Chapters 4&14

Concept Design, Projects, Teamwork, Ethics

IET 630- Engineering Design

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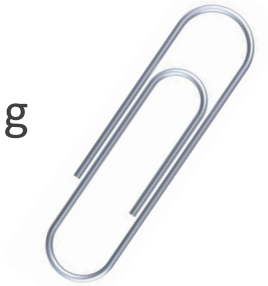
What is a concept design?

Stop a spinning shaft → 1. fan brake - fluid friction

2. regenerative brake - magnetic field

3. disk brake - surface friction

Fasten sheets of paper → embodiment that behaves according to the “spring force” physical principle



A design concept is an alternative that includes at least physical principles and abstract embodiments

Concept design

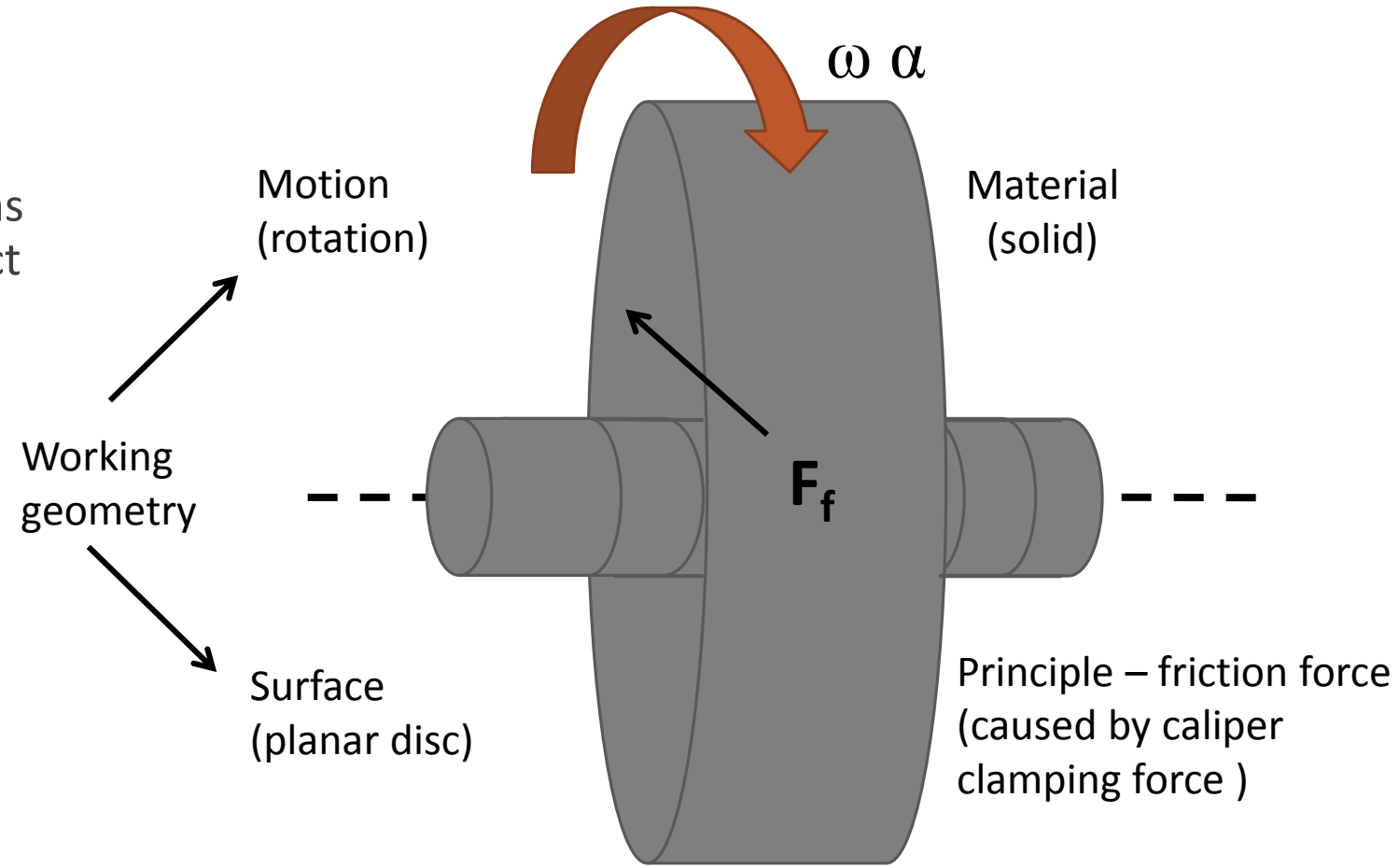
1. Concepts work by some physical principle
2. Physical principles act on some surface or location
3. Concepts exhibit geometric properties, or shapes
4. Have an abstract embodiment
5. Imply relative motion of surfaces, or objects
6. Imply general material types

Physical principle

We define a physical principle as the means by which some effect is caused, or produced

Working material

has mechanical, physical, and chemical properties.



