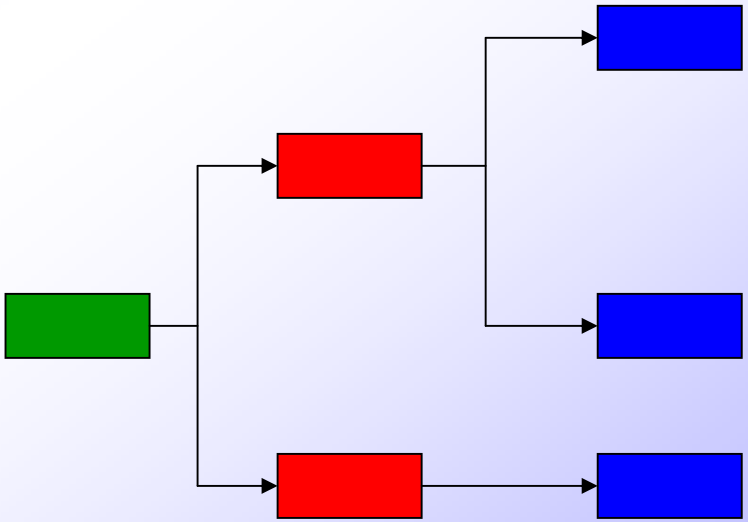
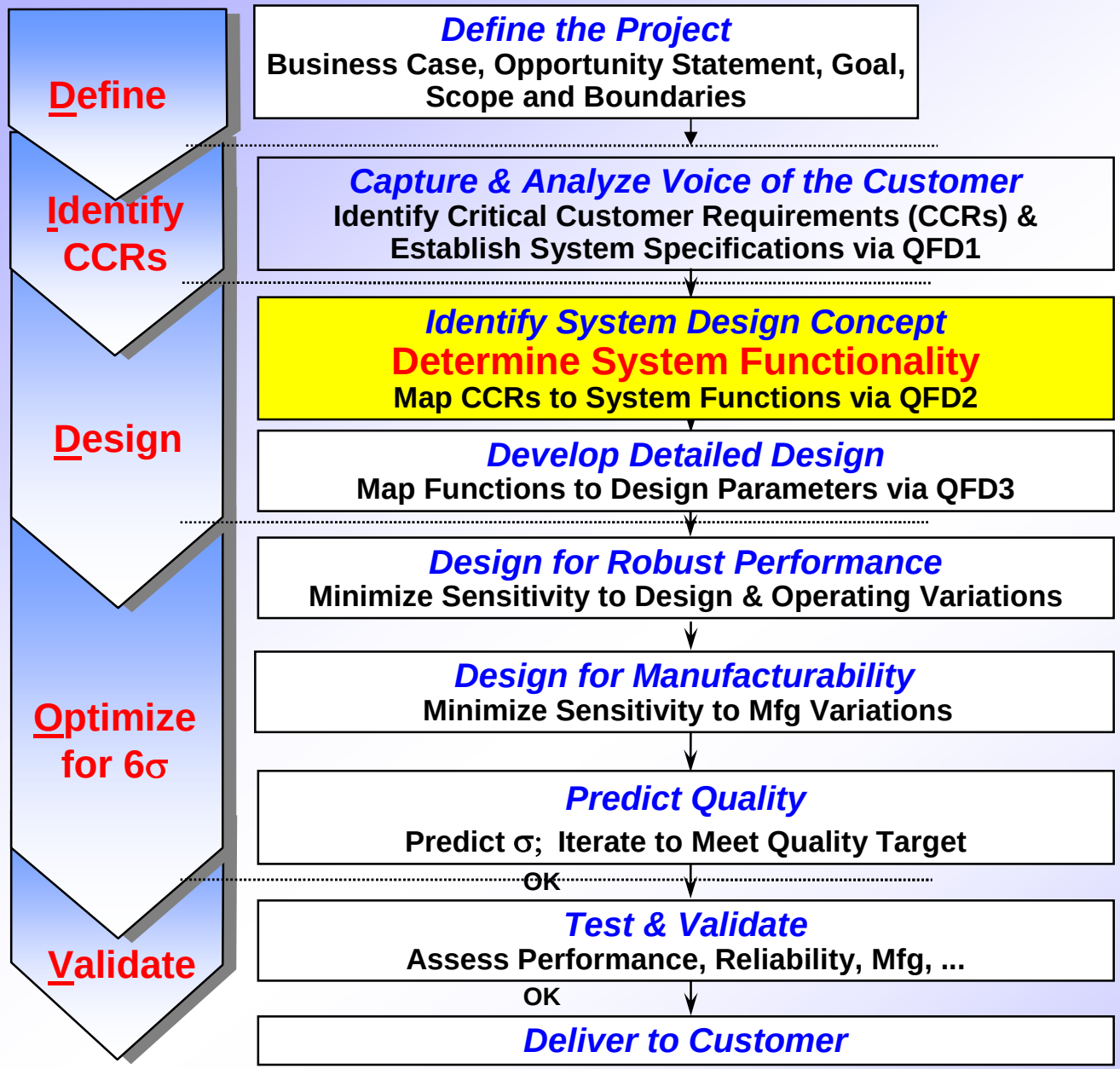
Function Definition

A Powerful Problem or Opportunity Analysis Technique





Typical DFSS Process

Source: Design for Six Sigma, K. Yang

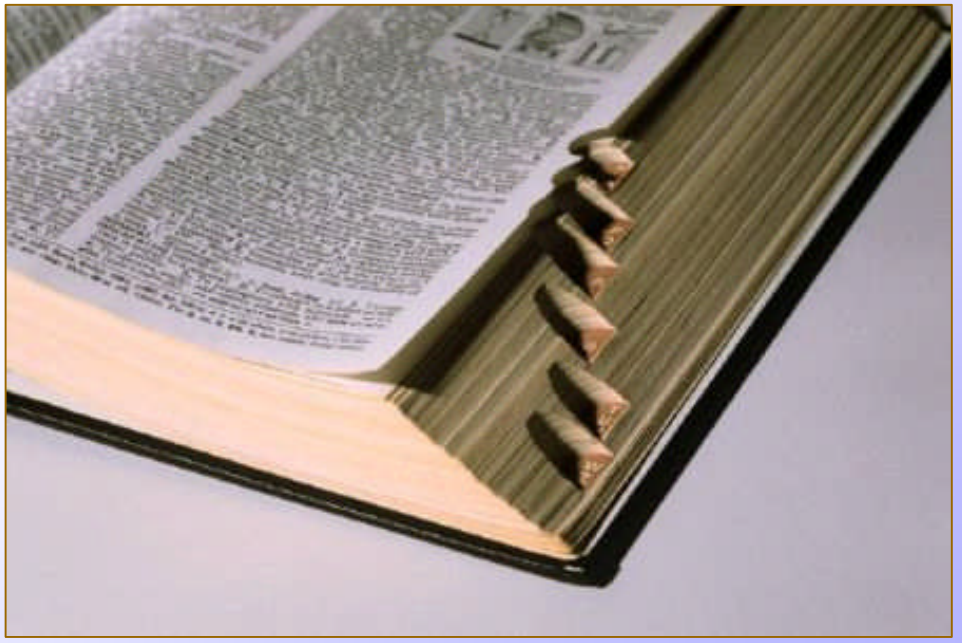
Objectives

- Learn "Best Practices" to Define Functions
- Identify Basic and Secondary Functions
- Develop a FAST Diagram
- Intro. to Value Engineering
- Assign Homework

FAST: Function Analysis System Technique

Function Definition

- Describes a product in terms of an Active Verb and a Measurable Noun
- Provides a complete understanding of the basic reason(s) something exist
- Explore new ways to deliver Customer Satisfaction
  - Improved performance
  - Lower cost



