ELE 491
Senior Design Project Proposal

These slides are loosely based on the book Design for Electrical and Computer Engineers by Ford and Coulston. I have used the sources referenced in the book freely and without re-attribution. Please see the book for full source attribution

ELE 491
Senior Design Project Proposal

Class 4 – Project Identification

Project Identification

Overview

- Project Flow
  - Identify problems
  - Create requirements
  - Generate/evaluate conceptual solutions
  - Decomposition
  - Modeling and Design
  - Validation
  - Delivery

Project Identification

Project Types

- Types of Designs?
  - Routine designs
    - Most common
    - Create a specific version of an existing well understood design
    - e.g.
      - Butterworth LPF at 10,500 Hz
      - Voltage supply with 50mv of ripple
      - Gain stage with a gain of 750
      - u-Controller design with external interrupt
  - Variant designs
    - Common
    - Modify or improve an existing design
    - e.g.
      - Add Bluetooth to existing GPS unit
      - Add foot activated tailgate to Ford F150
      - Integrate regulator onto wireless modem chip

Project Identification

Project Types

- Types of Designs?
  - Creative Designs
    - Un-common
    - Create a new product that is not closely related to any other existing product implementation (may have the same end use)
    - e.g.
      - Touch Screen
      - Virtual keyboard
      - Quadra-Copter
      - Electric bicycle shifter

Project Identification

Project Types

- Types of Projects?
  - Component / Block
    - Development of a specific component or block within a larger block, subsystem or system
    - e.g.
      - Op amp design within an analog filter chip
      - Regulator within the power management subsystem of an automobile infotainment system
      - Antenna within the RF subsystem of a cellular phone
  - Subsystem
    - Development of a system composed of various blocks and other subsystems intended to be integrated into a larger system
    - e.g.
      - Power management system within an aircraft avionics system
      - Audio subsystem within a cell phone
      - Flight control system for a drone

Project Identification

Project Types

- Types of Projects?
  - System / System Integration
    - Integration of all subsystems to create the complete solution
    - Typically includes hardware, software, test, and manufacturability
      - e.g.
        - Cell phone
        - Cable set-top box
        - Aircraft Carrier
    - NOTE: One persons system may be another persons subsystem and vice-a-versa
      - Avionics package on an airplane
      - Drive train in an automobile
      - “cell” in a wireless communications system

Project Identification

Project Types

- Types of Projects?
  - Analysis
    - Look for weaknesses in existing solutions to find opportunities to improve performance, cost, …
    - e.g.
      - Analyze customer returns for common failure modes and suggest design modifications
      - Regular reviews of existing products to evaluate component / design changes to leverage newer or cheaper components
  - Technology Evaluation
    - Review new technologies to determine their applicability to current or future products
    - e.g.
      - LED technology for automobile headlights
      - 18nm CMOS for next generation processor design
      - Solar cells for garden pathway lighting

Project Identification

Project Types

- Types of Projects?
  - Applied Research
    - Developing new systems based on existing fundamental physical concepts
    - e.g.
      - LTE development based on RF and CDMA concepts
      - 3D integrated circuits based on existing processing concepts
      - Multi-beam antennas based on established RF concepts
  - Fundamental Research
    - Discovery of new scientific principles
    - e.g.
      - Quantum computing devices

Project Identification

Project Sources

- How are projects identified?
  - Someone else - Most engineering projects are identified by:
    - Marketing
    - Business management
    - Manufacturing
    - Customers
  - You – or a friend / colleague
    - Some problem you identify based on your interactions
    - Blinding flash of inspiration
  - In rare cases you need to force identification (e.g. Sr. Project)
    - Poll for ideas
    - Brainstorm based on interests

Project Identification

Project Sources

- How are projects identified?
  - In our case you will choose your project
    - Existing idea you have thought of
    - External sources
    - Brainstorm
      - Brainstorm problems to solve – not project ideas
  - Projects must be approved
    - Complexity
    - Team make-up
    - Usefulness
    - Achievability

Project Identification

Project Selection

- Typical Project Characteristics
  - Match the goals and objectives of the organization
  - Match the expertise and capabilities of the organization
  - Have some sort of ROI
    - Financial
    - General knowledge
    - Entrepreneurial
    - Philanthropic
  - Time bounded

Project Identification

Project Selection

- Project Selection
  - Selection criteria are determined
    - ROI
    - Match to organizations goals
    - Resource match
    - Probability of success
    - Time to market
  - Each criteria is weighted (AHP process)
  - Each project is scored (AHP process)
  - Leading project is selected

Project Identification

Project Selection

- Project Selection Example – Real World

  - Your design team will be completing their current assignment in the next 6 weeks. You must recommend to your management which of the potential projects currently in the queue you would like to take on.

