



Professional Engineering

Problem Solving

lecture by Philip Rubie, C.Eng

based on material from:

Fogler and Le Blanc, “Strategies for Creative Problem Solving”, Prentice Hall, 1995

Kepner and Tregoe, “The New Rational Manager”, Princeton Research Press, 1997

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Lecture Outline

- **Problem Solving Overview**
- **Structure – how do we solve problems ?**
 - Problem Solving “Heuristic”
 - Problem Definition
 - Generating Options (for solutions)
 - Making Decisions
 - Implementing Solutions
 - Evaluation of Results



Overview – Types of Engineering Problems

- **Research**
- **Knowledge and Troubleshooting**
- **Mathematics**
- **Resource and Logistics**
- **Social**
- **Design**



Overview – Nature of Problem Solving

- **a Creative Activity**
 - you all have creativity and you all have knowledge
 - extra natural ability and aptitude is advantageous
- **can be a Learned Skill**
 - from effective problem solver “mentors”
 - many different published “strategies”
 - by discipline, perseverance, time and patience
 - by using “heuristic rules”

(heuristics = study of how discoveries are made; involves “trial and error”, “rules of thumb”, usually not precise mathematical equations)



Problem Solving Heuristic

- **Define** the problem
- **Generate** options for solution
- **Decide** on the course of action
(evaluate optional solutions)
- **Implement** the chosen solution
- **Evaluate** the result
(re-evaluate if required)



Define - the **Real** Problem (1)

Explore the Background

- **Research** the subject details
 - read, collect data, think
 - talk with others ... especially experts
- **Investigate** the subject “environment”
 - **Who** defined the problem ?
(is there a vested interest ?)
 - on **What Basis** is the problem defined ?
(is there bias, subjectivity or error ?)
- **Verify** your findings
 - is it **Really** a problem ?



Define - the **Real Problem (2)**

Lateral Assessment

- Does the problem **Change if Restated** in different ways ?
- Is there a **Relationship** between the **Desired Situation** (ie: without the problem) and the **Present Situation** (ie: with the problem) ?
- Can something be done to make it **OK to Do Nothing** ? (ie: not to solve problem posed)

Problem Restatement Example

Toasty O was a well selling cereal when it first came on the market. However, after several months, sales dropped. Marketing identified that customer dissatisfaction was expressed in terms of a stale taste.

The perceived problem was:

“Cereal is not getting to market fast enough to maintain freshness.”

