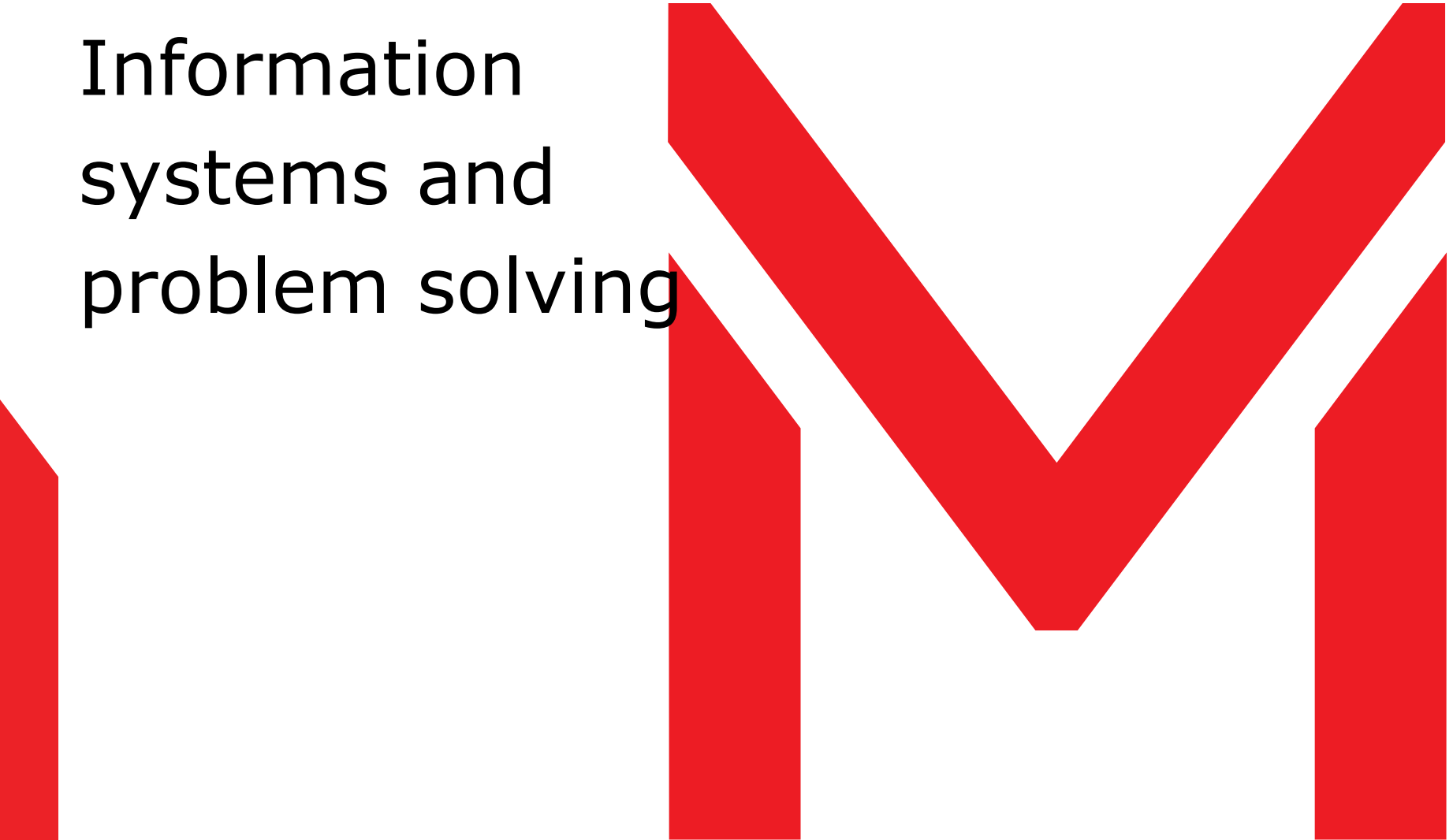
ICT158

Introduction to Information Systems

Topic2

Information systems and problem solving



Learning objectives

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After completing this topic you should be able to:

- Explain what a problem is
- Characterise problems in terms of their structure and complexity
- Explain why messes and wicked problems are difficult to deal with
- Describe the general problem-solving process
- Explain the significance of stakeholders in problem solving
- Identify ways in which information systems can contribute to problem solving

Readings

- Much of the material in this lecture is from Chapter 6 in Gammack, Hobbs & Pigott 'The Book of Informatics' – on My Unit Readings

- There is a good description of wicked problems by Tom Ritchey in the first half of 'Wicked Problems: Modelling Social Messes with Morphological Analysis' at http://www.swemorph.com/wp.html (first half only, not the part on morphological analysis)

Overview

1. What is a problem?
   - Stakeholders
2. Characterising problems
   - Complexity and structure
   - Wicked problems
3. Problem solving stages
   - Identifying the problem
4. Problem solving and information systems