  - What's at stake
    - You and your team members reputation
    - The well being of the company
    - Potential raises
    - Future freedom of action
    - Your position as team leader

  - **You want to pick a project that balances technical, market, and schedule risk.**

Project Identification

Project Selection

- Project Selection Example – Real World

  - 3 potential projects

    A. Simple modification of a previous design – low risk – low reward
    B. New to the company design – moderate risk – moderate reward
    C. New to the world design – high risk – high reward

  - Selection criteria
    - Match to team skills
    - Overall project timeline
    - Technical complexity - Risk of success
    - Technical complexity - Prestige
    - ROI

Project Identification

Project Selection

- Project Selection Example – Real World
  - Pairwise criteria comparison

Criteria	Match	Time	Risk	Prestige	ROI	Geometric Mean	Weight
Match	1	5	1/5	1/5	1/5	0.53	0.08
Time	1/5	1	1/3	1/5	1/5	0.31	0.05
Risk	5	3	1	1	1	1.72	0.27
Prestige	5	5	1	1	1	1.90	0.30
ROI	5	5	1	1	1	1.90	0.30

Project Identification

Project Selection

- Project Selection Example – Real World
  - Solution Rating

MATCH	A	B	C	Geometric Mean	Match α
A	1	2	3	1.82	0.54
B	1/2	1	2	1.00	0.30
C	1/3	1/2	1	0.55	0.16

1 = Equal Relative Match, 5 = Very Good Relative Match

TIME	A	B	C
Weeks	10	20	40
Time α	0.43	0.36	0.21

Project Identification

Project Selection

- Project Selection Example – Real World
  - Solution Rating

RISK	A	B	C	Geometric Mean	Risk α
A	1	2	5	2.15	0.58
B	1/2	1	3	1.14	0.31
C	1/5	1/3	1	0.41	0.11

1 = Equal Relative Risk, 5 = Low Relative Risk

PRESTIGE	A	B	C	Geometric Mean	Prestige α
A	1	1/2	1/5	0.46	0.12
B	2	1	1/3	0.87	0.23
C	5	3	1	2.47	0.65

1 = Equal Relative Prestige, 5 = High Relative Prestige

Project Identification

Project Selection

- Project Selection Example – Real World
  - Solution Rating

ROI	A	B	C
$M	10	20	60
ROI α	0.11	0.22	0.67

Project Identification

Project Selection

- Project Selection Example – Real World
  - Selection Matrix

Criteria	Weights	Alternatives		
		A	B	C
Match	0.08	0.54	0.30	0.16
Time	0.05	0.43	0.36	0.21
Risk	0.27	0.58	0.31	0.11
Prestige	0.30	0.12	0.23	0.65
ROI	0.30	0.11	0.22	0.67
Score		**0.29**	**0.26**	**0.45**

Project Identification

Project Definition

- Elements of a Project Definition
  - Problem Definition
  - Objective
  - Needs Hierarchy
  - Background Analysis
  - Marketing Requirements

Project Identification

Project Definition

- Elements of a Project Definition
  - Problem Definition
    - What problem is being solved
    - “There is a need for …”
  - Objectives
    - What conceptual solutions are suggested to solve the problem
    - Must meet the needs identified
    - Should NOT include potential implementations
  - Needs Hierarchy
    - Weighted hierarchy of the “needs” of the project
    - These are the parameters against which possible detailed solutions will be measured
    - These are the parameters against which success will be measured

Project Identification

Project Definition

- Elements of a Project Definition
  - Background Analysis
    - More detail on the problem
    - Existing alternate solutions (and why they are not good enough)
    - Market direction and trends
      - Provides a sense of value
      - Can identify time limitations
  - Marketing Requirements
    - Bullet points identifying user needs
    - Subset of the needs hierarchy – targeted at the customer

Project Identification

Project Definition

- Problem Identification
  - Someone identifies a problem
  - Need to be careful when capturing the problem definition
    - Very easy to include too much in the definition
    - Very easy to pre-suppose a solution
  - Attempt to abstract the discussion
    - What is it used for?
    - What higher level system/process is it used in?
    - What would you do if you could not have it?
    - Who is impacted
      - Users, clients, operators, customers, sales people, manufacturing, maintenance, …

Project Identification

Project Definition

- Needs Hierarchy
  - Create a hierarchy of what the product needs to do
  - Voice of the Customer
    - Review the problem with each of the stakeholders
    - Identify prioritized needs and wants (must have vs nice to have)
    - Interviews, focus groups, surveys
  - Organize the requirements
    - Identify key high level requirements across stakeholders
    - Refine the requirements into marketing statements
      - Simple single bullet statement
      - More qualitative than quantitative
      - Where “numbers matter”, they should be included

Project Identification

Project Definition

- Needs Hierarchy
  - Create a hierarchy of needs
    - Collect all requirements into a small number of high level groups
    - Subdivide as necessary to complete the hierarchy
  - Prioritize the requirements
    - Use a process to prioritize the requirements
    - Assign weights to each need (AHP)
  - Review
    - Does the final weighted needs hierarchy make sense
    - Review with stakeholders
    - Can some requirements be removed
    - Are some requirements missing