Steps to Function Definition

1. Define Project Scope

2. Define the Functions

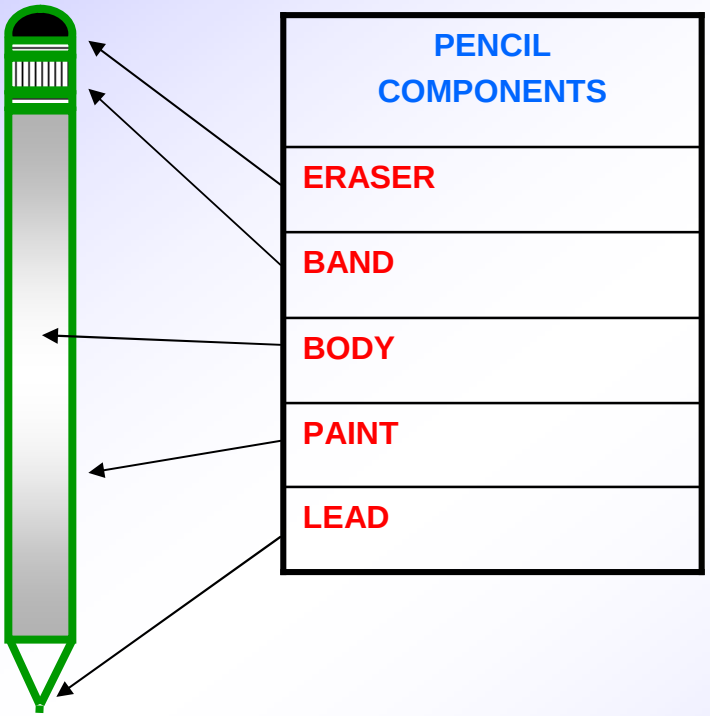
3. Construct the FAST diagram

4. Perform FAST diagram logic checks

FAST = Function Analysis System technique

Source: Value Management, J. Kaufman

1.) Project Scope is a Lead Pencil



Product could be anything:

- Power Supply
- Circuit Breaker
- Remote Village Computer Kiosk
- IT Operating System
- Radar Set
- Boat Simulator
- Fridge Ice Maker
- Ski Speed & Distance Monitor
- RR Tie Conductivity Sensor
- Sparty T-Shirt Launcher
- etc.

Source: Value Management, J. Kaufman

2.) Define Functions for Project

Functions are defined in two word phrases

1. **Active Verb:**
   - Describes the specific action we plan to achieve our intended purpose

2. **Measurable Noun**
   - Defines the object onto which the action operates

Any Verb and Noun may be combined to describe the Function

Acid Test – "Does it describe what something actually does in the system under study?"

Verbose Descriptions Indicate Lack of Design Understanding

Start Engine
Steer Automobile
Stop Automobile
Remove CD
Attract Attention
Reduce Size
Collect Data
Collect Dirt
Control Deflection
Create Image
Educate Students

Establish Budget
Increase Incentive
Maintain Clearance
Prevent Contamination
Protect Children
Tighten Bolt
Reward Achievement
Save Time
Transmit Information
Cut Grass
Suppress Noise

Verbs to Avoid

Passive and Indirect Verbs

Provide	Give	Is
Supply	Furnish	Prepare
Review	Attend	

Goal-Like Verbs

Improve	"ize" words	Optimize
Least	Maximize	Prioritize
Present	Minimize	
	Economize	

Use Active Verbs Rather Than Passive Verbs

To change passive description to active, try using the noun as the verb and then select another noun

Examples

Passive	Active
Provide Support	Support Weight
Seek Approval	Approve Procedures
Develop Exhibits	Exhibit Products
Submit Budget	Budget Expenses
Determine Resolution	Resolve Problem

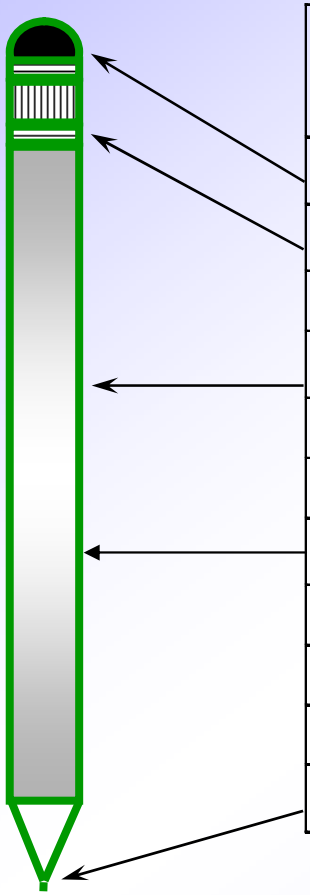
Functions are intended to be taken literally . . .

as we attempt to BRING CLARITY . . .

in describing WHAT a system actually does

Source: Stimulating Innovation in Products and Service with Function Analysis and Mapping

Function Description Of A Lead Pencil



Pencil Components	Description
ERASER	Remove Marks
BAND	Secure Eraser
	Improve Appearance
BODY	Support Lead
	Transmit Force
	Accommodate Grip
PAINT	Protect Wood
	Improve Appearance
	Display Information
	Deliver Message
LEAD	Make Marks

What is wrong here?

Source: Value Management, J. Kaufman

3.) Every Design has Basic and Secondary Functions

Basic Function:

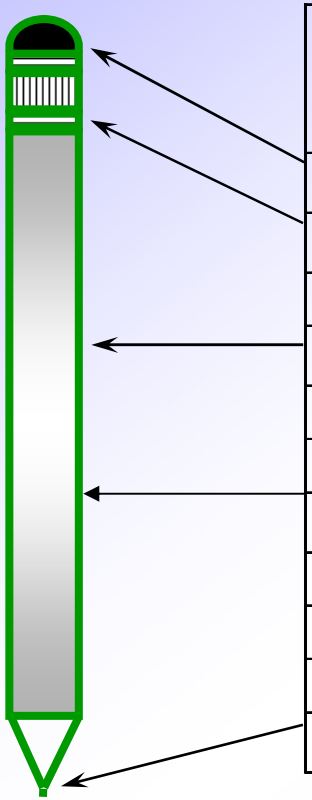
- Principal reason for the product's existence
- Has value to the Customer
- Loss of Basic Function results in total loss of market value for the design
- May be Performance or Esteem based

Secondary Function:

- Assist in, or necessary for, the realization of a Basic Function
- Targets for modification and/or elimination to:
  - Reduce cost
  - Reduce design complexity
  - Achieve Breakthrough in design

Source: Value Management, J. Kaufman

Basic and Secondary Functions Of A Pencil



Pencil Components	Description	Functions (Basic or Secondary)
ERASER	Remove Marks	Secondary
BAND	Secure Eraser	Secondary
	Improve Appearance	Secondary
BODY	Support Lead	Secondary
	Transmit Force	Secondary
	Accommodate Grip	Secondary
PAINT	Protect Wood	Secondary
	Improve Appearance	Secondary
	Display Information	Secondary
	Deliver Message	Secondary
LEAD	Make Marks	Basic