2.1 What is a problem?

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2.1.1 Examples

2.1.2 Definition

2.1.3 Stakeholders

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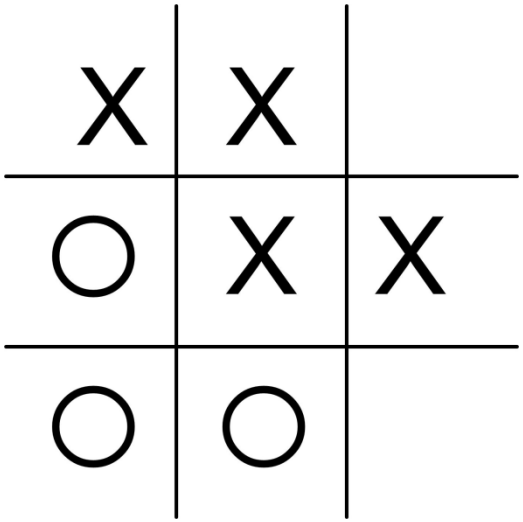
Let’s start with some examples…

In this game of noughts and crosses (tic-tac-toe) you are O and it is your turn to play…



E.G.

Where do you put the O?

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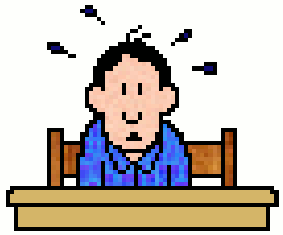
You have a timetable clash between two of your core units. What do you do?



Problem! – café door senses anyone walking past and opens – annoying and wasteful (lets heat/cold out)

How to solve it?


sliding door sensor problem
Griffith
Homestay Families Needed
PIRANHA SOY
SNACK
MENAGE A TROIS
ASSORTED 100GM PACKETS

Solution – sandwich board deflects passing traffic

How can we solve poverty?

Definitions - What is a problem?

- A difference between the current state and the desired state

-- something isn't happening that should

-- something is happening that shouldn't

Problem situations

Problems can exist as a set (or system) of related problems

- Losing your job
- Can't pay for house
- Partner leaves you
- Stress from all this …

Which do you fix first??

What is the real problem? Whose problem is it?

Problem or **symptom**?

- e.g. Ibises in suburbs on east coast – nuisance or endangered through lack of natural habitat?

E.G.

http://www.abc.net.au/science/scribblygum/november2007/

http://blogs.smh.com.au/science/archives/2006/10/_they_seem_to_b.html

Stakeholders

- All problems have stakeholders – people (or groups of people) to whom the problem matters in some way
  - Individuals
  - Teams
  - Organisations
  - Society
- Different stakeholders often have different views on what the problem ‘really’ is – must take them all into account
- Who ‘owns’ the problem - whose responsibility is it to solve?

Problems and solutions

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- Some problems can be formally expressed and solved with calculators or computers
  - Solutions are clearly determined
- Other problems have political, social and human dimensions
  - Solutions not so clear cut: may be possible, but not acceptable or feasible in practice
- Some problems are intractable or incapable of solution in practice
- Some are impossible or nearly impossible even to analyse adequately

Recap

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Problems can range from simple puzzles to complex problem situations

Problem analysis may be needed to distinguish problems from symptoms

All problems have stakeholders

2.2 Characterising problems

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2.2.1 Ackoff's classification

2.2.2 Structure

Characterising problems

Using different ways to describe problems can highlight different ways in which we might approach dealing with them

There's no single classification, but two of the most commonly used ideas are:

- Complexity (Ackoff's classification)
- Structure

Puzzle, problem, mess

Russell Ackoff described problems in terms of their complexity:

- Puzzles – simple problems, well defined, with a single solution
- Problems – more complex, still with an agreed definition, but many possible solutions
- Messes – very complex, interrelated problems, no agreed definition, often social or political in nature

Puzzle, problem, mess

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1. Puzzles

- Simple problems, commonly quantifiable or logical, with well understood methods
  - What discount applies for cash now, rather than over a three-year term?
  - What combination of crops maximises productivity on this piece of land?
- Discipline-specific methods/formulae apply
- Solution usually unambiguous: exact numbers

2. Problems

- Well defined or formulated, but has different possible solutions – each ‘depending on…’
- Some quantification, but also unknowns
    - How many prisons/hospitals should we have?
    - How much should I spend on marketing, compared with research and development?
    - What new LMS should Murdoch adopt?
- Possible approach:
    - Identify assumptions, work out an answer, then consider wider feasibility

How many hospitals?

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Work out the *population* to be served by the hospitals, the average *percentage* in hospital at any one time, and their *average* stay

Other information shows that:

- the population is expanding
- people are living longer
- health problems increasingly manageable at home
- a policy trend towards keeping people out of hospital where possible.

Assumptions (such as whether the population is likely to get sicker or healthier overall) moderate original number up or down.

-- Answers more approximate than exact.

