

Design Process

5 Major Design Stages

1. Idea Generation
2. Conceptual Design
3. Detailed Design (Design Embodiment)
4. Prototype/Verifications
5. Refinement/Final Design/Documentation

The lectures on these topics will be enhanced by the assignments, labs, and PROJECTS

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Step 1. Idea Generation - Problem Definition and Information Gathering

- What are the needs?
 - Often vague statements
 - Market survey, clients' request, focus group, interviews, business opportunities
- What are the constraints?
 - Regulatory, standards, codes, ethics, environmental
 - Cost, materials, manufacturing process
- What are the attributes (features)?
 - Features of the new products in clear statements
- What are the tech. requirements (objectives)?
 - Technical objectives of the new products

Brainstorming, information gathering ECE3031

Idea Generation - Identify Needs

- Identify potential opportunities - keep eyes open
 - Opportunities for creation, innovation, and business growth.
How to do it? --->
 - Market survey/study, focus groups, customers' interview
 - Clients' requests/suggestions/complaints
 - Trade shows, trade journals
 - Publications, patents
- Identify industry trends - stay current with the developments in your business (know what is going on in your business)
 - Trade shows, journals, publications, patents, market studies, consulting firms, government reports

Initial statements of needs are often vague. Your job is to refine them and make them clear and precise.

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Idea Generation - Identify Constraints

- Technical constraints
 - Materials, manufacturing process, standards
- Regulatory constraints
 - Standards and codes, product safety, acts and by-laws
 - Patents - (ex. variable speed wind turbine in N.A.)
- Economic constraints
 - Costs, payback, investments
- Environmental constraints
 - Environmental impacts, life cycle assessment, recycling
- Social and ethical constraints
 - Engineering ethics, public safety

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Idea Generation

- Identify Attributes (Features)

Identify what is important to the product:

- Major attributes of the product
 - Major features of the product: what makes the customers to buy your product rather than others
 - Required attributes (Demands) or desired attributes (Wishes)
- Product functional structure
 - A problem (product) is decomposed into smaller/single functioned modules (sub-problems)
- Business goals (timing, market share etc.)
- Target market (whom do you want sell to?)

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Idea Generation

- Determine Technical Requirements (Will discuss in details later)

- Quantify qualitative objectives
- Utilize techniques to organize specifications into categories (Quality Function Deployment method - House of Quality)

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Information Gathering

- Gathering industry information - big picture
 - What? Industry trend, labor costs, market size etc.
 - Source? Trade associations, trade journals, statistics, government reports
- Gathering company information
 - What? Major players, market shares, company financials
 - Sources? Directories, web pages, corporate reports etc.
- Gathering market information
 - What? Target market, market share, market reports
 - Source? Market research reports, company reports etc.
- Gathering product information
 - What? Product name, function/features, price, parts etc.
 - Source? patents, market interviews, questionnaires, focus groups, studying customers' purchasing habits, observing products in use, analyzing customer complaints, analyzing competing products

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Brainstorming

Come up with imaginative solutions by a group

- Write a clear, focused objective (statement)
- Select participants for the team: a leader & members
- State individual ideas in short sentences in the group session
- Everyone should actively participate
- Rules For Brainstorming:
 - Weird, wild, wacky and off-the-wall ideas are welcome.
 - Negativity is not allowed (Important: no criticisms).
 - No interruptions from outside are allowed.
 - Leader will write down all the ideas.
 - Take a short break in a fixed duration.

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Brainstorming:
In-Class Exercise (10 minutes)
How can you do well in ECE3031?

- Break the class in small groups of 3-5 people (one person will take notes);
- Think hard and list approaches/methods/strategies /behaviors/actions that you can take in ECE3031 and that can help you to do well in ECE3031;
- Hand over the sheet of your group at end of the 10 minutes;
- The instructor will put your thoughts together and will present your ideas in the next class.

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How Can You Do Well in ECE3031 (2016)?