The successful embodiment of a physical principle on a working geometry in a working material, has been defined as a **working principle**

Concept Design

A design concept is the abstract embodiment of a physical principle, material, and geometry

Phase → a review of the engineering design specifications and related documents

one or more concepts to be developed further

Decision-making activities → determine if a concept is **feasible**

reject infeasible concepts and iterate

select the best concept

Clarifying functional requirements

Engineering design specification

Provides information

Customer and company requirements

Details on specific functions
and/or subfunctions

Clarifying functional requirements

1. Activity Analysis
2. Component Decomposition
3. Functional Decomposition

Activity Analysis

How the costumer will use and retire the product

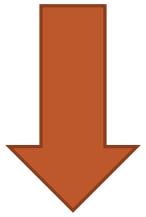
Activity analysis help us to understand all the required functions of the product and how it interacts with the environment

Customer activities relating to using and retiring a Product	
Use	Set up Operating Maintain Repairing
Retire	Take down Disassemble Recycle Dispose

Activity Analysis List for Electric Shaver Use and Retirement		
Use	Set up	1. Open package 2. Examine shaver, cord, travel case, and cleaning brush 3. Read instruction booklet 4. Fill out warranty card 5. Plug in shaver to charge batteries 6. Put shaver, case, cord, brush in bathroom cabinet drawer
	Daily Use	1. Remove charged shaver from drawer 2. Trim hair 3. Shave face or legs 4. Remove cutter blade cover 5. Brush cutter blade 6. Replace cover 7. Repeat step 5 8. Store shaver in drawer 9. Repeats steps 7-14 until blades need replacing
	Replace blade	1. Remove cutter blade cover 2. Install new cutter blade 3. Replace cutter cover
	Daily Use	1. Repeat steps 7-13 until batteries need replacing
	Replace batteries	2. Install new rechargeable batteries
	Daily Use	3. Repeat steps 17-19 until shave becomes unrepairable
Retire	Dispose of shaver	1. Throw out shaver and auxiliaries

Product Component Decomposition

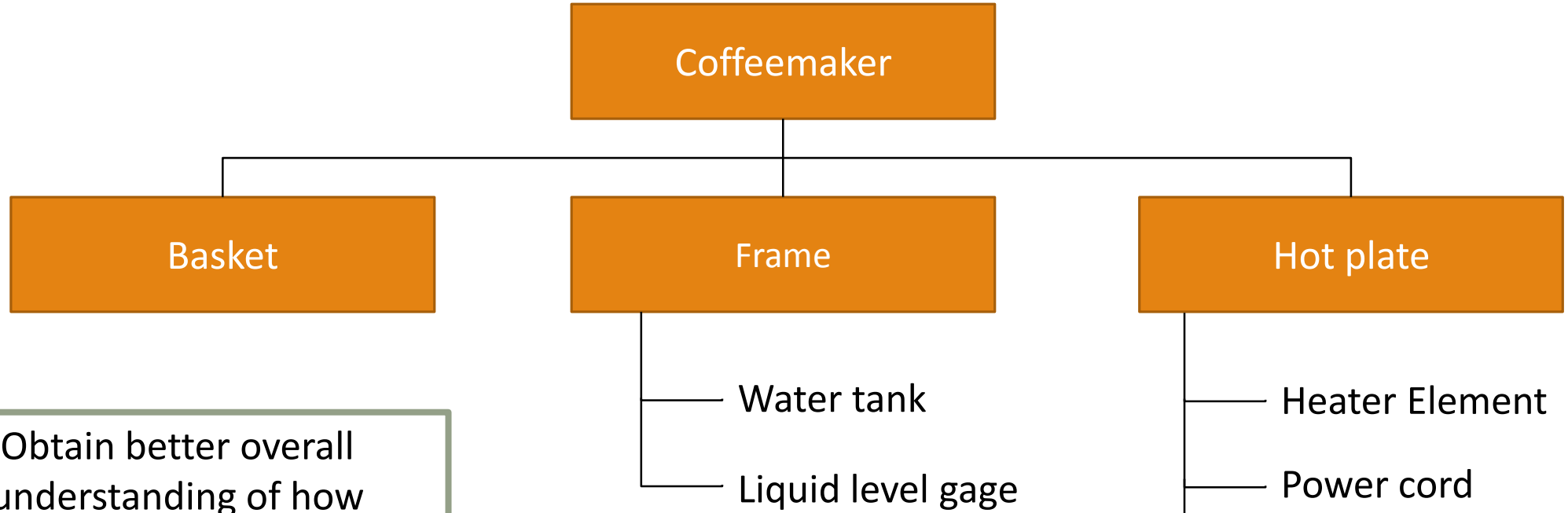
A component decomposition diagram can be drawn.



Block diagram of the parts and subassemblies that make up the product

- Illustrate the hierarchical structure of component forms.