Why someone buys a pencil

Source: Value Management, J. Kaufman

3) Construct the FAST Diagram

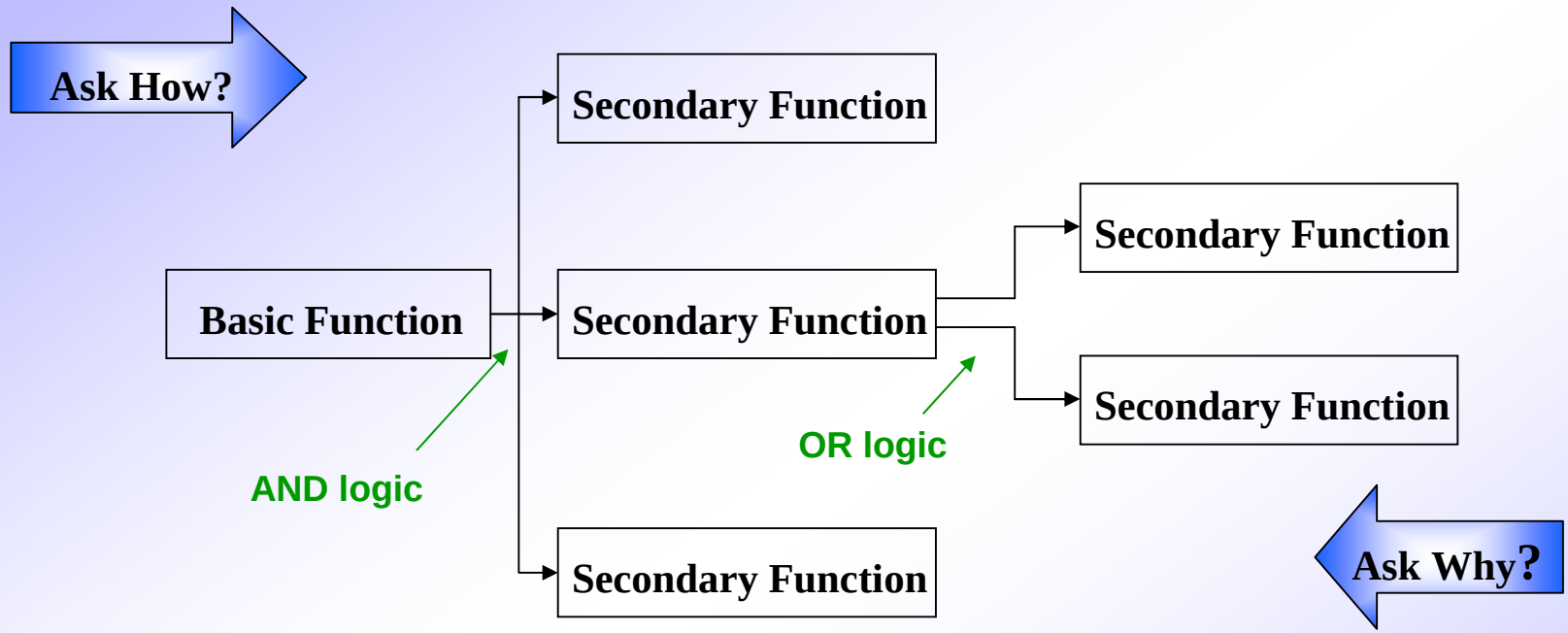
FAST Diagram

- Visual layout (Tree Diagram) of product's Functions
- Starts with the Basic Function, and builds to the right with supporting or Secondary Functions

Why do a FAST Diagram?

- Understand Functions to be eliminated, or improved, to deliver Basic Function(s)

Construct FAST Diagram Left to Right, and Check it Right to Left

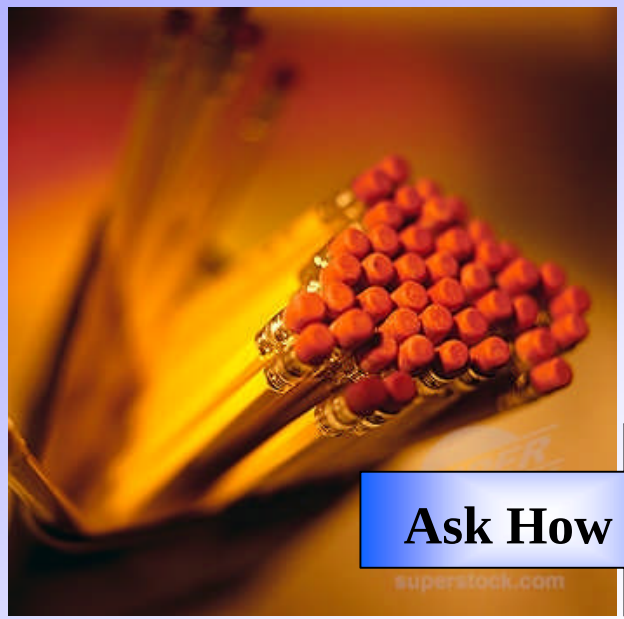


Process of Construction:

1. **Identify what you feel is the Basic Function.**
2. **Ask the question: *"How is this Function actually accomplished?"* Place Secondary Functions to the right of the Basic Function.**
3. **Check the FAST diagram by starting at the right and working left. Ask the question: *"Why must this Function be performed?"***

Source: Value Management, J. Kaufman

Pencil FAST Diagram



Ask How ?

Keep Records

Maintain Information

Record Information

Make Marks

Deposit Medium

Apply Pressure

Correct Information

Remove Marks

Absorb Medium

Apply Pressure

Rub Eraser

Secure Eraser

Support Lead

Transmit Force

Display Information

Improve Appearance

Protect Wood

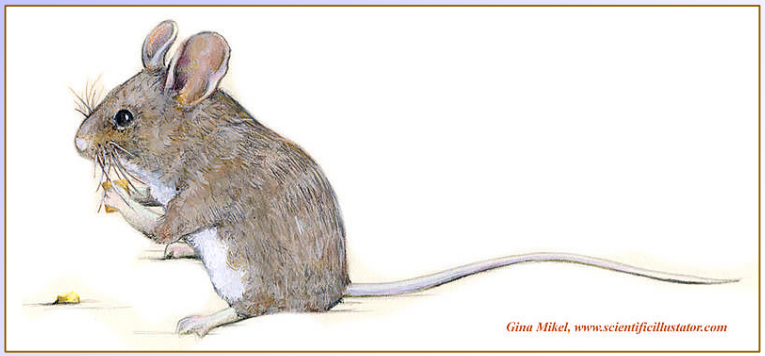
Accommodate Grip

Ask Why ?

Example Mouse Trap

Objective: Eliminate Mice

Ask Why ?



Attract Mouse

Bait Trap

Set Trigger

Arm Trap

Trip Trigger

Release Striker

Strike Mouse

Kill Mouse

Ask How ?

Position Striker

Compress Spring

Store Energy

Release Energy

Example:

Sliced Ham Process

- Produce Sliced Ham
  - Ensure Flavor
    - Add Flavoring
      - Inject Brine
    - Spread Flavoring
      - Retain Brine
  - Enhance Appearance
    - Adjust Meat Color
      - Add Coloring (to Meat)
    - Remove Air Bubbles
    - Form Meat
      - Tenderize Meat
    - Remove Fat
  - Fabricate Slices
    - Remove Casing
      - Lower Meat Temp
    - Space Meat Length
    - Determine Meat Weight
      - Fix Meat Thickness

Source: Function Analysis, K. Akiyama, pg 207

Four Rules of Function Definition

1) Once defined, Basic Function does not change. . . becomes principle work a system does. Example: flashlight is expected to emit light

2) Cost contribution of a Basic Function is a minimal percentage of total system cost

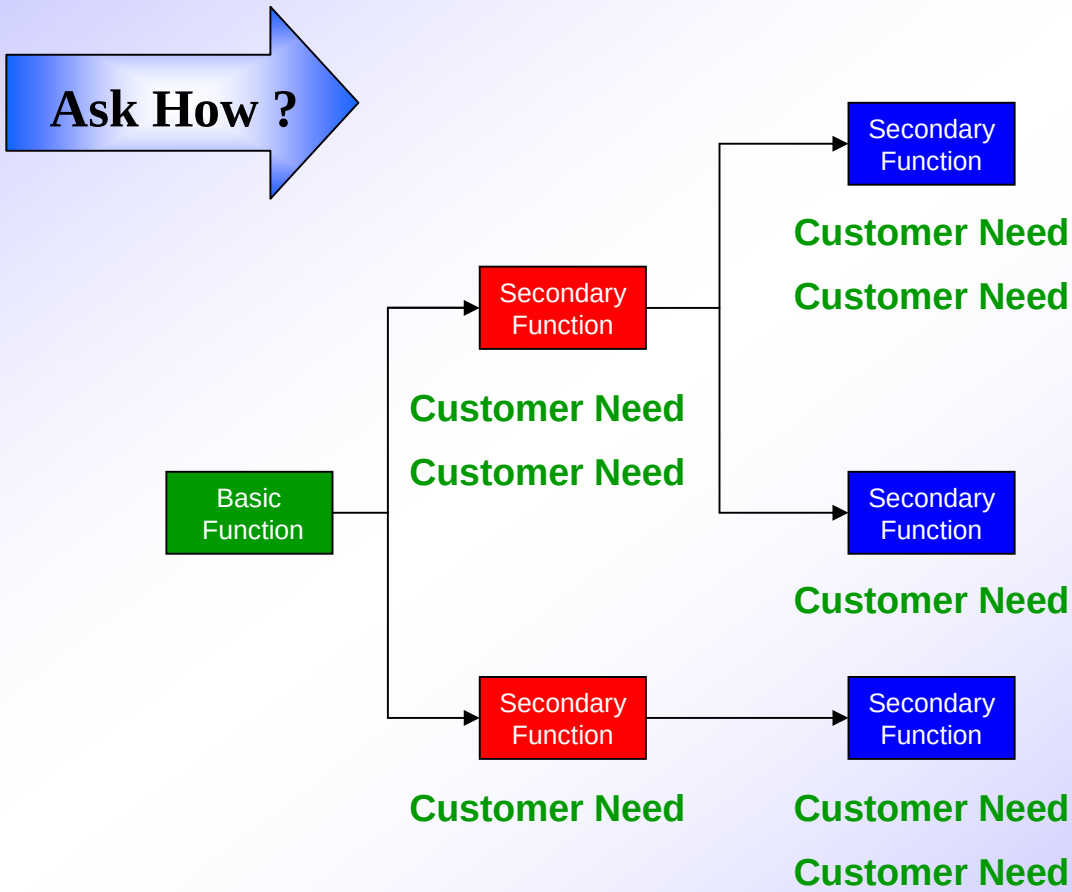
3) Can not sell supporting Secondary Functions without performing Basic Function satisfactorily