3. Messes

- Complex, highly connected and interdependent set of problems that is impossible to break down into simpler components; often human/social
- Problem and possible solutions (may) be defined, but method to reach solution is arguable
- Or there may be disagreement among stakeholders even on how to define what the problem is
- Impossible to solve only in part – need to address the whole mess
- Fixing one part may make other parts worse
- May be insoluble and need managing rather than solving
- Most management problems are messes

3. Messes (continued)

"A mess is a system of constantly changing, highly interconnected problems, none of which is independent of the other problems that constitute the entire mess. As a result, no problem that is part of a mess can be defined and solved independently of the other problems."

(Russell Ackoff, in 'Redesigning the Future')

"One of the greatest mistakes that can be made when dealing with a mess is to carve off part of the mess, treat it as a problem and then solve it as a puzzle – ignoring its links with other aspects of the mess."

(Michael Pidd, in 'Tools for Thinking')

Wicked problems

- Rittel and Webber termed these very complex social messes **wicked problems**:
  - No definite formulation
  - No set of potential solutions, or operations
  - Every wicked problem unique
  - Solutions are not right or wrong, only better or worse
  - … *

*See list of 10 criteria at http://www.swemorph.com/

Also summarised at http://en.wikipedia.org/wiki/Wicked_problem

- Wicked problems are common in organisational and human systems – where there are social, economic and political problems

Recap

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Puzzles, **problems** and **messes** are three classes of problems. Each has particular qualities and general approaches to solution which can be used.

Structure

Structure is a way of looking for regularities in the problem so that it is amenable to solution by computation

- **Structured problems**: routine, readily solved with known methods. Suited to computer analysis
- **Semi-structured problems**: part of the problem is structured. The structured part may be solved in a familiar way, then that solution can be used to support judgement
- **Unstructured problems**: no ready method of solution, may need to be structured somehow for solving or management

We will meet the idea of structure again in *decision-making*

Examples

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Structured problem

- Sudoku

	4		1				5	8
6				5		2		
		2	4		3	1		
							6	
5		8		2		4		1
	6						8	
		1	6			7		
2				4				3
4	3		5		9		1	2

Semi-structured problem

- Choosing which car to buy within your budget

Unstructured problem

- Should we build a dam?

Recap

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Structure also helps define problems.

The more *structure* a problem has,

the easier is a generalised solution.

Unstructured problems usually

require human judgement

2.3 Strategies for problem solving

2.3.1 General problem solving methods

2.3.2 Stages for problem solving

General problem solving methods

Simon's model of problem solving and decision making is widely used in in management decision making

- **Intelligence**
  collect information, identify and define the problem
- **Design**
  conceive alternatives, select criteria
- **Choice**
  evaluate alternatives, select
- **Implementation**
  put decision into effect, allocate resources, control