- Attend class; be attentive (be awake); following instructions
- Take good notes (record everything, have a pen and paper ready); study notes every night
- Prepare (well) in advance for class, presentation, lab...
- Do not skip labs/lectures/homework, allow for extra time
- Have good communication; work together/cooperate/actively participate in teams, don't be mean to others
- Talk to people who have taken the class
- Get organized (Google tools)
- Ask questions; ask for help
- Keep up with assignments/tasks; be punctual; start early; don't delay
- Read class e-mails, handouts

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How Can You Do Well in ECE3031 (2016)?

- Get good sleep, eat a good (well-balanced) breakfast (look after yourself, be healthy; don't show up hungry and tired)
- Exercise regularly
- Choose good partners
- Do your work independently (do not copy others' work)
- Don't text, or sleep, or play, or phone, or Facebook in class
- Sit in class where you can see and hear well
- Bring coffee
- Call your parents
- Do research, and search online; make use of resources
- Have all prerequisites; Apply the knowledge learnt from other courses

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How Can You Do Well in ECE3031 (2017)?

- Participate in class, labs, tutorials actively&positively
- Show up for classes
- Go to labs, and come prepared (do not miss labs)
- Review lecture notes, understand the materials
- Do homework (assignments, labs ...)
- Follow design/course guidelines
- Avoid over-complication of project
- Find out what tools are available (incl. internet)
- Identify strengths of group members
- Team work, and inter-team collaboration
- Effective communications (Google docs, group chat)
- Group/class Facebook group
- Ask questions, and ask for help when needed

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How Can You Do Well in ECE3031 (2017)?

- Take breaks, lots of rest and daily exercise
- Two hours of concerted meditation daily
- Time management, start early, stay on track (make a timeline and stick to it – Gantt Chart)
- Have designated group work time (extra meetings)
- Maintain healthy/positive attitude
- Work hard, and stay focused
- Take good notes, have a record for all work done
- Drink lots of generously spiked coffee
- Hygiene and eating well; balanced breakfast
- Bribe
- Shave head (aerodynamics)
- Use good judgment

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How Can You Do Well in ECE3031 (2017)?

- Talk to former students
- Drop all other courses
- Drive safe
- Spa day
- Find a smart group
- Get enough sleep
- Try hardest not to die
- Come to class early to get a good seat
- Division of tasks among group members (equally)
- Do not cheat; cheat
- Practice presentation skills
- Do a lot of research (papers, projects...)
- Buy paper/pencils

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How Can You Do Well in ECE3031 (2018)?

- Pick an interesting project.
- Go to class, and pay attention. Able to see the board
- Take organized (good) notes. Read course materials
- Do a lot of research, find lots of resources for info beyond class & labs, utilize Makerspace
- Organization. Good plan.
 - Assign tasks
 - Make a schedule & keep track progress, start work early
 - Make color coded to do list
 - Break project down into milestones
 - Prioritizing
- Stay active throughout the semester
 - Participate in class and project
- Study. Check e-mails frequently, class website
- Be on time (deadlines). No procrastination. ECE3031

How Can You Do Well in ECE3031 (2018)?

- Be open-minded and respectful. No negativity
- Stay focused. Be prepared
- Go to bed (enough sleep). Don't binge Netflix
- Stay away from MMO RPGs
- Good team dynamic. Pick a good group
- Wing nights
- Identify strengths and weaknesses
- Measure twice, cut once
- Be professional
- Snacks/hydration/mental health. Eat well
- Group bonding (yoga)
- No drug/alcohol
- No drama

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How Can You Do Well in ECE3031 (2018)?