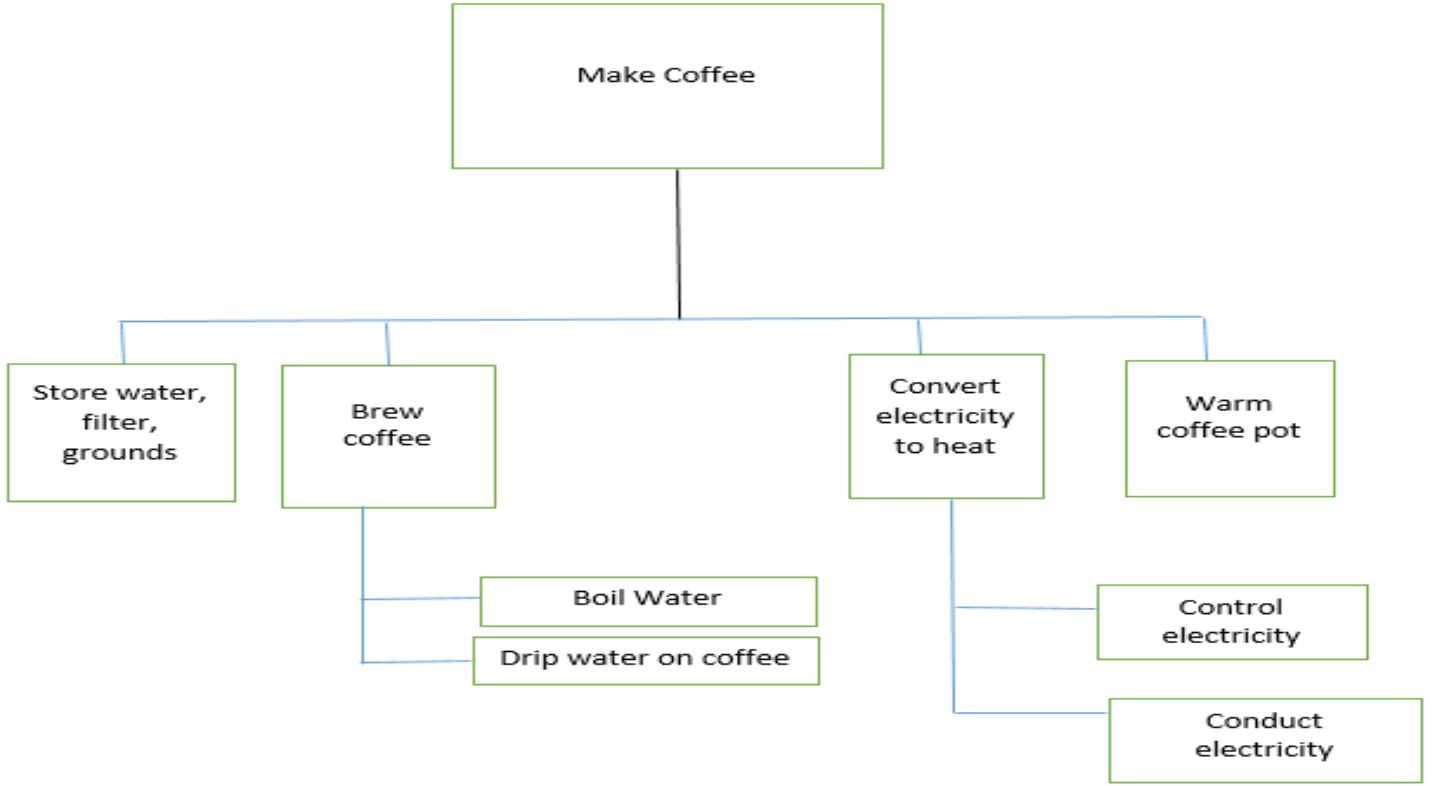
Component decomposition diagram



Obtain better overall understanding of how individual components interact with each other

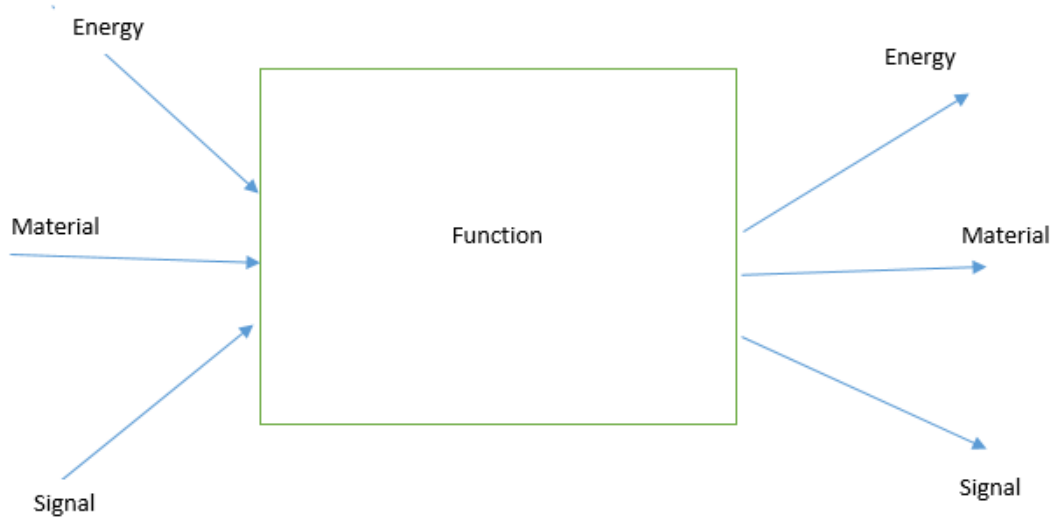
Product Function Decomposition

Function Decomposition: subdivides major functional requirement into respective subfunctions and sub-subfunctions



Product Function Decomposition

- Function decomposition separates what the product needs to do versus how it gets done
- Functions are usually expressed as verbs such as amplify, channel, join, translate, etc.
- Noun-objects are classified into energy, material, and signal categories.