And **Review** the outcome to see if the solution worked

Stages of problem solving and decision making process

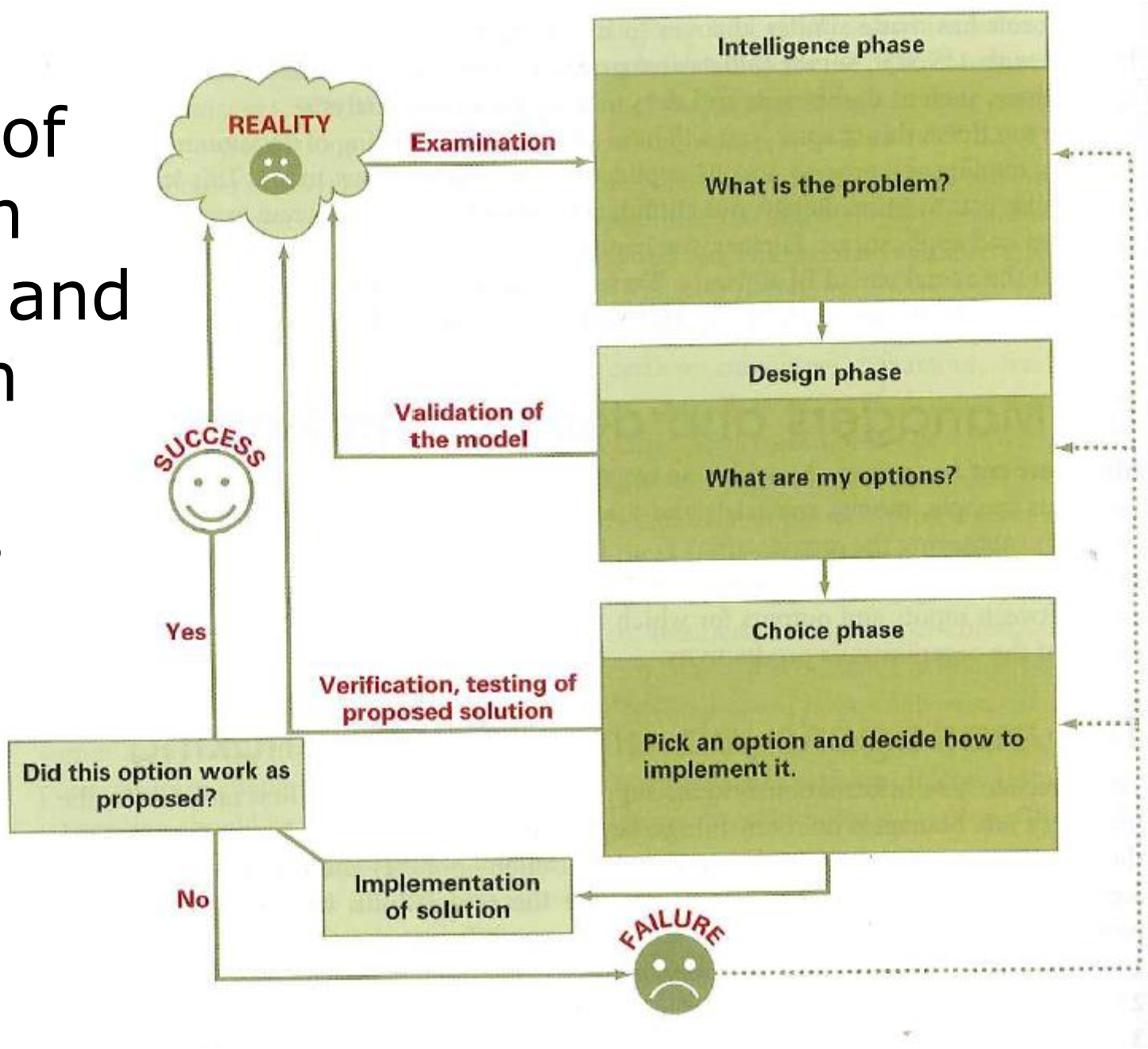


Figure 5.1 in Gray et al

Problem solving: 1. Defining the problem (intelligence stage)

Some related aspects of *defining the problem to be solved*…

- Identify the real problem
- Problem formulation (describing and representing)
- Problem ownership
- Scoping (choosing which problem to solve in an complex problem situation)
- Structuring the problem (making use of any structure already present, making structured representation)