4) Loss of Basic Function(s) results in total loss of market value. Example: Rolex watch that does not display correct time

4.) FAST Diagram Logic Checks

- Double check tree diagram “How?” and “Why?” logic.
- Identify possible Secondary Functions for elimination?
  - Test by removing Secondary Function, and ask the “How ?” and “Why ?” logic questions.
- Check “AND” logic and “OR” logic diagramming.
- Ensure project Scope lines are clearly drawn.

FAST Model is complete when . . .
Customer Needs can be Mapped to Functions



Cost Function Matrix is Workhorse of Value Engineering

Operations, Parts, Assembly	Total Cost	Functions (V-N)			
Total					
%					

Operations, Parts, and assemblies come from:

- Block diagram
- Process Map
- Logic Diagram
- Value chain

Functions come from detailed level of FAST Diagram

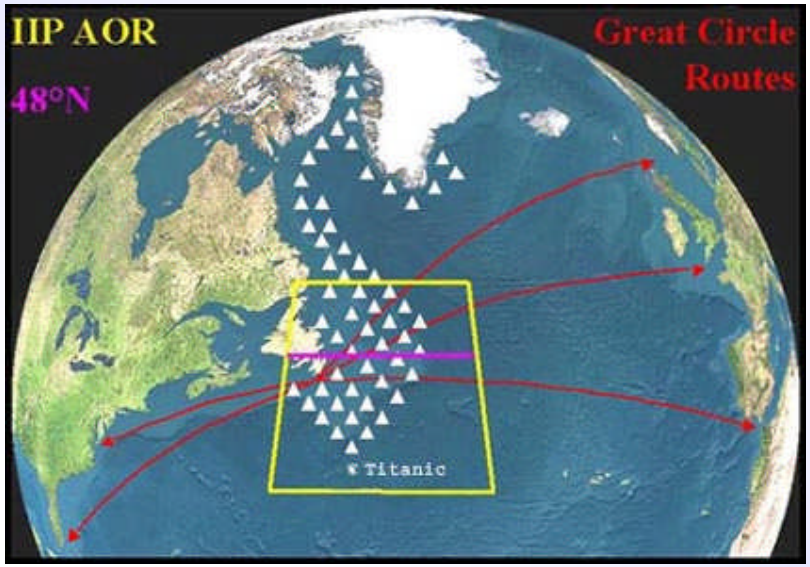
Cost – Function Matrix Identifies Areas of Opportunity

Steps to Create Matrix:

1.) List major operations, parts, or assemblies in left hand column
2.) List total cost for each group in adjacent column
3.) Place Functions across top from FAST Diagram
4.) Identify Functions contributing to each line of cost (indicate with dot in cell)
5.) Determine portion of cost associated with each function
6.) Sum Functional cost
7.) Calculate Function %
8.) Show Function % on FAST diagram

Example: International North Atlantic Ice Patrol

- Formed in 1913
  - Result of Titanic sinking April 14, 1912
- Iceberg condition data collected by
  - Fixed wing aircraft
  - Buoys



- Report warnings at 9 pm each day in “plain, concise English” during ice season from February thru July.

Example: International Ice Patrol

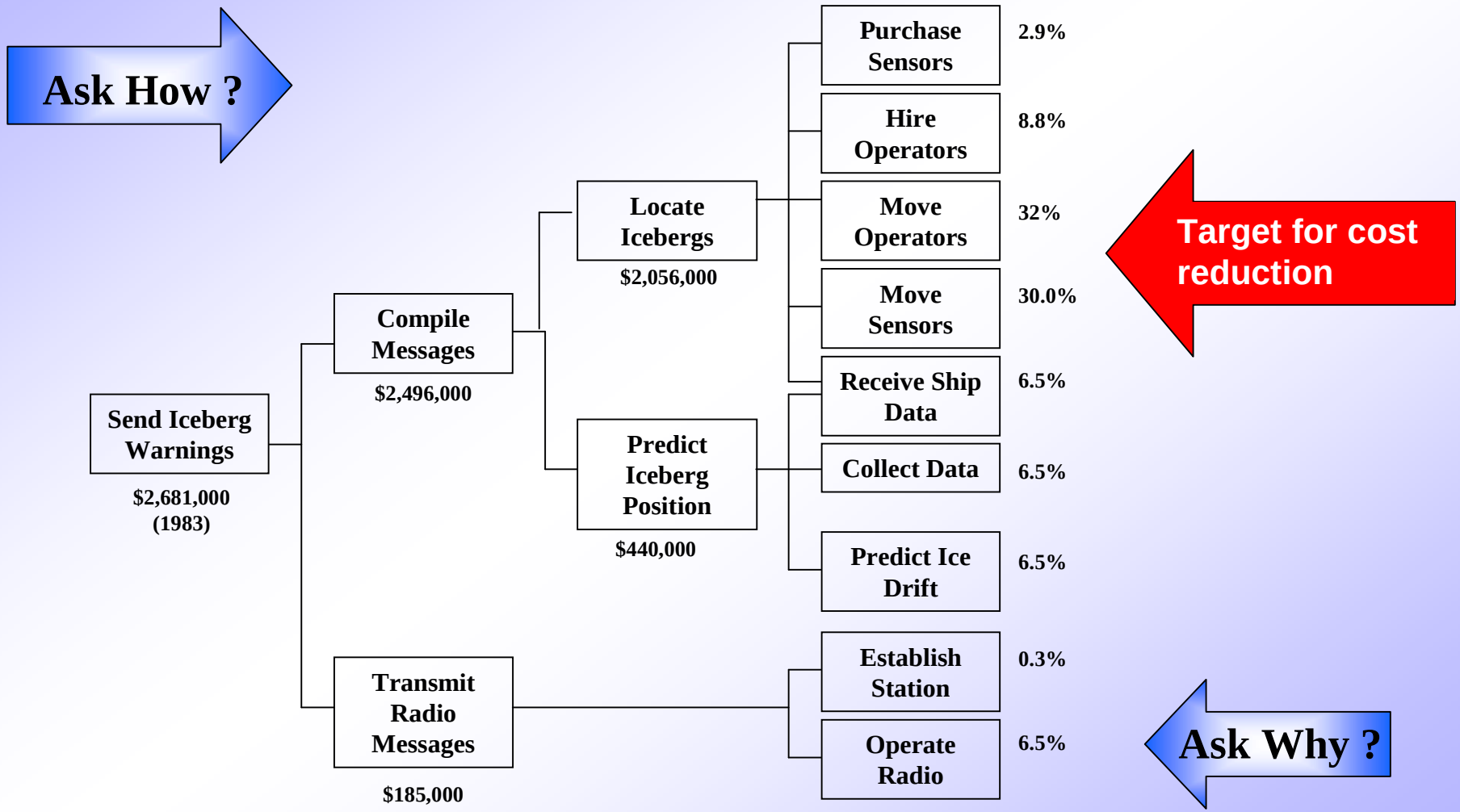
Source: Value - Its Measurement, Design, and Management by M.L. Shillito Fig 7.7