- Share your ideas
- Bribe the professor
- Be ethical
- Review frequently
- Practice brainstorming
- Do not drop the course
- No plagiarism (no getting caught)
- Positive attitude
- Set short-term & long-term goals
- Work hard, complete all course work

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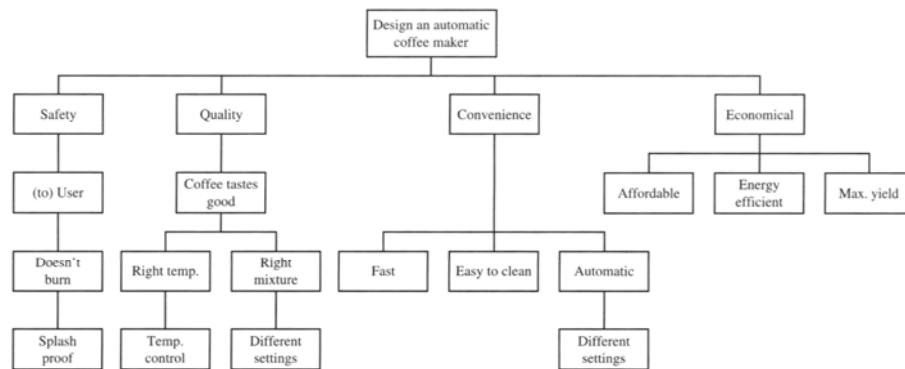
Identify Attributes (i.e. Features of Your Product)

Using Information Gathering Techniques

- Gathering product information
 - market interviews (details are in Gregson's Notes)
 - questionnaires
 - focus groups (details are given in Gregson's Notes)
 - studying customers' purchasing habits
 - observing products in use
 - analyzing customer complaints
 - analyzing competing products
 - patents
 - trade shows etc.

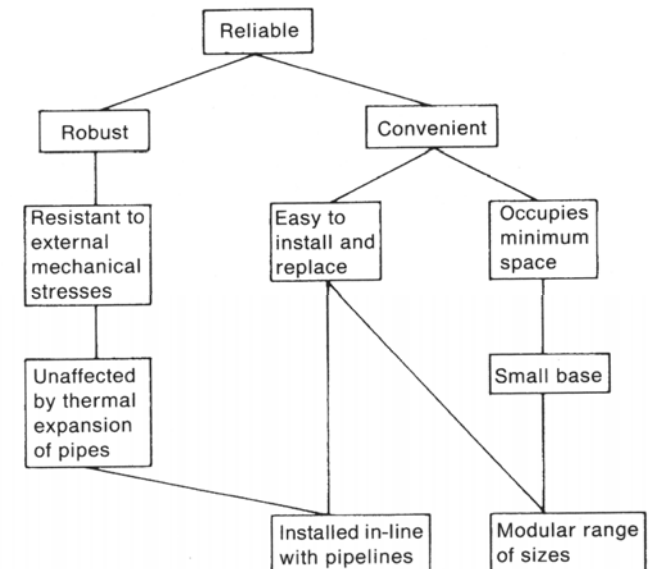
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Attributes of a Coffee Maker Represented by a block diagram



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Attributes of a Tea Maker



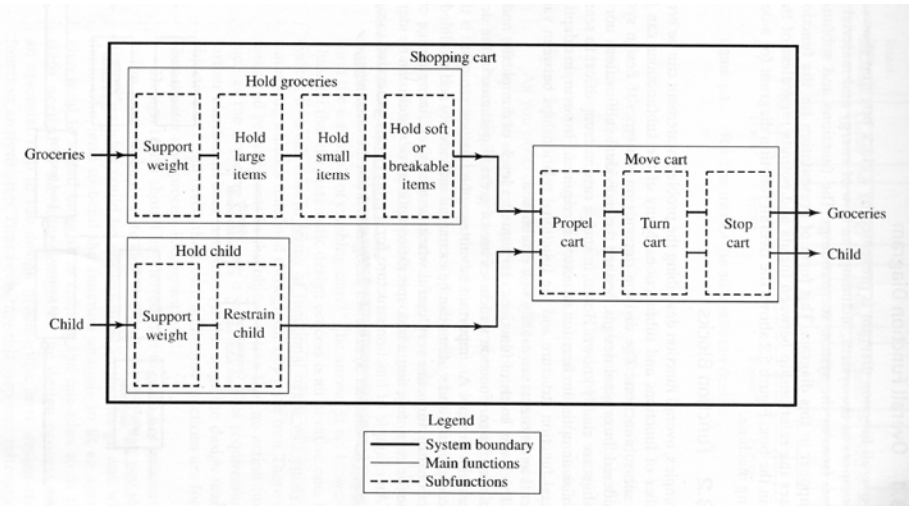
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Establish Functional Structure