Generating Alternative Products

- **Synthesis** is the process of generating alternatives
- **Archives** include university, public, and corporate libraries and should be considered first on the list of places to look for alternatives
- **Conferencing one on one** with people knowledgeable in the field would be another place to look for alternatives
- **Internet and existing products** would also be useful to look for alternatives

Generating Alternative Concepts

Brainstorming

- an iterative group method that takes advantage of the team members adverse skills, experience, and personalities to generate innovative ideas.
- Wild and crazy ideas are encouraged
- No criticism of alternatives or ideas is permitted
- Ideas are transcribed until no new ideas are stimulated
- Use note cards or note cards and write on whiteboard for group to see anonymously
- After each group sees ideas transcribed on white board they should fill out another with more ideas
- Method 6-3-5 is a method where a group of 6 members each write down 3 ideas on a note card and circulate to neighbors and they write 3 more ideas

Generating Alternative Concepts

Synetics

- a method that requires the problem solver from four perspectives: analogy, fantasy, empathy, and inversion.
- Analogy stimulates idea creation such as a tree as an analogy to a structure
- Fantasy asks us to imagine the impossible such as using a jetpack to get to work
- Empathy asks us to imagine being each product and how we would perform each function
- Inversion asks us to take an inverted or reverse point of view

Developing Product Concepts

- Listing the sub-functions in a column of a matrix and the alternative concepts for each function in adjacent rows is called a morphological matrix.
- To stimulate alternative combinations the design team selects one concept from any column for each function proceeding down the matrix

Analyzing Alternative Concepts

Screening criteria during Concept Design Phase

- concept function
- concept meeting the customer's minimum performance requirements
- concept surviving the operating environment
- concept satisfying other critical customer requirements
- concept being manufacture-able
- concept satisfying financial and or marketing requirements

Evaluating Alternative Concepts

- After screening, the remaining concepts must be evaluated in a more precise manner
- Two methods are commonly used
- Pugh's concept selection method
- The weighted-rating method

Pugh's Method for Concept Selection

- A matrix of the concepts and evaluation criteria is used
- One concept is labeled as the datum
- All other concepts are compared to the datum concept
- +'s, -'s, and S's are used to denote whether the concept is better or worse or the same as the datum

Pugh's Method

Criterion	Gears	V-Belts	Chain
High Efficiency	+	D	+
High Reliability	+	A	+
Low Maintenance	+	T	S
Low Cost	-	U	-
Light Weight	-	M	-
∑ +	3	NA	2
∑ -	2	NA	2
∑ S	0	NA	1

Weighted-Rating Method

- Weights are given to the criteria usually as percentages of 100
- Concepts are rated on a scale of 0-4
- Concept ratings are multiplied by the weighted criteria and summed

Weighted-Rating Method

		Gears		V-Belts		Chains	
Criterion	**Weight (%)**	**Rating**	**Weighted Rating**	**Rating**	**Weighted Rating**	**Rating**	**Weighted Rating**
High Efficiency	30	4	1.20	2	0.60	3	0.90
High Reliability	25	4	1.00	3	0.75	3	0.75
Low Maintenance	20	4	0.80	3	0.60	2	0.40
Low Cost	15	2	0.30	4	0.60	3	0.45
Light Weight	10	2	0.20	4	0.40	3	0.30
	100	NA	3.50	NA	2.95	NA	2.80

Rating	Value
Unsatisfactory	0
Just tolerable	1
Adequate	2
Good	3
Very good	4

Design Phase Communications

- All ideas and decisions should be documented
- The current team will find it useful to refer back to
- Subsequent design teams may find it useful for future projects

Intellectual Property

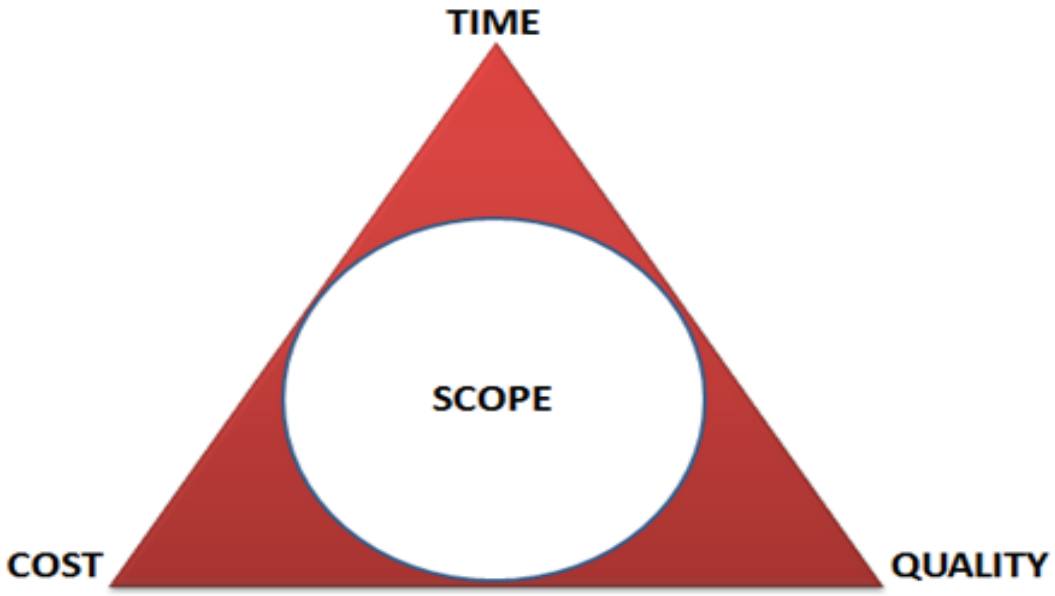
	Protects	Length	Application	Registration	Cost
Trade Secret	Formulas, recipes, processes	Indefinite	no	No	Some
Contract	Items specified	Length of contract	No	No	>$500
Trademark	Graphical symbol or word	20 yrs. Renewable	No	Yes	>$350
Copyright	Literary, musical, or art works	Author's life +70 yrs.	No	Yes	>$30
Utility Patent	Function, Process	20 yrs.	Yes	Yes	>$1,100
Design Patent	Appearance	14 yrs.	Yes	Yes	>$500

