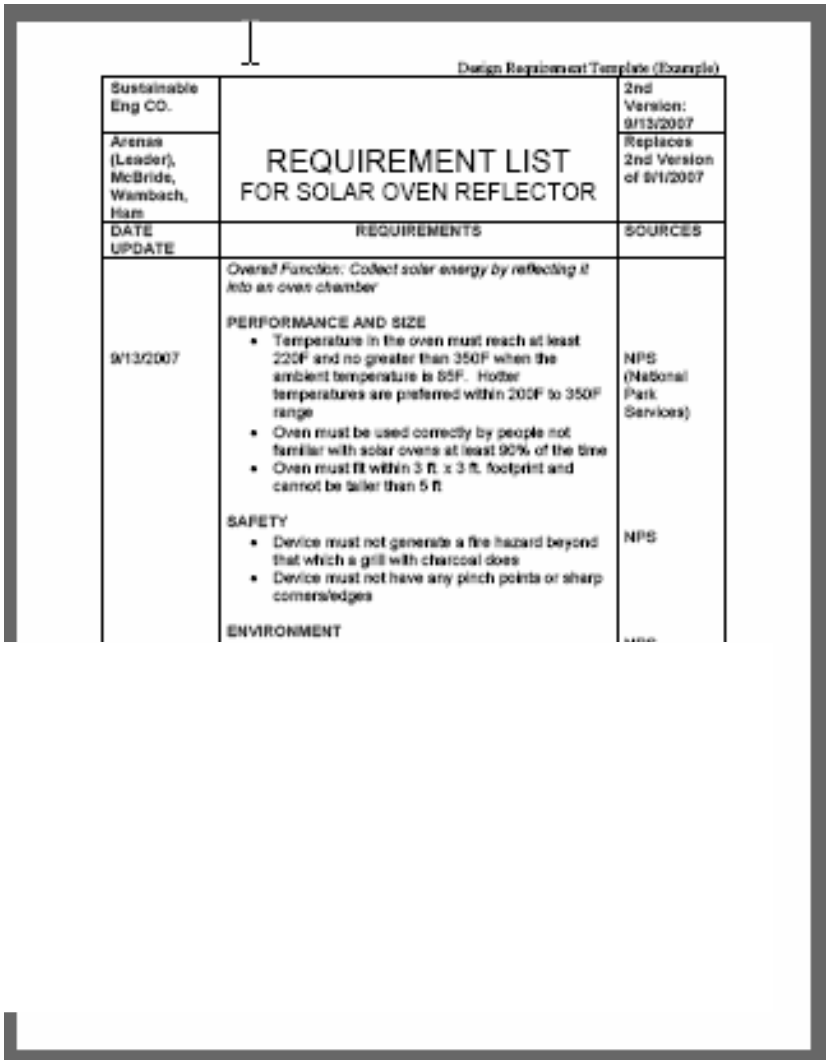
- **Maintenance**: “Required annual maintenance should be minimized and must not exceed 10 minutes per 1 person”
- **Manufacturability**: “Must be able to produce 1000 systems per day”
- **Noise Level:** “The noise level of the system should be less than 60dB at 2 feet from front of the device when operating”
- **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”
- **Reliability:** “Less than 0.01% of the system should fail”
- **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 approved”
- **Weight:** “The system must be less than 1 pound”

Grouping the Design Requirements into Design Requirement Template



Design Requirement Template (Example)

KOKAKOLA Co.	REQUIREMENT LIST FOR 2-LITER CONTAINER	3rd Version: 9/13/2007
Bruce Arenas (Leader), Donovan McBride, Abby Wambach, Mia Ham		Replaces 2nd Version of 9/1/2007
DATE UPDATE	REQUIREMENTS	SOURCES
9/13/2007	*Overall Function: Hold pressurized soda and provide means for some to access the soda and reclose the container* CONTAINER • Must fit within a volume that is 10" wide x 6" deep x 15" tall volume • Volume must be 2.05 liters plus/minus 0.03 liters ACCESS TO SODA • Soda must exit the container at a rate of 2 ounces/sec ±0.5 ounces/sec • Must not require more than 2 seconds to open or close • Must not require any tools to open or close • Must require less than 5 in-lb of torque to open or close ENVIRONMENT	Mia Ham



Design Requirement Template (Example)

Sustainable Eng CO.	REQUIREMENT LIST FOR SOLAR OVEN REFLECTOR	2nd Version: 9/13/2007
Arenas (Leader), McBride, Wambach, Ham		Replaces 2nd Version of 9/1/2007
DATE UPDATE	REQUIREMENTS	SOURCES
9/13/2007	*Overall Function: Collect solar energy by reflecting it into an oven chamber* PERFORMANCE AND SIZE • Temperature in the oven must reach at least 220F and no greater than 350F when the ambient temperature is 85F. Hotter temperatures are preferred within 200F to 350F range • Oven must be used correctly by people not familiar with solar ovens at least 90% of the time • Oven must fit within 3 ft. x 3 ft. footprint and cannot be taller than 5 ft SAFETY • Device must not generate a fire hazard beyond that which a grill with charcoal does • Device must not have any pinch points or sharp corners/edges ENVIRONMENT	NPS (National Park Services) NPS

Summary – Problem Formulation

- The most important first step in design process
- Is focused on identifying the requirements of a design project
- Involves activities of
  - gathering information about needs
  - Formulating functional requirements
  - Design Requirements: Constraints and Criteria
- Will be used throughout the design process as Guideline for
  - Concept development and exploration
  - Basis for testing

First Assignment – Individual Work

- For a provisional design project
  - Individual Assignment
  - Identify the overall customer needs using the gathered information
  - Identify the functional requirement
  - Search and investigate the current status of art?
  - Identify the design requirements and Complete a design requirement form
  - SUBMISSION by Wednesday, 17SEP08 Class.
    - **Summary on Current Status of Art**
    - **1-Sentence Functional Requirement**
    - **Design requirement (1st version)**