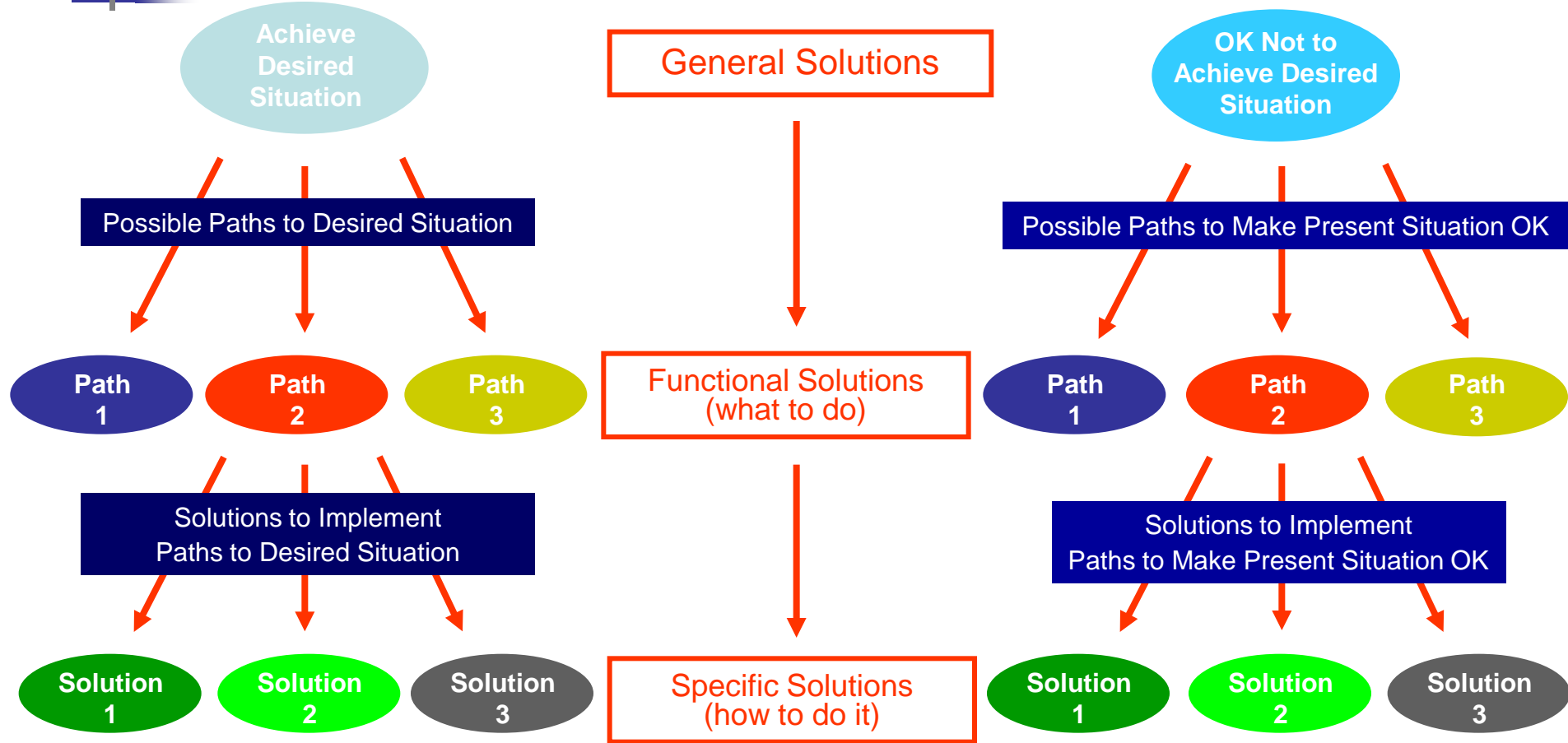
- *Vary word stress by placing emphasis on different words and phrases.*

Cereal is not getting to market fast enough to maintain freshness.
(Do our other products get there faster ?)

Cereal is not **getting** to market fast enough to maintain freshness.
(Can we make the distance or time shorter ?)