Chapter 14
Project, Teamwork, Ethics

Project

- Unique sequence of activities (work tasks) undertaken ONCE to achieve a specific set of objectives.
- Changing the length of any leg of the pr

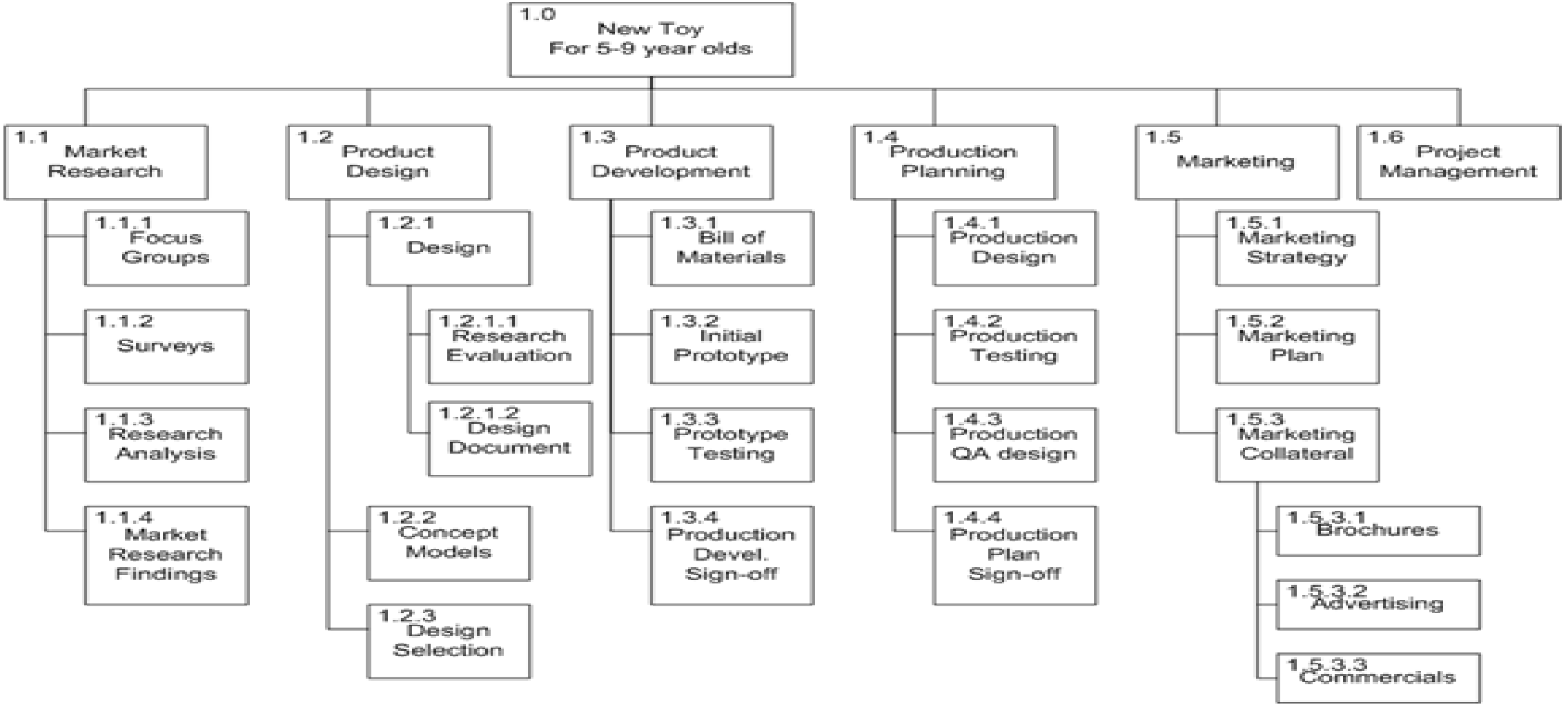
  affects the other legs!
- cost work
- scope
- quality
- time