Project Identification

Project Definition

- Background Analysis
  - More detail on the problem
    - Research on the basic problem
    - Identify technical, business, and operational aspects of the problem
  - Examine existing alternate solutions
    - What is good
    - What is bad
    - Patent search
    - Technological trends
  - Market direction and trends
    - Who is involved
    - Levels of investment
    - Existing and potential markets and market values
    - Identify time limitations

Project Identification

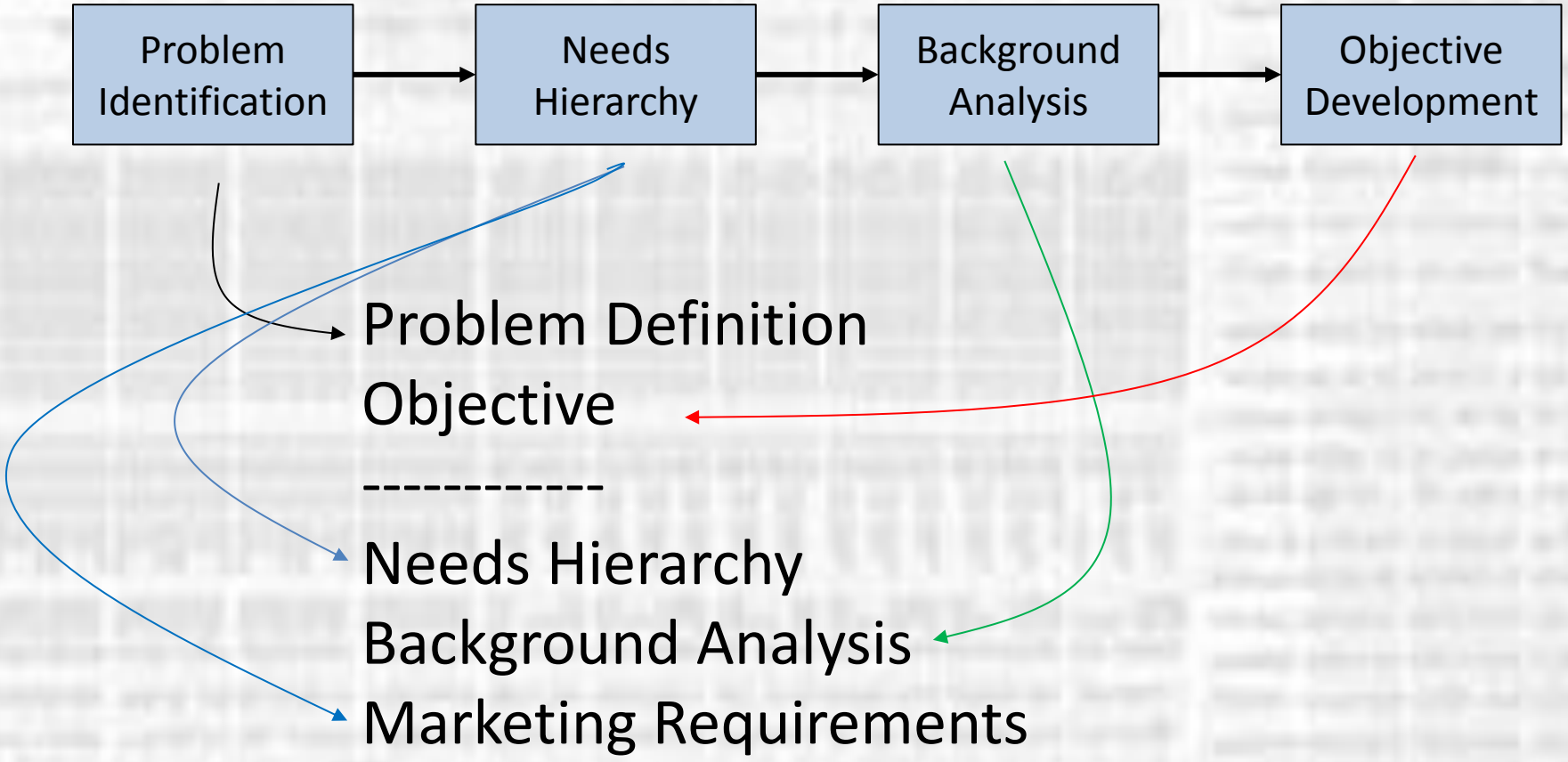
Project Definition

- Objective
  - Conceptual proposal to solve the problem
    - Simple statement of the proposed solution
    - Does not provide details on any particular implementation
    - Addresses the top level issues in the needs hierarchy

Project Identification

Project Definition

- Project Definition Flow



Project Identification

Project Definition

- Project Definition Example
  - Appendix E – section 1.x

In Class Activity