The next few slides illustrate some of these

Techniques for identifying the problem

- **5 whys** – keep asking ‘why’ until the fundamental problem is revealed

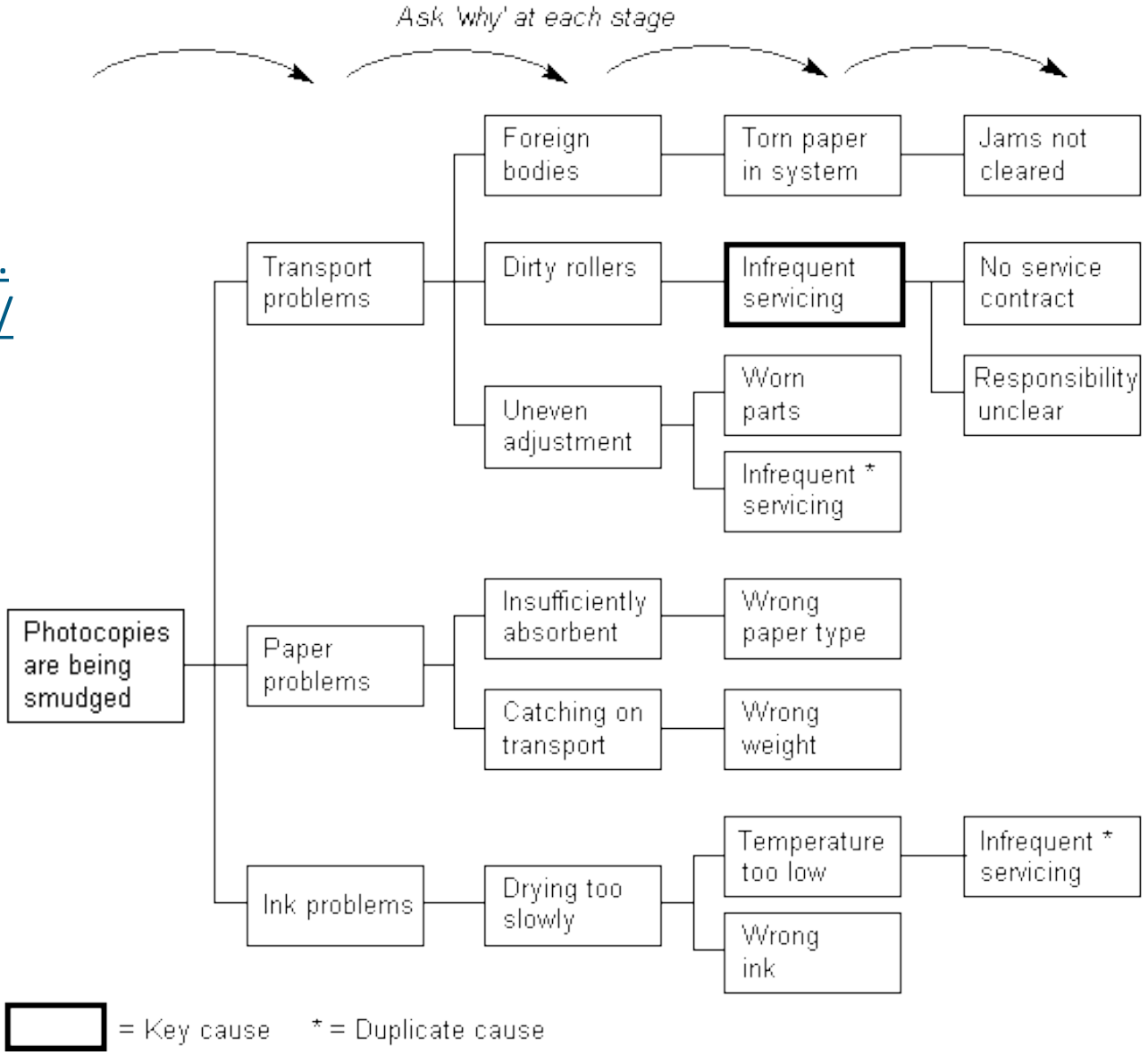
  e.g. The photocopier keeps smudging –

  WHY? (next slide)

- **Cause-effect** or Ishikawa diagram – different causes and effects contribute to the stated problem

Example of a 'why-why' diagram

Image from http://www.syque.com/quality_tools/tools/Tools24.htm



Example of a cause-effect diagram

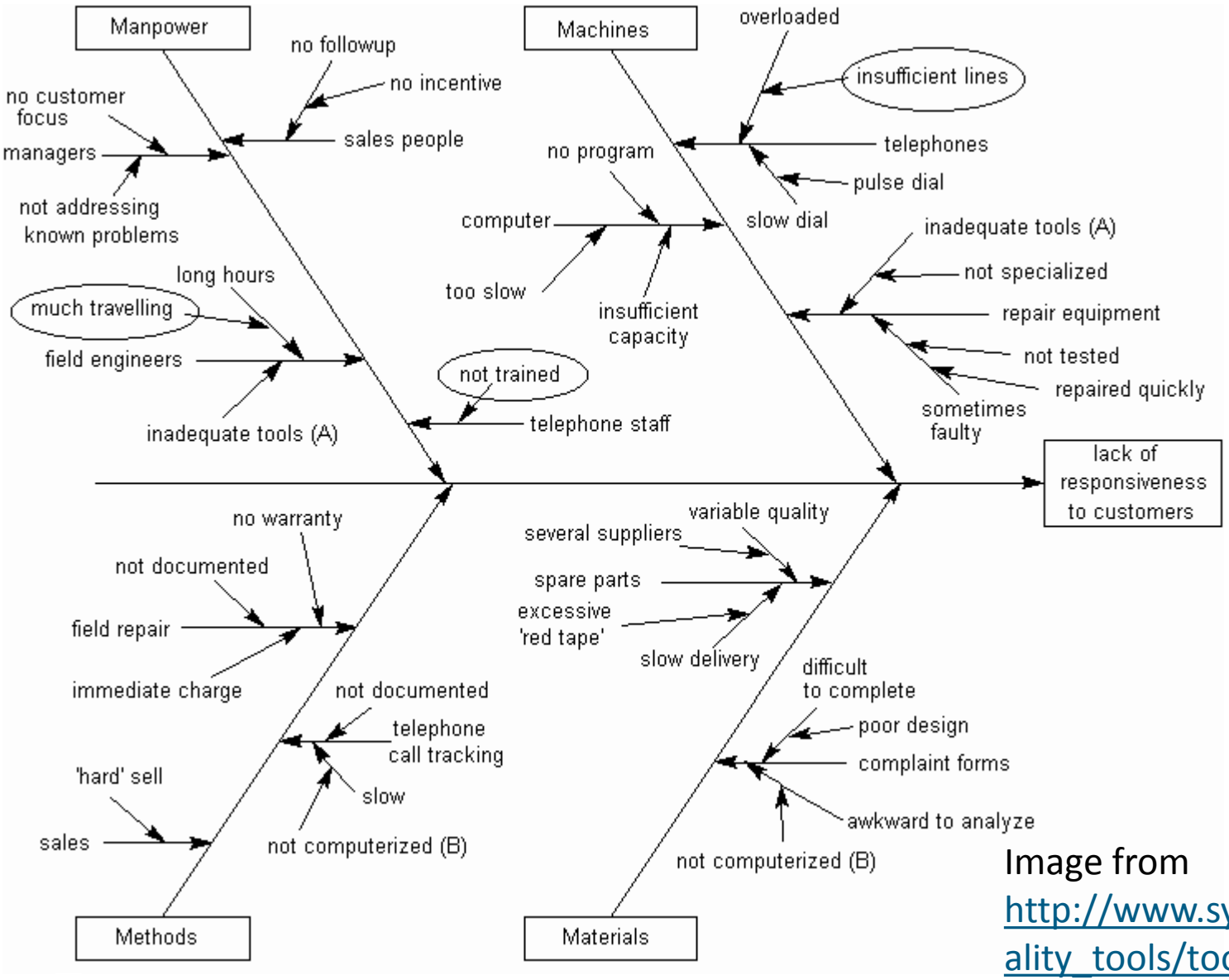


Image from http://www.syque.com/quality_tools/toolbook/cause-effect/example.htm

Representing the problem

- How a problem is described and represented may make it easier (or harder) to handle