Planning a Project

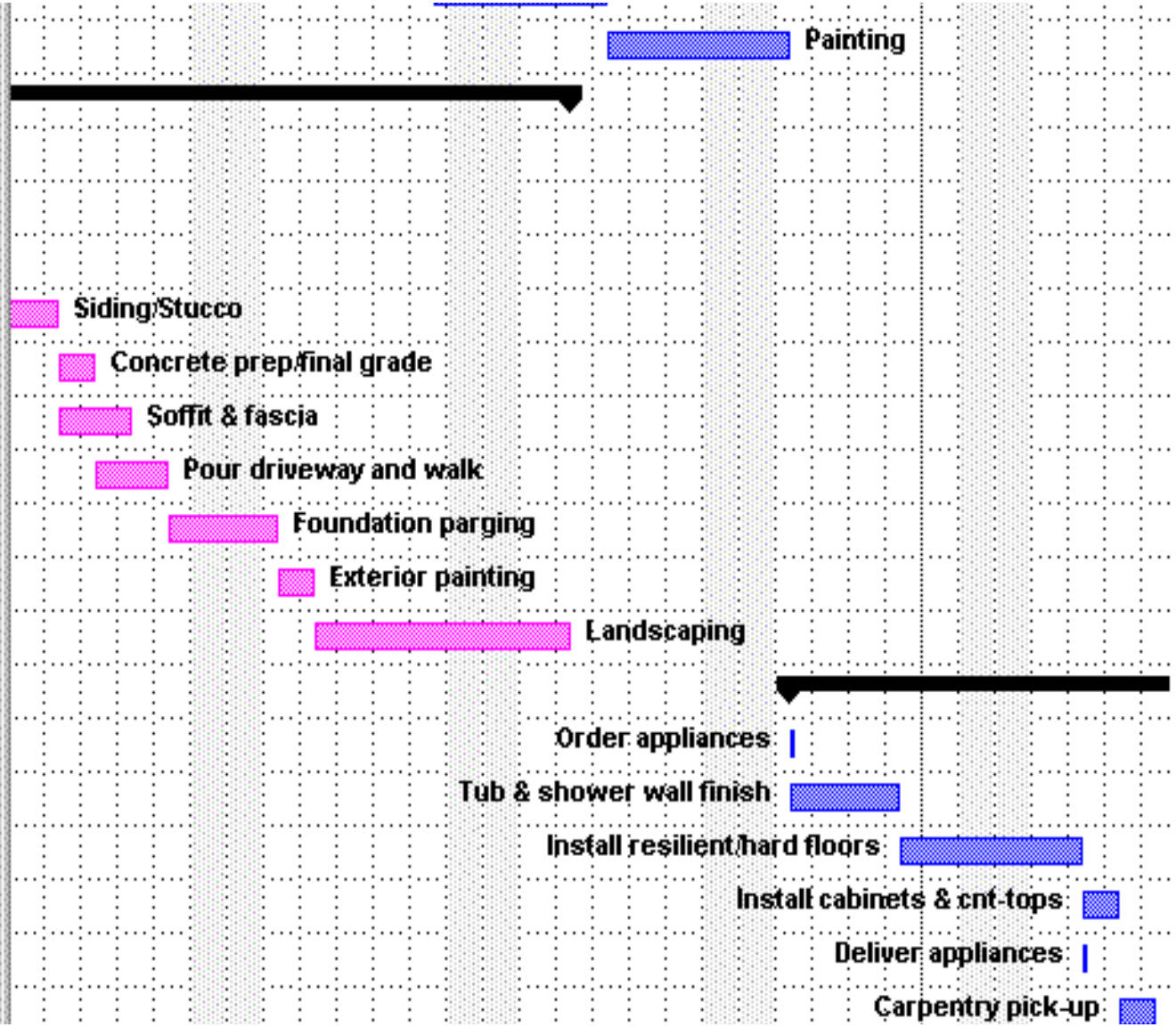
- Problem statement
- Mission statement
- Project objectives
- Work Breakdown Structure(WBS)
- Scope of work
- Responsibilities table
- Organization chart
- Budget
- Schedule
- Risk assessment

Work breakdown structure



Project Schedule

		Task Name	Duration	Start	Finish
62		Painting	3 days	Wed 7/23/03	Mon 7/28/03
63		**Phase 4 Exterior Finish**	**20 days**	**Tue 6/24/03**	**Tue 7/22/03**
64		Install housewrap	1 day	Tue 6/24/03	Wed 6/25/03
65		Roofing	3 days	Wed 6/25/03	Mon 6/30/03
66		Masonry	5 days	Wed 6/25/03	Wed 7/2/03
67		Siding/Stucco	4 days	Wed 7/2/03	Tue 7/8/03
68		Concrete prep/final grade	1 day	Tue 7/8/03	Wed 7/9/03
69		Soffit & fascia	2 days	Tue 7/8/03	Thu 7/10/03
70		Pour driveway and walk	2 days	Wed 7/9/03	Fri 7/11/03
71		Foundation parging	1 day	Fri 7/11/03	Mon 7/14/03
72		Exterior painting	1 day	Mon 7/14/03	Tue 7/15/03
73		Landscaping	5 days	Tue 7/15/03	Tue 7/22/03
74		**Phase 5 Interior Finish**	**16.38 days**	**Mon 7/28/03**	**Tue 8/19/03**
75		Order appliances	2 hrs	Mon 7/28/03	Mon 7/28/03
76		Tub & shower wall finish	3 days	Mon 7/28/03	Thu 7/31/03
77		Install resilient/hard floors	3 days	Thu 7/31/03	Tue 8/5/03
78		Install cabinets & cnt-tops	1 day	Tue 8/5/03	Wed 8/6/03
79		Deliver appliances	2 hrs	Tue 8/5/03	Tue 8/5/03
80		Carpentry pick-up	1 day	Wed 8/6/03	Thu 8/7/03



Planning and Control Processes

Risk

- anything not in the project plan that may occur and cause your project to be late, cost more or compromise its quality/performance.