Example: International Ice Patrol Cost-Function Matrix

	Total Cost $M	Purchase Sensor	Hire Operators	Move Operators	Move Sensors	Receive Ship Data	Collect Data	Predict Drift	Establish Stations	Operate Transmitter
Aircraft Personel	**705**		235	235	235					
Fuel	**494**			247	247					
Aircraft Maintenance	**490**			245	245					
Aircraft Op. Support	**152**			76	76					
Office Staff	**224**					56	56	56		56
Travel/Lodging	**50**									
Leasing	**5**	1							4	
Bouys	**63**	63								
Radar Film	**13**	13								
Misc.	**5**								5	
Admin.	**480**					120	120	120		120
Total	**$2,681**	**77**	**235**	**853**	**803**	**176**	**176**	**176**	**9**	**176**
%	**100**	**2.9**	**8.8**	**32**	**30**	**6.5**	**6.5**	**6.5**	**0.3**	**6.5**

Note: Cost in 1983 dollars
Source: Value – Its Measurement, Design, and Management by M.L. Shillito, Fig 7.8

Example: International Ice Patrol



Source: Value - Its Measurement, Design, and Management by M.L. Shillito Fig 7.7

Homework Assignment

Objective

- Develop a FAST Diagram for your ECE 480 Senior Design Project

Instructions

- Provide a few sentences describing your Project objectives to orient me in grading this assignment
- Follow Step-By-Step process in slides
- Refer to examples and list of useful Verbs and Nouns in Slides and Appendix
- Only diagram a maximum of 3 levels of Secondary Functions beyond Basic Function(s)

Deliverables

- Typed FAST Diagram in Word, Excel, or PowerPoint from each Team
- E-Mail Diagram to G. Motter at sail1070@Yahoo.com and to Dr. Goodman

Due Date

- One week from today

Questions?

Appendix: Classic Text Book Examples

- Useful Verbs and Nouns
- FAST Diagram Examples

Useful Verbs in Describing Functions

Add	Display	Maintain	Sense
Analyze	Distribute	Measure	Separate
Arrange	Eliminate	Obtain	Start
Attach	Evaluate	Position	Store
Create	Expand	Prevent	Support
Collect	Extend	Protect	Test
Combine	Freeze	Recommend	Transmit
Confirm	Harden	Record	Transport
Contain	Heat	Reduce	Use
Conduct	Implement	Remove	Verify
Control	Increase	Resist	
Convert	Insulate	Retain	
Cool	Invert	Reverse	
Destroy	Isolate	Rotate	
Develop	Locate	Select	

Source: Stimulating Innovation in Products and Service with Function Analysis and Mapping

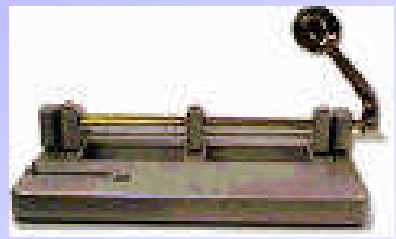
Useful Nouns in Describing Functions

Air	Fluid	Noise	Time
Area	Force	Opening	Torque
Assembly	Frequency	Pressure	Vehicle
Atmosphere	Friction	Protection	Vibration
Cold	Gas	Resistance	Volume
Color	Heat	Resistance	Voltage
Comfort	Humidity	Rotation	Waste
Communication	Indication	Shape	Water
Component	Information	Size	Wear
Current	Length	Solid	Weight
Distance	Material	Sound	
Enclosure	Mixture	Space	
Energy	Mobility	Stress	
Environment	Moisture	Temperature	
Expansion	Motion	Texture	

Source: Stimulating Innovation in Products and Service with Function Analysis and Mapping

Example:

Paper Punch



Organize Paper

Produce Holes

Task

Basic Function

Scope

Ask How ?

- Locate Sheet
  - Support Sheet
- Pierce Sheet
  - Drive Punch
  - Guide Punch
  - Retract Punch
- Adjust Holes
  - Locate Punch Assembly
- Collect Waste
  - Drop Holes
  - Collect Holes
- Attract User
  - Prohibit Rust
  - Protect Work Surface
  - Decorate Surface

Ask Why ?

Source: Acquiring, Processing, and Deploying the Voice of the Customer, M. Shillito, pg 74

Mapping of Voice Of Customer to Functions
Example: Paper Punch

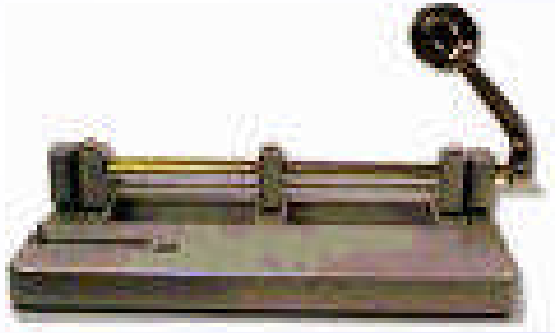
Produce Holes

Locate Sheet
- Easy to insert
- Stays in place

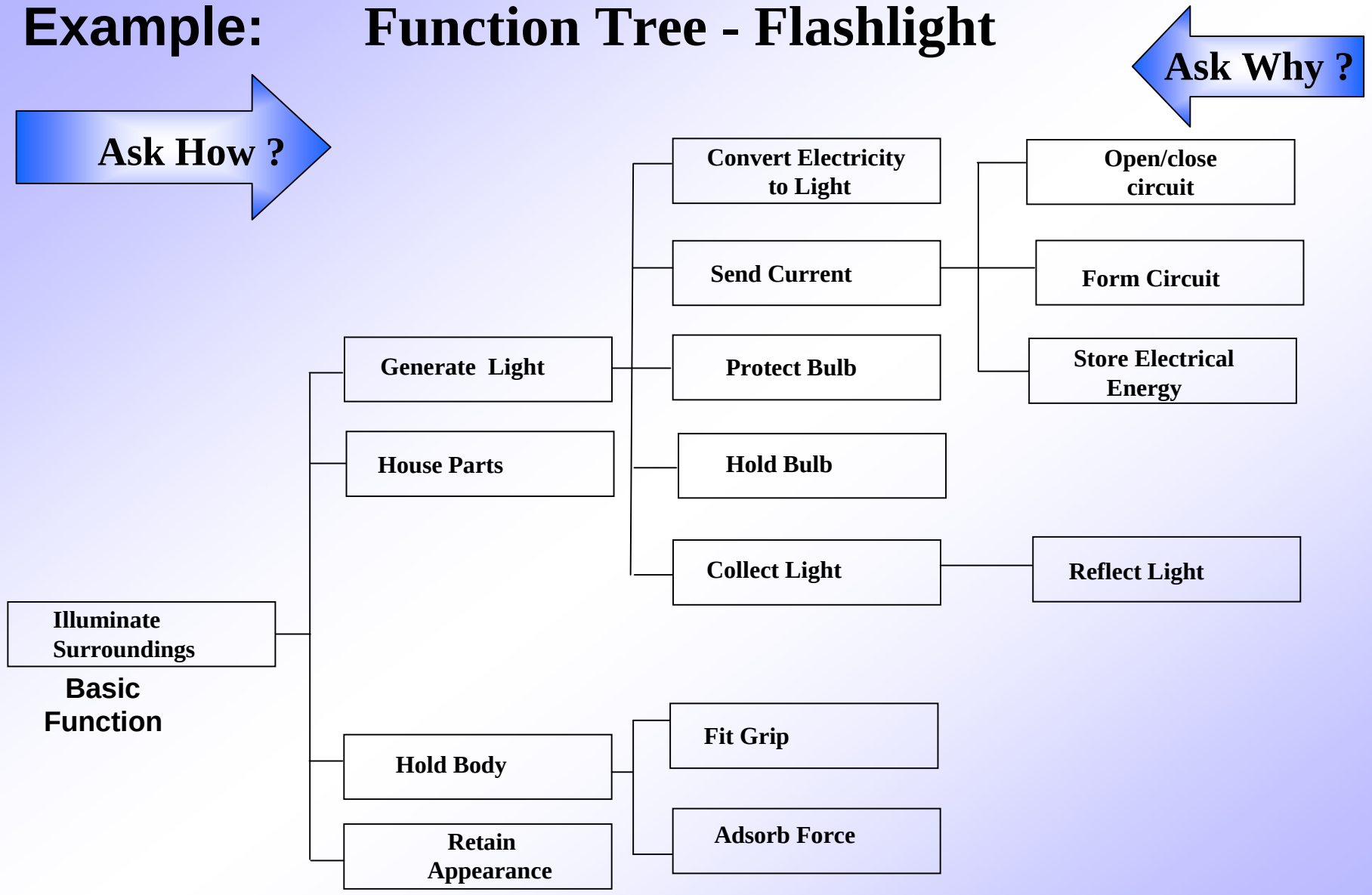
Pierce Sheet
- Easy to press
- Won't hurt hand
- Pierce multiple sheets
- Non-jamming