- Break down the design problem into functional modules which are essential for later stages of design
- Use a block diagram in which each block performs one function.
- Ensure that each function is easily described in a very few words.
- Make absolutely sure that the word “*and*” never appears in a function statement.
- Do not state *how* the function is to be performed; merely state *what* function is to be performed.
- Use a word for function, not a specific device or component

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Functional Structure for a Grocery Cart



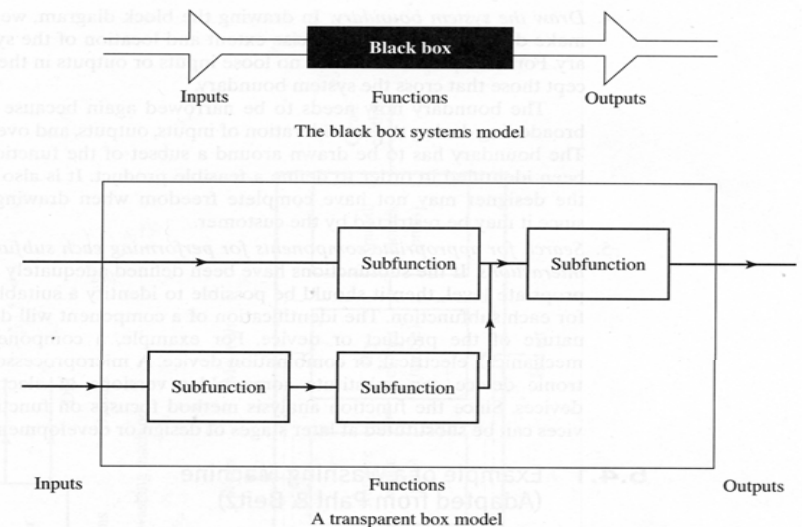
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How to Establish Functional Structure?

- Identify input and output of the overall function
- Break down the overall function based on needs and attributes into essential subfunctions or sub-subfunctions
- Draw a block diagram showing the interactions between subfunctions (linked by input/output of them)
- Draw the system boundary

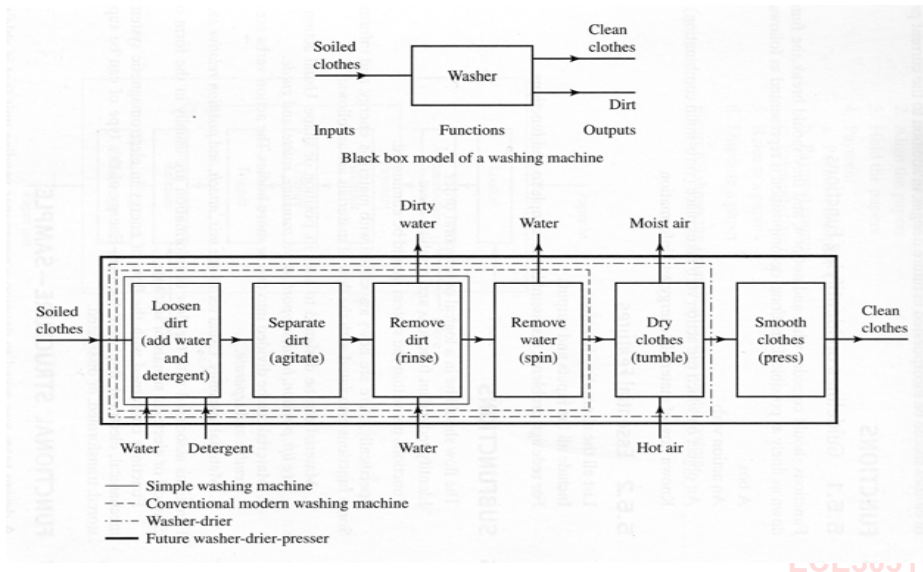
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Establish Functional Structure: Guide