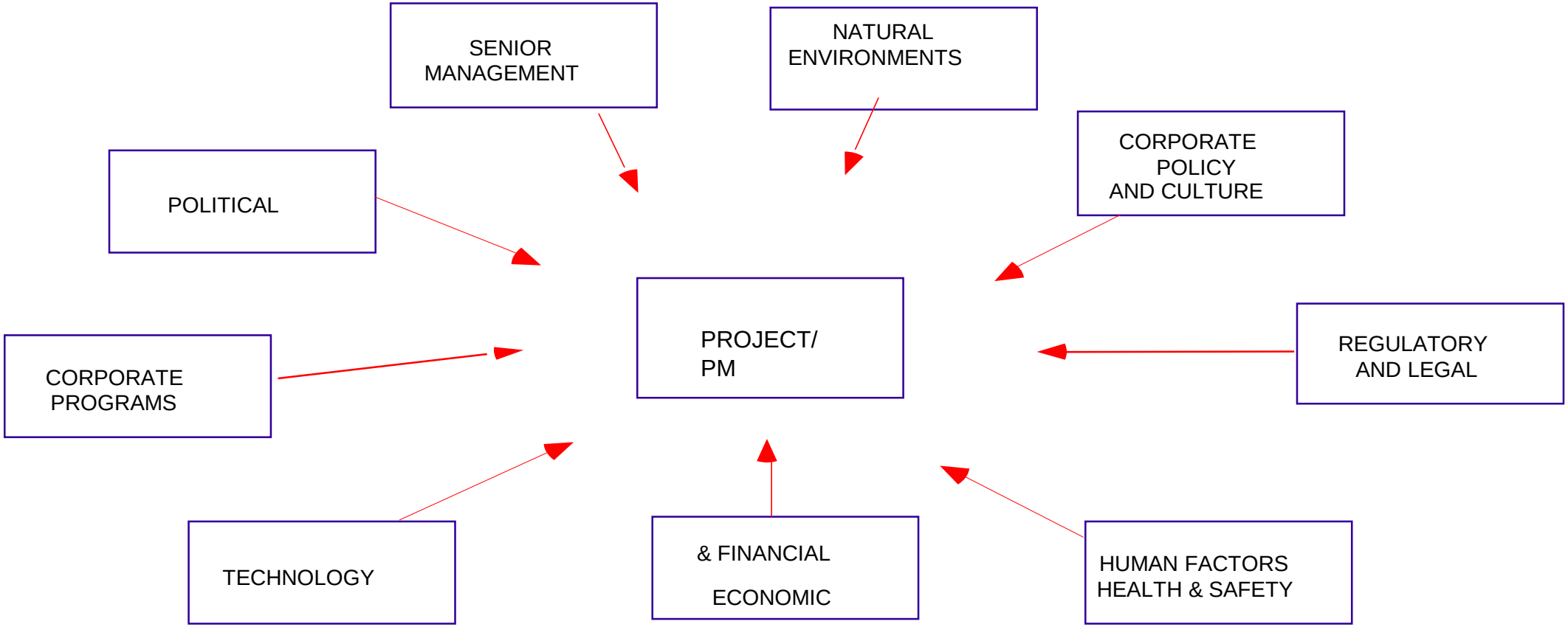
- Risk is an opportunity as well as a threat

Four Steps to Minimize Engineering Risk

1. **Identification**
   - Anticipate the risk
   - List the risks, event triggers, symptoms
2. **Analysis**
   - Evaluate probability, impact
   - Qualitative Vs Quantitative
3. **Risk Response**

   Strategy Development to mitigate the risk:
   - Eliminate the risk or reduce impact
   - Contingency planning
4. **Risk Control**
   - Monitor
   - Update lists, strategies
   - Action the contingency plan
   - Fight the fires

Risk Identification: Inputs



History of past Similar Projects

Risk Assessment

Risks might exist

- What is likely to go wrong with the project?
- What could prevent us from achieving our objectives?

Consider and recommend a variety of contingency plans

- Recognizing key risks in project.
- Having a couple of ready fallback plans.

Team Notebook

Project Notebook

- Identification sheet
- Design problem formulation
- Alternative generation, analyses, and evaluation
- Project engineering
- Vendor information

Project Proposal

- Design project proposal
- Introduction
- Scope of team
- Schedule
- Budget
- Project management
- Appendix