Adjust Hole (location)
- Easy access to assembly
- Easy to position
- Finger tight
- Stays in place

Collect Waste
- Holds large quantity of holes
- Holes won't fall out
- Easy to clean



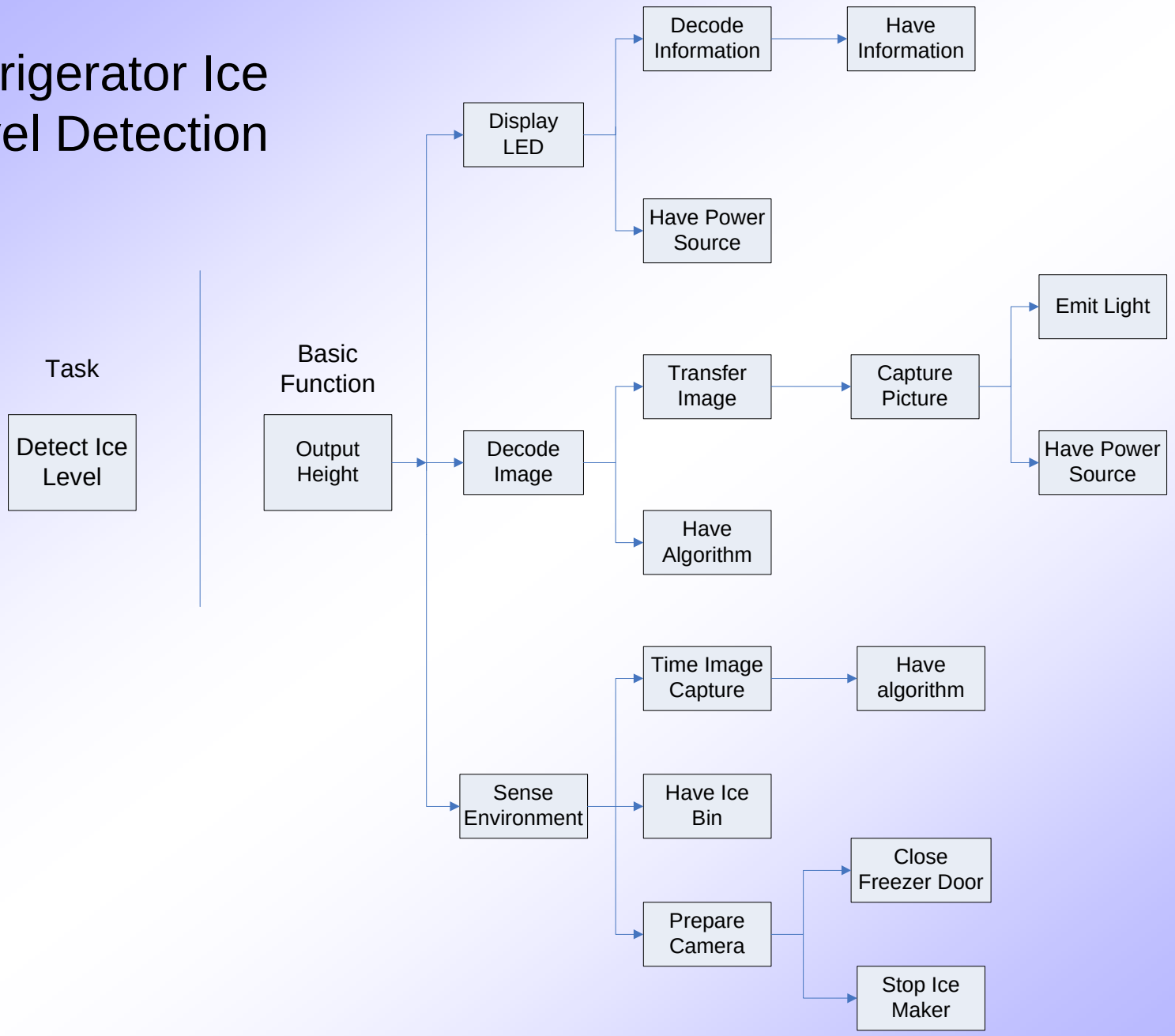
Example: Function Tree - Flashlight

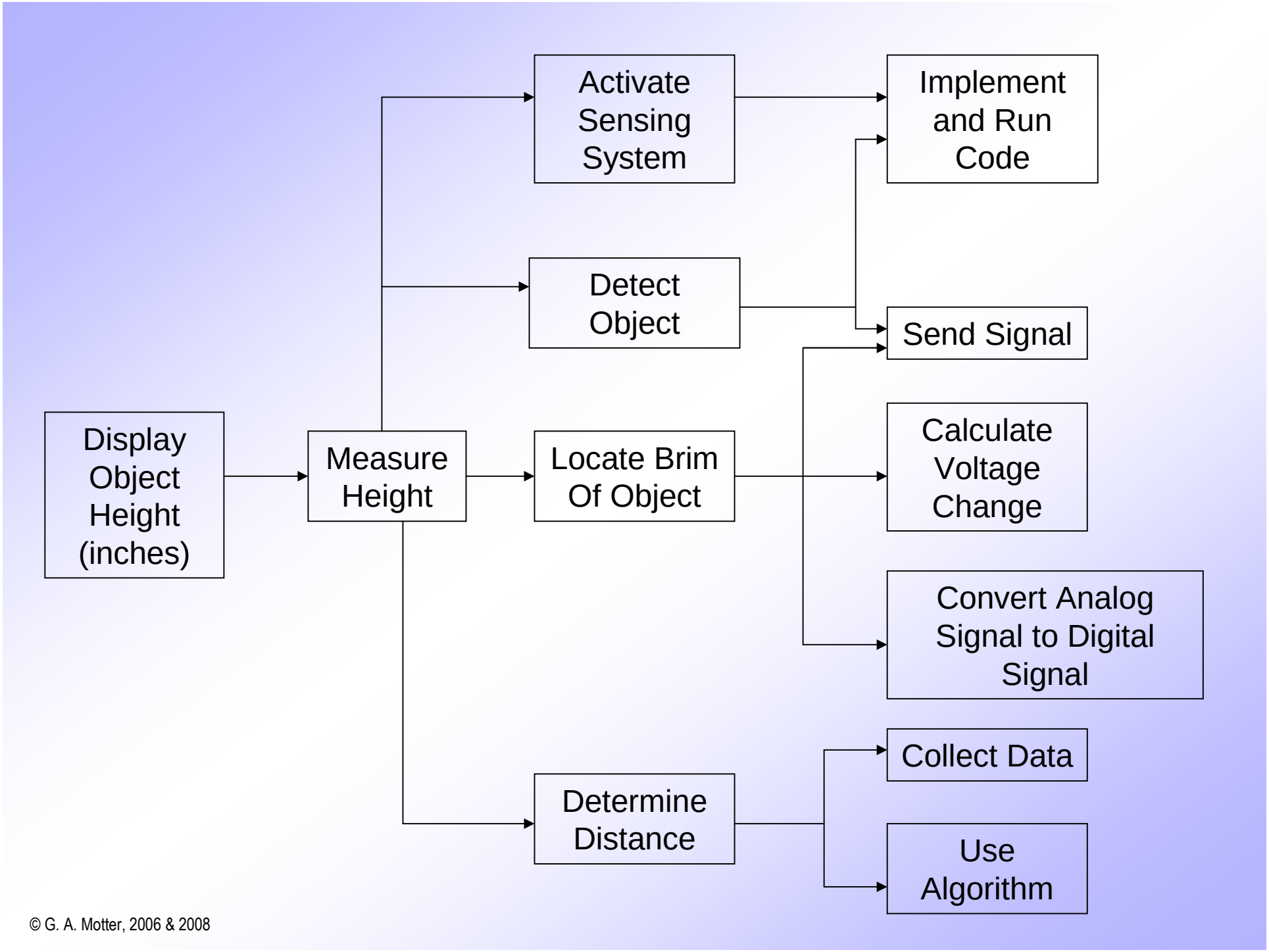


Source: Function Analysis, K. Akiyama, pg 55