24+76+97+3+33+77 =

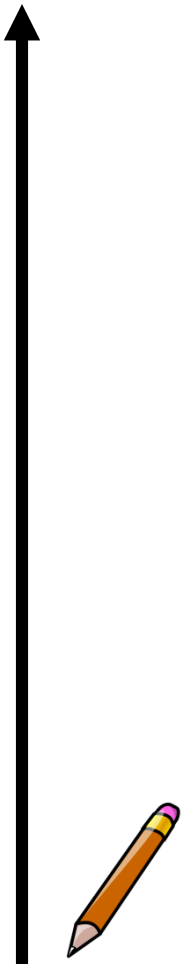
(24+76)+(97+3)+(33+77) =

Which is easier to solve?

Representing the problem

- A rock climber sets off at first light to ascend a cliff-face.
- Taking all day, pausing at various tricky bits, he spends the night at the top.
- He starts climbing down at the same time the next morning.
- How can we prove that *there must be a point on the cliff that will be passed at the same time of day*, no matter how much more quickly he descends?

click



x

a diagram may be the best representation

Problem Ownership

Problem analysis identifies the responsibility, which in turn shapes the nature of the solution

- Who 'owns' your timetable problem?
  - The timetabling office, for not avoiding the problem?
  - You, for choosing an unusual combination of units?
- Solutions can *cause* problems!
  - Fixing one timetable clash causes another…
  - Missing a lecture means you have to listen to the recording later…

Example: (after Gause & Weinberg)

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- A road tunnel through the Swiss Alps has been built. For safety a sign is made:

Tunnel ahead - please turn on headlights

- At a scenic viewpoint just beyond the far end of the tunnel people stop for photos and refreshment. Many then find their car batteries dead from leaving lights on! Gendarmes are fed up jump-starting cars. Tourists are upset.

WHOSE PROBLEM IS IT?

WHOSE PROBLEM IS IT?

- Drivers
- Tunnel engineer
- Gendarmes
- Swiss canton president
- Other
- All of the above
- None of the above

Probably the ***tunnel engineer's*** problem

WHAT SOLUTIONS MIGHT WORK?

Possible solutions

- Sign at tunnel end?

- Ignore it?
- Battery chargers at rest stop?
- Franchise battery charging?

Each solution causes new problems!

Possible solutions

- Sign at tunnel end?

Problem: people would turn off lights at night

- Ignore it?

Problem: no changes and loss of reputation

- Battery chargers at rest stop?

Problem: expensive, maintenance, unpopular…

- Franchise battery charging?

Problem: commercialises rest stop, unacceptable to tourists, govt.