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Functional Structure of a Washing Machine



Idea Generation

- Determine Tech. Requirements

- This is the last step of defining a design problem.
- At this stage, you continue to provide additional clarification of “needs”.
- “Technical Requirements” set limits of the product, i.e., define the **range** of the product. (Here “technical requirements” are **measurable engineering characteristics** along with attributes for your design.)
- (Technical requirements = engineering characteristics)
- (Attributes = customer requirements = features)

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Technical Requirements Are Engineering Characteristics

- Engineering characteristics (i.e., technical requirements) capture the attributes and constraints in a measurable form.
- Engineering characteristics define a product range (not a specific product)
- Engineering characteristics can be derived from studies of customers’ demands/wishes and constraints
- Engineering characteristics can be refined in the House of Quality (next few slides)

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House of Quality (HoQ) Method

- House of Quality method is one of the methods in Quality Function Deployment Method
- “House of Quality” is a product development tool for new product development process.
- “House of Quality” uses a comprehensive matrix for documenting information, perceptions and decisions.
- Please review the "House of Quality" tutorial:
<http://www.webducate.net/qfd/qfd.html>

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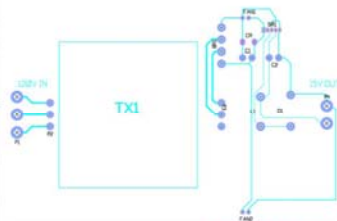
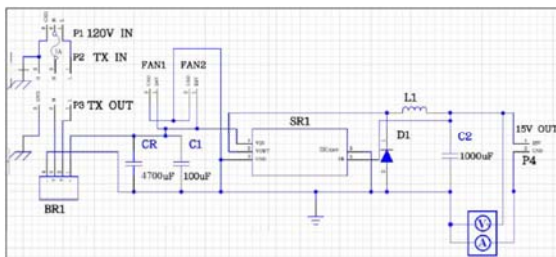
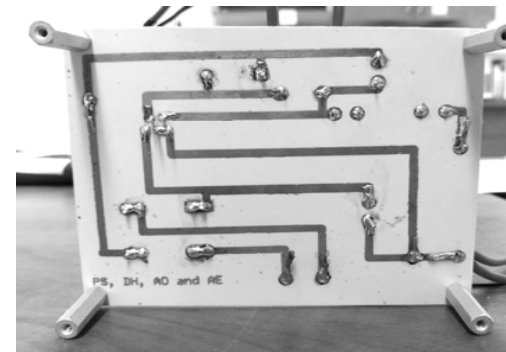
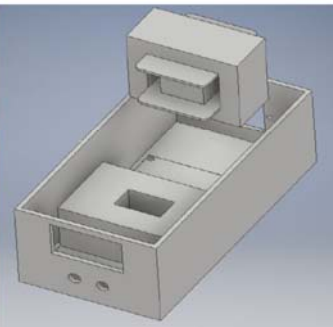
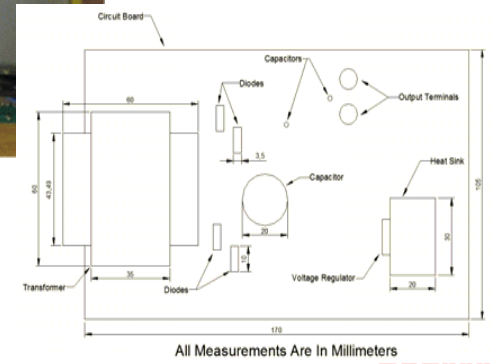
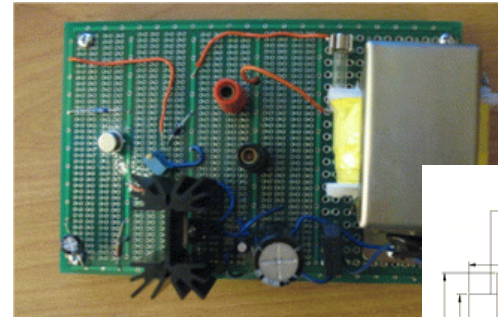
Example House of Quality Matrix Product - Rock Climbing Harness