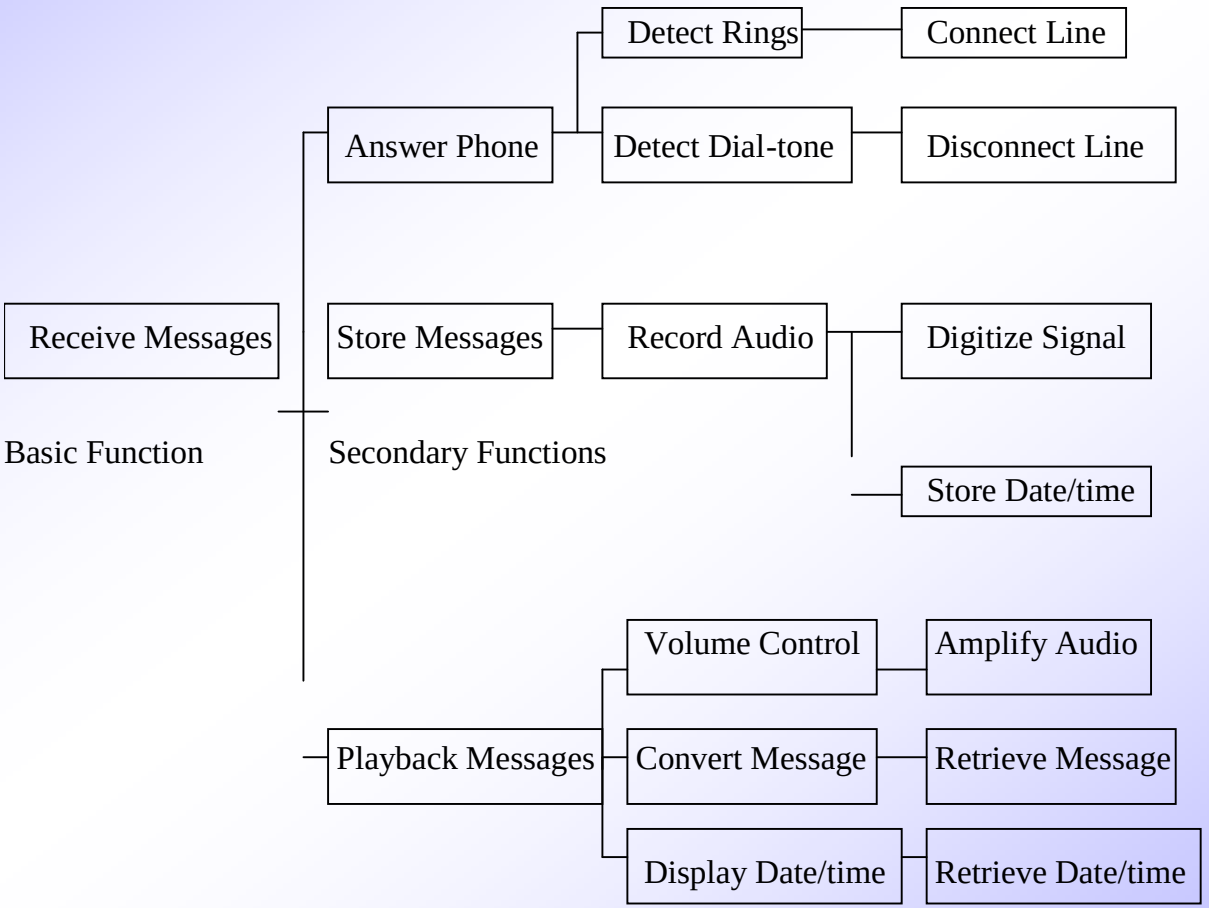
Appendix
Past ECE 480 Project Examples

Refrigerator Ice Level Detection

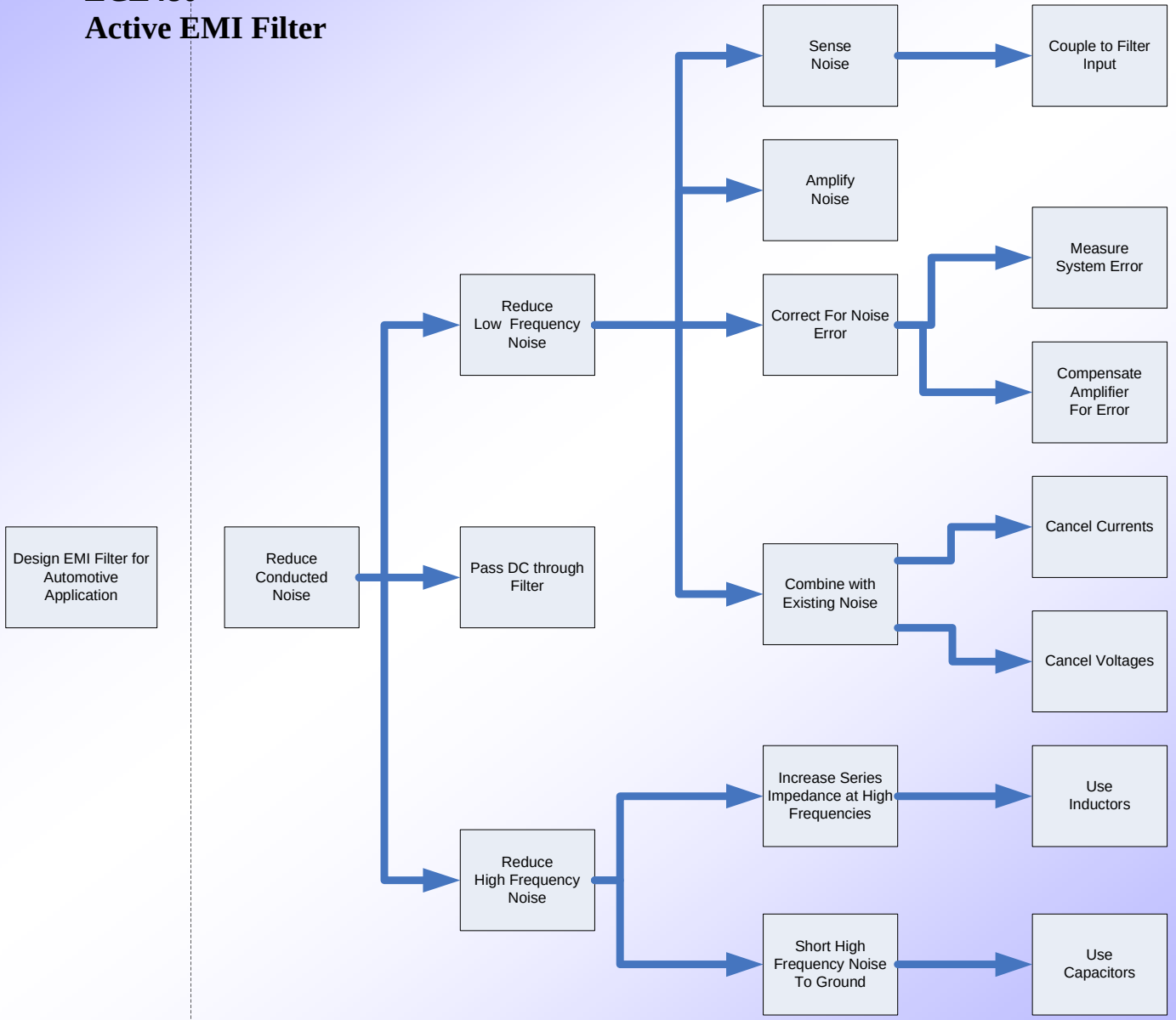




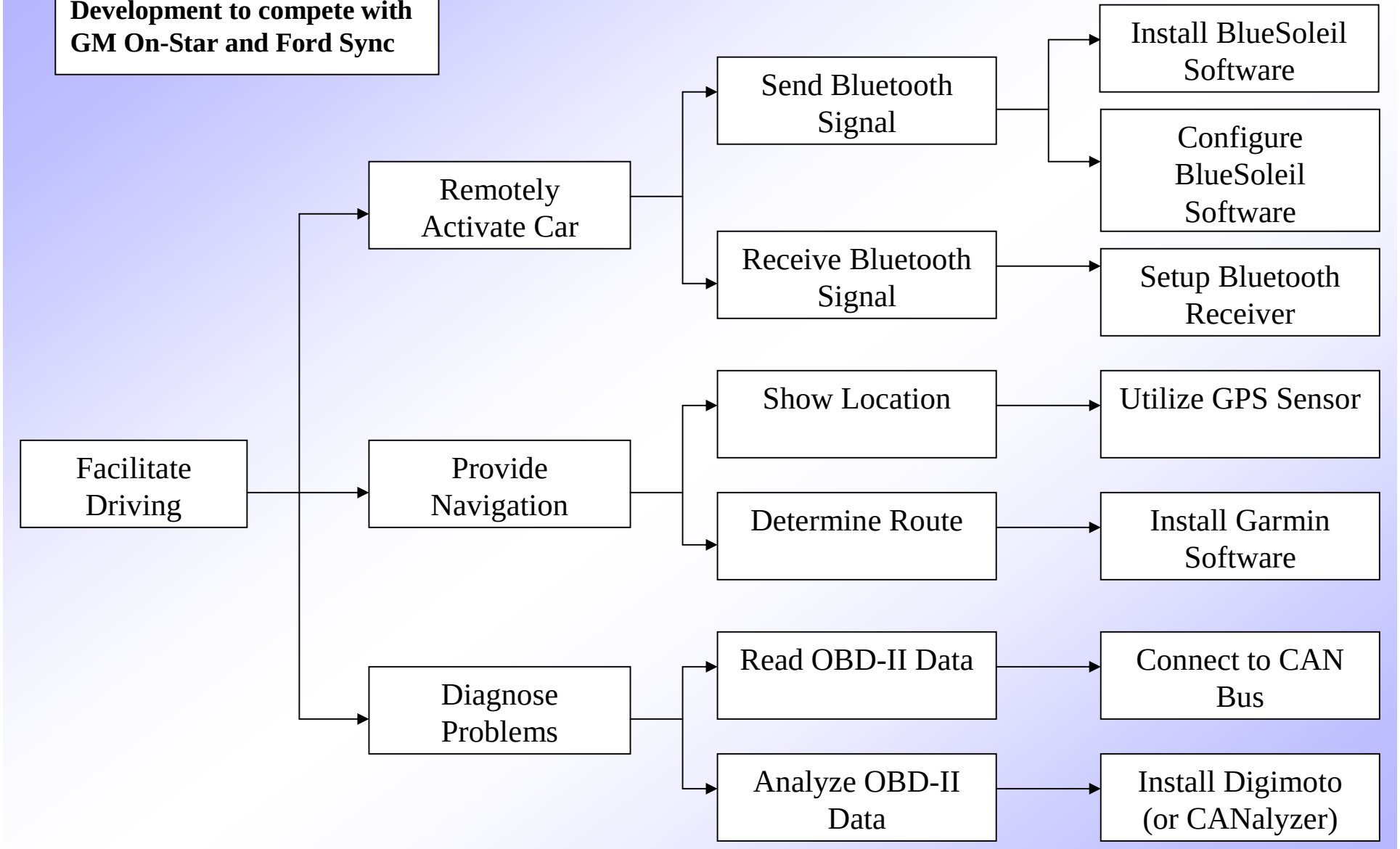
Digital Answering Machine
FAST Diagram



ECE480
Active EMI Filter

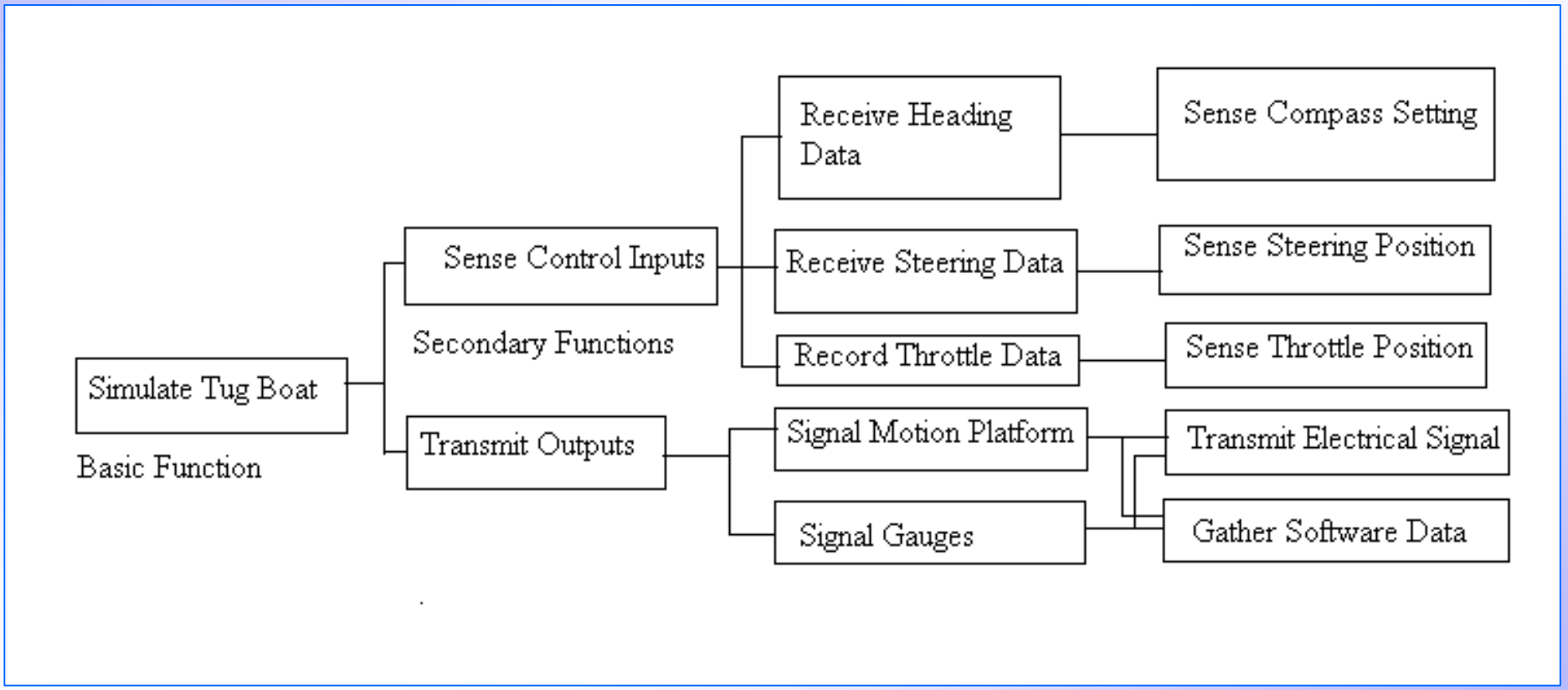


DigiDrive IV Platform Development to compete with GM On-Star and Ford Sync



Designing and assemble a tug boat simulator.

We will be using a software program which will take in hardware inputs, perform appropriate calculations, and transmit outputs.



Detecting an audio signal of a siren external to a vehicle and warning the driver of the proximal emergency vehicle.