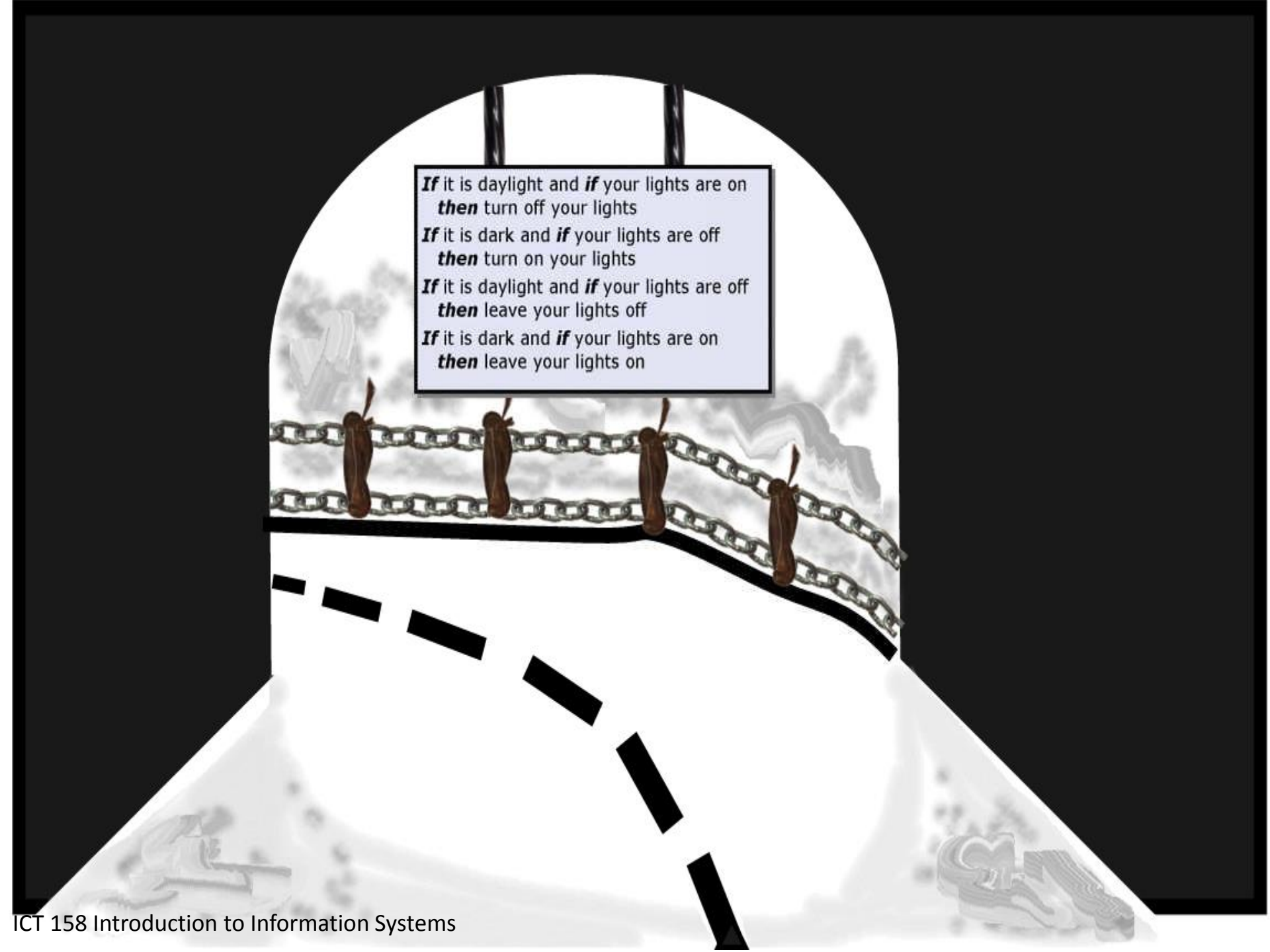
…

A better sign?

A better sign?

~~**Turn off your lights**~~

- ***If*** it is daylight and ***if*** your lights are on ***then*** turn off your lights
- ***If*** it is dark and ***if*** your lights are off ***then*** turn on your lights
- ***If*** it is daylight and ***if*** your lights are off ***then*** leave your lights off
- ***If*** it is dark and ***if*** your lights are on ***then*** leave your lights on


If it is daylight and if your lights are on
then turn off your lights
If it is dark and if your lights are off
then turn on your lights
If it is daylight and if your lights are off
then leave your lights off
If it is dark and if your lights are on
then leave your lights on


Are your
lights on?

Scoping: which problem to solve in a complex situation?

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Which problem to solve in a complex problem situation?

- identify components, scope and prioritise the sub-problems
- Look for any interdependencies among sub-problems

- Medical triage at an accident. Who to treat first with the limited resources of ambulance officers and time?

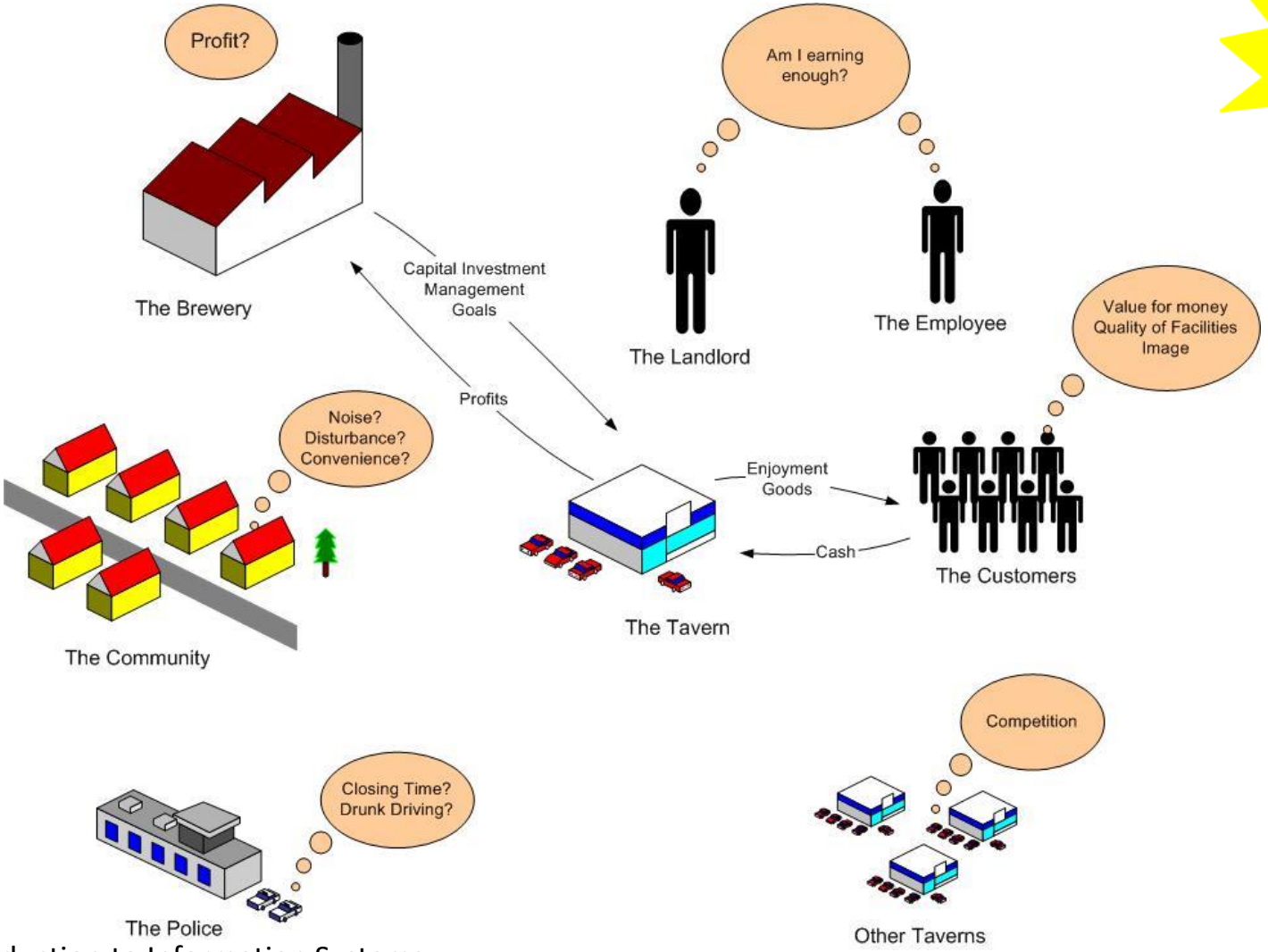
- An organisation identifies problems in its marketing, finance, IT, and innovation departments. Further business analysis may suggest fixing the IT aspects is most critical.