Key to roof / correlation matrix symbols
 + Positive / Supporting
 - Negative / Tradeoff

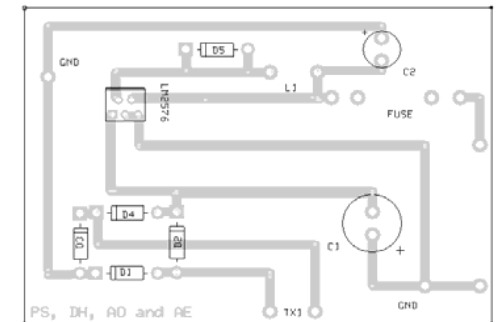
DIRECTION OF IMPROVEMENT		CORRELATION MATRIX							PLANNING MATRIX								
TECHNICAL REQUIREMENTS	CUSTOMER REQUIREMENTS	Performance measures		Size of range		Technical details			PLANNING MATRIX								
		Meets European standards	Harness weight	Webbing strength	Nc. of colors	Nc. of sizes	Padding thickness	Nc. of buckles	Nc. of gear loops	Our product	Competitor A's product	Competitor B's product	Planned rating	Improvement factor	Sales point	Overall weighting	Percentage of total
Facilitates climbing	Usability																
	Easy to put on	2															
	Comfortable when hanging	5															
	Fits over different clothes	1															
	Accessible gear loops	3															
	Does not restrict movement	5															
	Lightweight	3															
Performance	Safe	5															
Attractive	2																
TECHNICAL PRIORITIES		54	81.2	63	23.4	70.2	191.6	98.6	30	Key to interrelationship matrix symbols							
PERCENTAGE OF TOTAL		9	13	10	4	12	31	16	5	● Strong interrelationship ■ Medium interrelationship ▲ Weak interrelationship							
Technical Benchmarking	Our product	Y	174g	250	5	4	4mm	1	4								
	Competitor A's product	Y	193g	321	3	5	8mm	4	5								
	Competitor B's product	Y	157g	198	6	4	3mm	1	3								
DESIGN TARGETS		V	160g	195g	8	6	4mm	2	4								

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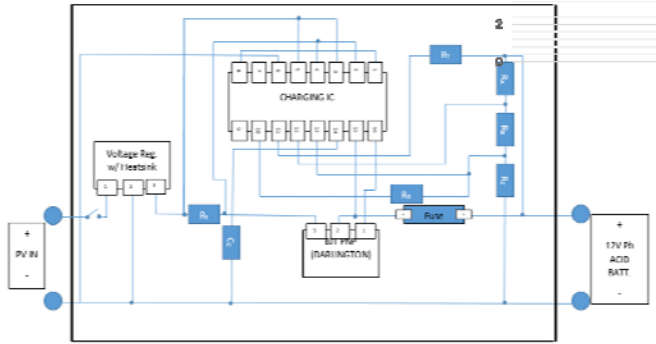
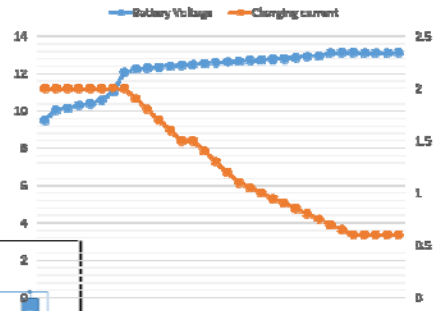
A Previous Design Project - A Working Power Supply



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A Battery Charger



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