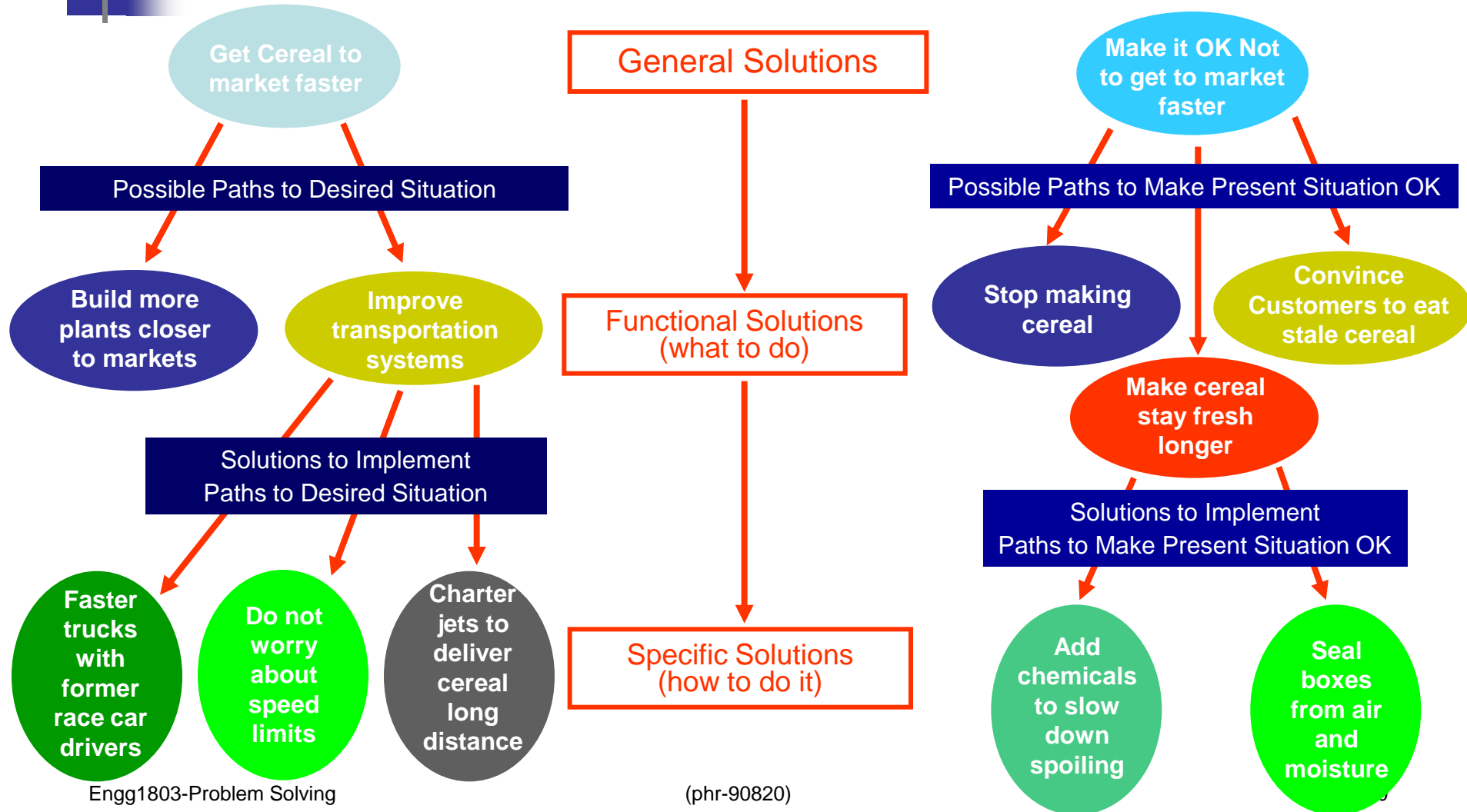
Cereal is not getting to market fast enough to maintain **freshness**.
(How can we keep the cereal fresher for longer ?)

Duncker Diagram



Duncker Diagram Example

Problem: Cereal is not getting to market fast enough to maintain freshness





Define - What Next

- **Evaluate New Problem Definition**
 - are all **components & constraints** identified ?
 - have we distinguished **fact from opinion** ?
- **Should the Problem be Solved ?**
 - is it **worth** solving ?
 - does a solution **exist already** ?
 - are **resources available** to solve the problem ?
 - is there **enough time** available to solve the problem ?



Generate – Several Key Issues

- **Rush to accomplishment / premature closure**
 (“Nothing is more dangerous than an idea, when it is the only one that you have”)
 - does a solution **exist already** ?
 - are enough **resources** available ?
 - is there enough **time** available ?
- **Start Considering Solutions**
 - once you have defined the problem you want to make sure you generate the **best** solution
 - many times **blocks** hinder your progress