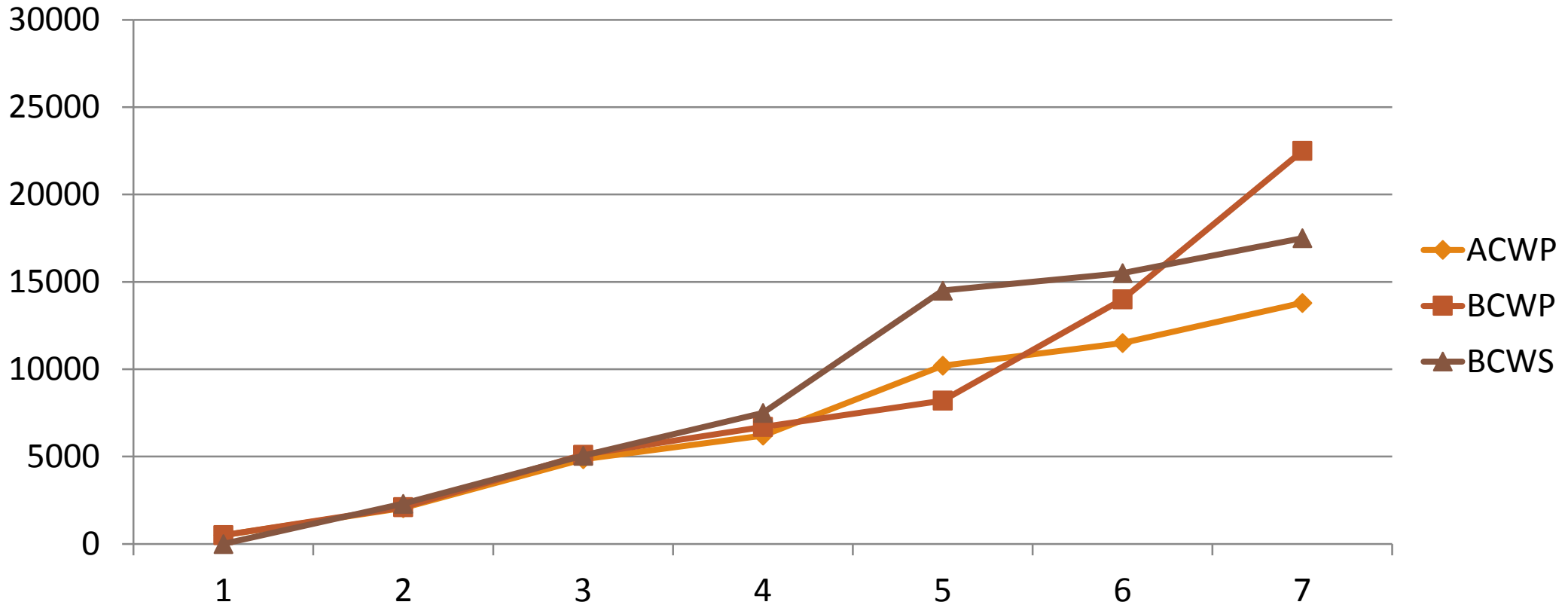
Executing a Project

- Individual work
- Work in group
- Monitoring project expenditures

Earned-Value Analysis

1. Budget cost of work scheduled (BCWS)
2. Actual cost of work performed (ACWP)
3. Budget cost of work performed (BCWP)
4. Schedule Variance (BCWP – BCWS) and Cost Variance (BCWP – ACWP)

Earned-Value Analysis



Project Control

Project control

- comparing project progress to the plan that corrective action can be taken when deviation from planed performance occurs.

Closing a Project

- What we did well
- What we could have done better
- What were our mistakes

Team& Teamwork

TEAM

Consists of a group of people who

- Have complementary skills & knowledge
- Work together toward common goals
- Hold each other mutually accountable

PRODUCT DEVELOPMENT TEAM

- Sales
- Marketing
- Engineering
- Design
- Purchasing
- Manufacturing engineering
- Production
- Distribution

Teamwork Features

TEAMWORK BREAKS DOWN DUE TO

- Personality issues
- Poor timing
- Lack of attention

TEAMWORK FEATURES

- Communication
- Decision making
- Collaboration
- Self-management

Teamwork Skills

Collaboration	Understand & commit to team goals
	Participate actively in team activities
	Accept criticism
	Respect individual viewpoints/differences
	Assist other teammates
Communication	Listen attentively to team members
	Provide constructive feedback
	Communicate clearly/ concisely

Teamwork Skills

Decision Making	Make decisions based on facts
	Anticipates problems
	Contribute to meeting
Self- Management	Monitor self- progress
	Complete individual tasks thoroughly
	Complete individual task on time
	Ask for help when needed

Team Development Stages

1. Forming

- Transition
- Nature of tasks
- Project goals
- Work styles & personalities

2. Storming

- Enormity realization
- Difference recognition
- Occurrence of tension,conflicts,scapegoating

3. Norming

- Cooperation
- Weaknesses & strengths
- Main goals focus
- Open communication
- Standard behavior& conflict resolution

4. Performing

- High productivity& satisfaction
- Accountability
- United, trust, mutual support

Effective Team Meeting& Rules

1. well-planned

- Time-framed agenda

2. Well-executed

- Punctuality
- Practice listening skills
- Facilitate the facilitator
- Come prepared
- Discuss facts not fiction
- Take action
- Take minutes
- Draft next agenda
- Turn off cell phones

3. Rules

- Commitment
- Accurate performance
- Respect
- Assistance and active participation
- Guidelines
- Focus
- Constructive conflict resolution
- Clear comments

Ethics & Code of Ethics

Professional ethics

- standards of conduct followed by every member of the profession

Importance of codes of ethics

- Systematic collection of rules of guidance
- Encouragement of value-laden decisions for the public good
- Working environment to resist the pressure of unethical practices
- Professional protection from harm caused by other fellows
- Sustainability of the moral reputation of the profession

Ethical Values

Integrity

- Exercising good judgment in the practice of our profession

Honesty

- Telling the truth, being sincere

Fidelity

- Being loyal to employee, clients, public, profession

Responsibility

- Being reliable, dependable, accountable, trustworthy

Ethical Dilemmas Resolution

- Obtain the facts of the situation
- List stakeholders with an interest in the outcome
- Consider stakeholders' motivation
- Formulate alternative solutions considering ethical values
- Evaluate alternatives and reject unethical ones
- Seek assistance form co-workers, supervisors, ombudsmen
- Select the alternative that satisfies the highest ethical values
- Implement the selected solution through chain of command
- Monitor the outcome
- If unsatisfactory, contact legal counsel, professional society, the media

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