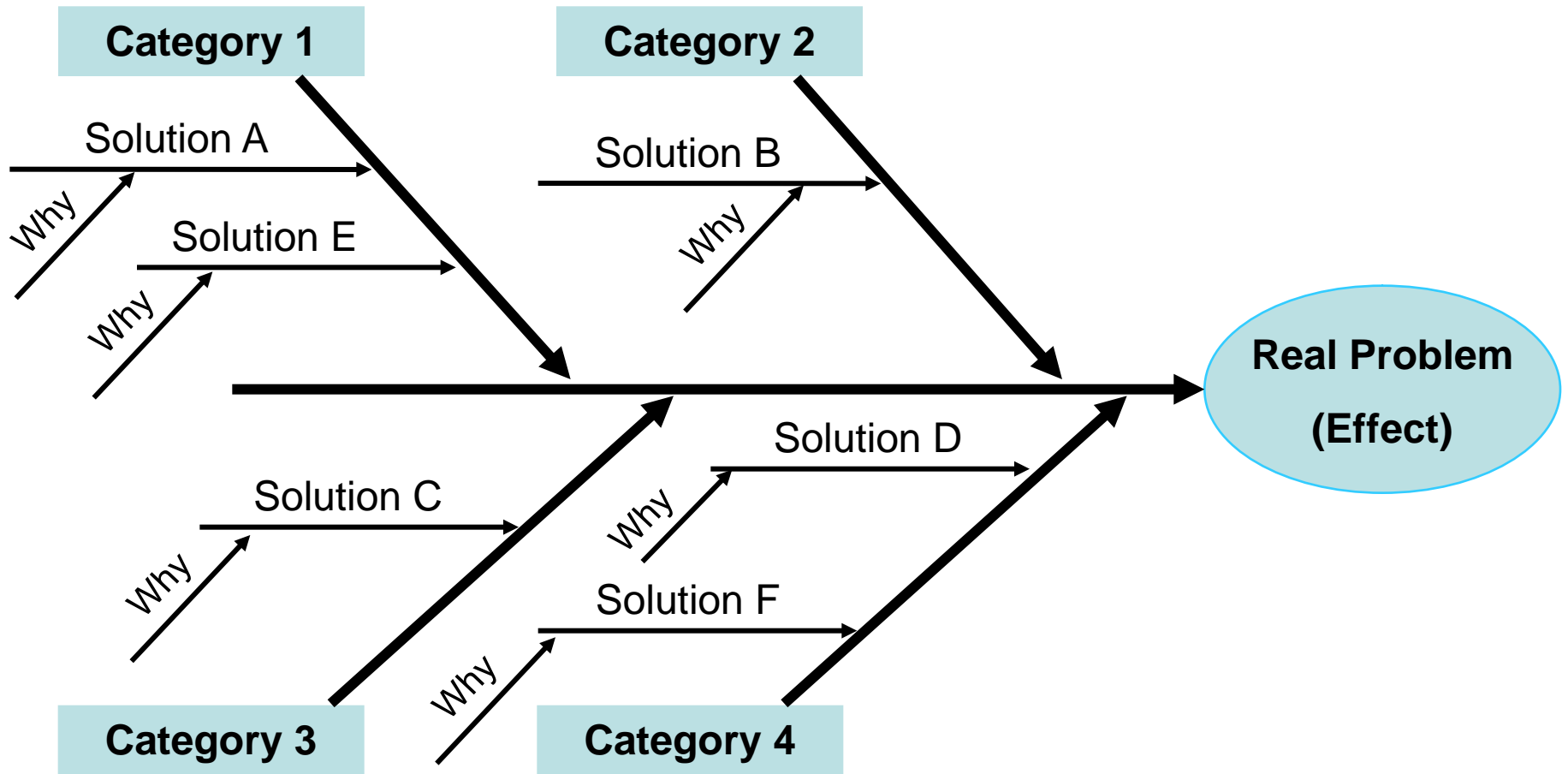


Ways through the Blocks

- **Brainstorming** — be open and positive
- **Stimulation** — look at randomly chosen words
- **Substitution** — what would someone else do
- **Futuring** — imagine a solution infeasible today
- **Cross-fertilisation** — get an artist's opinion
- **Rumination** — stop and let things 'percolate'
- **“Osborn’s” Activity Checklist**
 - adapt, modify, enlarge, reduce, substitute, re-arrange, combine

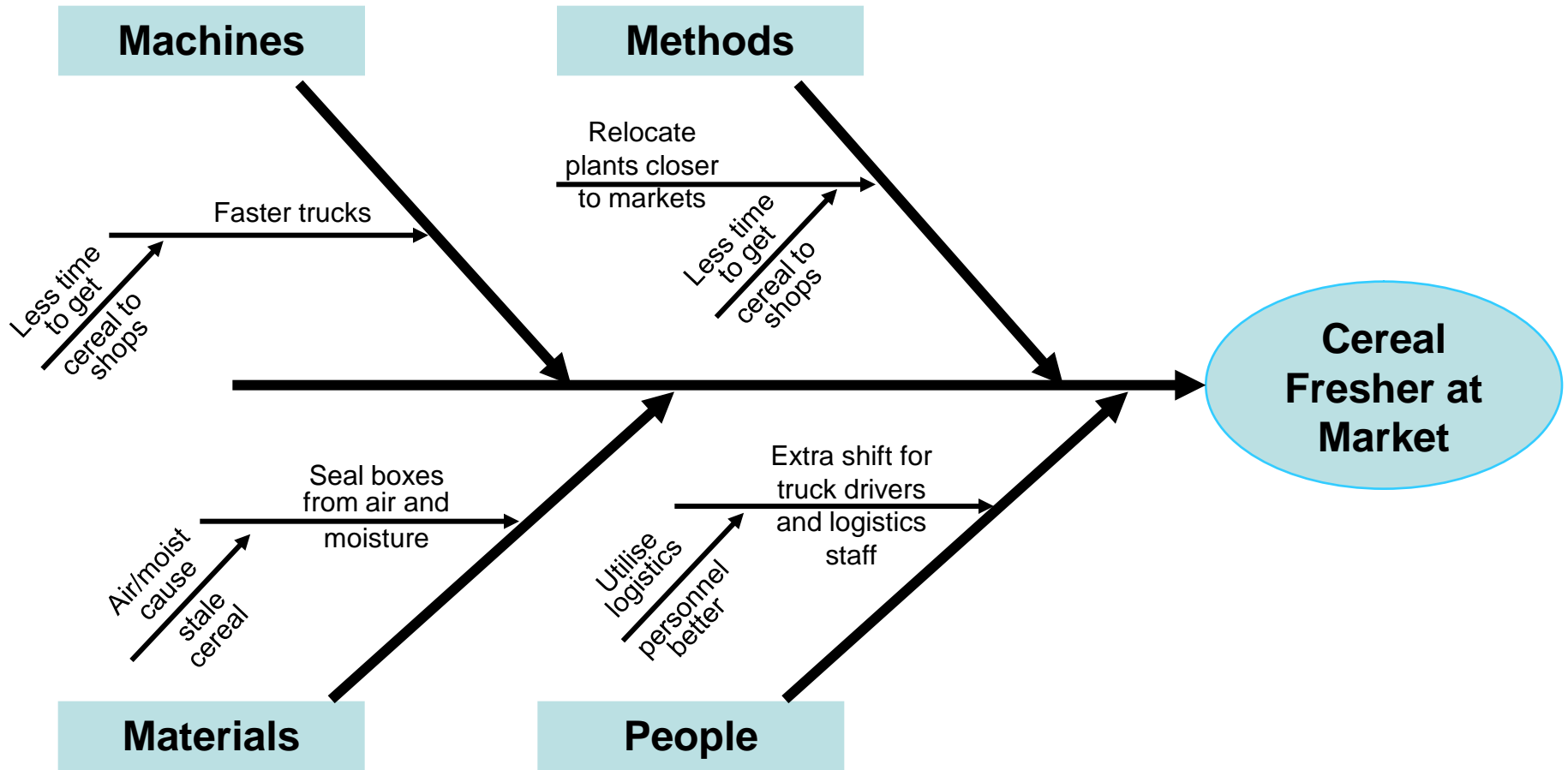
Organising Ideas

Ishikawa's Fishbone Diagram



Fishbone Diagram Example

Problem: Cereal is not getting to market fast enough to maintain freshness





Decide – Organisational Approach

- **How to choose the **best** solution from a number of “Alternatives”**
 - the Alternatives are the Potential Solutions identified in the Generate step
- **Write a concise **decision statement****
 - collect and analyse information and data
 - talk with people familiar with the problem
 - if possible, view the problem first hand
 - confirm all findings



Kepner–Tregoe Decision Analysis

- Specify the **objectives** of the decision
- Divide objectives into **musts** and **wants**
- **Musts** are **mandatory** to a successful solution
 - if a solution satisfies **all** musts then it is a **GO**
 - if it **does not** satisfy **even only just one** of the musts it is a **NO GO**

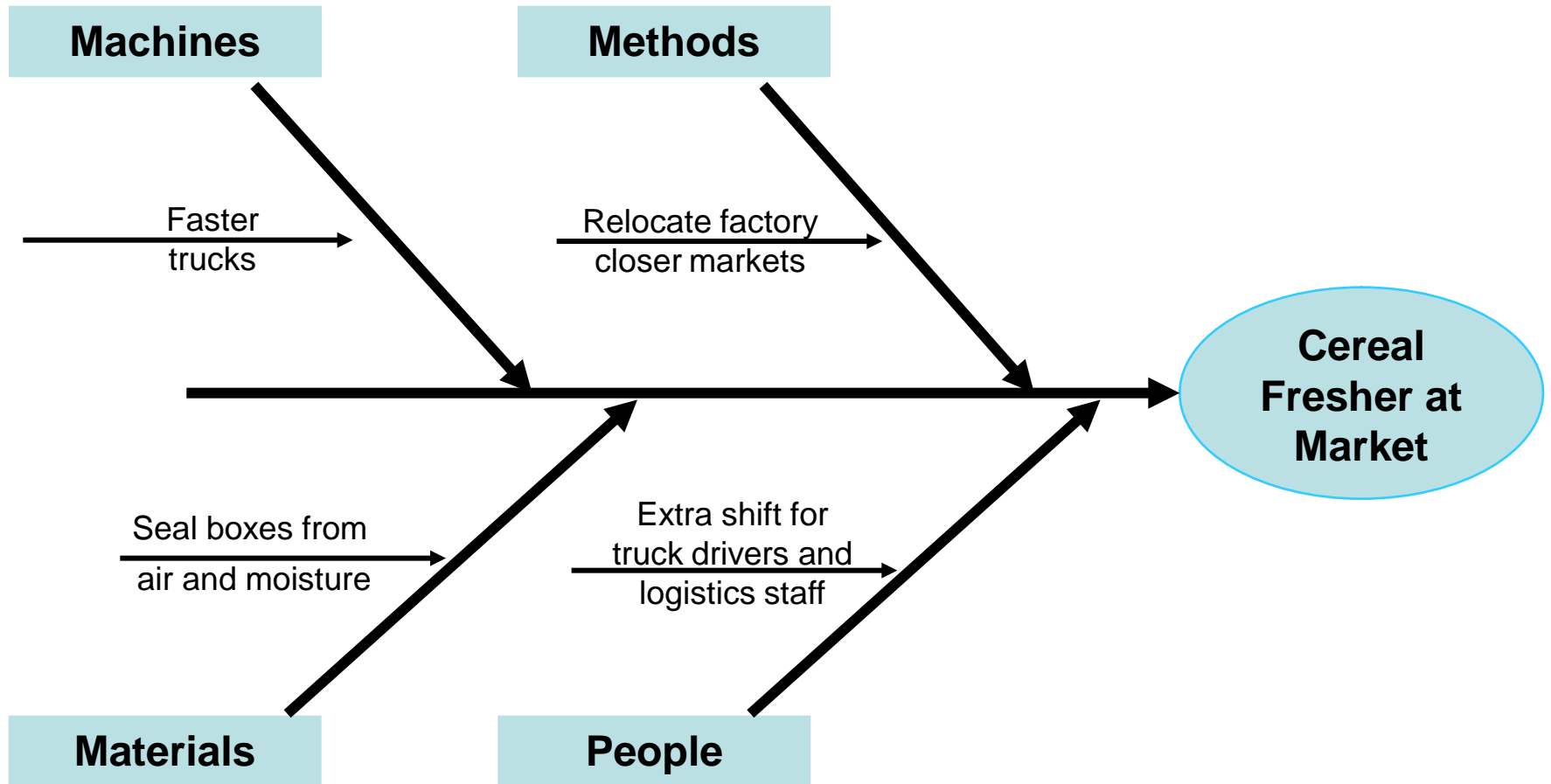


K–T Decision Analysis (2)

- **Wants are desirable but not mandatory**
 - assign a **Weight (1-10)** to each Want on **how important** it is
 - assign a **Rating (0-10)** to each Alternative Solution as to how well it **satisfies each Want**
 - a **Score** for a particular solution can be determined by **multiplying** its Weight and Rating
- Alternative Solutions are **Ranked** by aggregate (ie: total) level of **Score**

Example illustrated by Fishbone Diagram

Problem: Cereal is not getting to market fast enough to maintain freshness



K-T Decision Analysis Example

Problem: Cereal is not getting to market fast enough to maintain freshness

Objectives	Alternatives							
	Alternative A	Wgt	Ratg	Mult	Alternative B	Wgt	Ratg	Mult
Cereal Fresher at Market - <u>M</u> ust								
Maintain Competitive on Price in Market - <u>M</u> ust								
Minimal Change to Work Practices - <u>W</u> ant		10				10		
Minimal Change to Ingredients - <u>W</u> ant		6				6		
Minimal law, regulation, or policy effect - <u>W</u> ant		2				2		

K-T Decision Analysis Example (2)

Problem: Cereal is not getting to market fast enough to maintain freshness

Objectives	Alternatives							
	a Faster Trucks	Wgt	Ratg	Mult	b Relocate Factory Closer to Market	Wgt	Ratg	Mult
Cereal Fresher at Market - <u>Must</u>	Yes – GO				Yes – GO			
Maintain Competitive on Price in Market - <u>Must</u>	Yes – GO				No – too expensive to recover costs			
Minimal Change to Work Practices - <u>Want</u>	Probably Minimal Change	10	8	80				
Minimal Change to Ingredients - <u>Want</u>	There will be no change at all	6	10	60				
Minimal law, regulation, or policy effect - <u>Want</u>	Possibly Minimal Effect	2	5	10				
Sum of Multiple = <u>Score</u>				150				0

K-T Decision Analysis Example (3)

Problem: Cereal is not getting to market fast enough to maintain freshness

Objectives	Alternatives							
	c Seal Boxes from Air & Moisture	Wgt	Ratg	Mult	d Extra Shift for Logistics Staff	Wgt	Ratg	Mult
Cereal Fresher at Market - <u>Must</u>	Yes – GO				Yes – GO			
Maintain Competitive on Price in Market - <u>Must</u>	Yes – GO				Yes – GO			
Minimal Change to Work Practices - <u>Want</u>	There will be no change at all	10	10	100	Changes will be significant	10	2	20
Minimal Change to Ingredients - <u>Want</u>	There will be no change at all	6	10	60	There will be no change at all	6	10	60
Minimal law, regulation, or policy effect - <u>Want</u>	Probably Minimal Effect	2	8	16	Possibly Minimal Effect	2	5	10
Sum of Multiple = <u>Score</u>				176				90

K-T Decision Analysis Example (4)

Problem: Cereal is not getting to market fast enough to maintain freshness

Rank (by Sum of Multiple)	Alternative	Score
1	c. Seal Boxes from Air & Moisture (provides most benefit)	176
2	a. Faster Trucks	150
3	d. Extra Shift for Logistics Staff	90
4	b. Relocate Factory Closer to Market (does not meet one of the 'Must')	0



Implement (1)

- **Peer Review & Approval to Proceed**
 - management
 - financial
 - regulatory
- **Planning**
 - schedule (Gantt chart, critical path)
 - coordination and development
 - necessary resources
(people/equipment/money)



Implement (2)

- **Application / Execution**

- Evaluation: qualitative/quantitative judgments about how material and methods satisfy problem criteria
- Synthesis: formulation of problem statement and testing procedures from “fuzzy” situations
- Analysis: break the problem into parts, identify missing, redundant and contradictory information
- Organisation: set of activities to be undertaken
- Comprehension: understanding, manipulation and/or extrapolation of information
- Knowledge: remember previously learned material



Evaluate – Guidelines

- Evaluation should be **ongoing** process
- **Fully** examine solutions **regularly**
 - check that solution is **blunder free**
 - check the **reasonableness** of the results
 - check that **criteria and constraints** are **satisfied**
 - check **procedure and logic** of all **arguments**
 - analyse for **potential problems**
 - confirm **all** findings
- **Have an independent review of the work**



Evaluation Checklist

- Does solution address the **real problem**
- Is it a **permanent** solution or a **patch-up**
- Have **all** consequences been identified
 - economics
 - environmental
 - occupational health and safety
 - social
- Does solution meet all **customer needs**
- Is it an **Ethical** solution