Messes and wicked problems

- A major part of the ‘solution’ activity is modelling the problem in the first place and attempting to structure it
- There are various approaches for structuring complex, messy problems, e.g. SSM or **Soft Systems Methodology**
  - Originated by Peter Checkland in his 1981 Book: ‘Systems Thinking, Systems Practice’
- SSM focuses on the *human* activity aspects and social and political contexts of a problem
- Provides guidance in defining complex problems thoroughly and identifying feasible and desirable solutions
- “Rich pictures” are used widely in SSM

Diagram from Gammack, Hobbs & Pigott (2007) 'The Book of Informatics'

Using a rich picture to represent problem issues to do with a tavern



Solving a problem: 2. Identifying possible solutions

- There are likely to be many potential solutions to a problem, particularly if it is complex
- Different **stakeholders** will have different views on what is a good solution
- Solutions may have side effects that cause further problems

Solving a problem: 3. Choosing a solution

- Once potential solutions have been identified, a **decision** can be made about which to choose
- May be straightforward or may involve some judgement
- Candidate solutions can be **evaluated** against particular criteria (we will look further at this in later topics)
- There may be some **risk** associated with the solution (losing time, money, effort)
- Risks can be identified and quantified in terms of risk/reward ratio, and reduced by testing the solution in a limited manner
- Organisations and individuals will also differ in how 'risk averse' they are

Solving a problem: 4. Implementing a solution

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Once a problem has been understood and defined and a suitable method of solution chosen, it is then implemented

Information systems can assist this stage by building structured, repeatable solutions in software, or by providing options to the decision-maker

Many techniques, applicable to different types of problems, e.g.

- Computational, for structured problems
- Various forms of decision support techniques, for semi-structured problems
- Specialised techniques for messes or wicked problems

Some barriers to effective problem solving

- Including irrelevant information (obscuring the real problem)
- ‘Confirmation bias’ (only looking for information to support a preconceived idea, perhaps subconsciously)
- Unnecessary constraints (limiting the solution unnecessarily)
- Becoming ‘fixed’ on a particular type of solution (perhaps one that has worked in the past)

Recap

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General methods for problem-solving have been developed.

Stages include: defining the problem; identifying possible solutions; choosing a solution; implementing the solution; and reviewing the outcome

2.4 Information Systems and problem solving

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2.4.1 Types of problems and decisions in an organisation

2.4.2 Information systems support

Where IS can provide support for problem solution/decision making

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Different types of problems and different types of decisions are typically made at different levels in the organisation

- Routine, structured decisions are typically made at the lower, operational level
- Semi-structured decisions involving some judgement are made by middle level managers
- Strategic, long range decisions are typically made by top level managers

Information systems can offer support at each of these levels (next slide)

Where IS can provide support for problem solution/decision making

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	Operational control	Management control	Strategic planning	IS support
Structured	Accounts receivable, order entry 1	Budget analysis, short-term forecasting, personnel reports, make-or-buy analysis 2	3	MIS, statistical models (management science, financial, etc.)
Semistructured	Production scheduling, inventory control 4	Credit evaluation, budget preparation, plant layout, project scheduling, reward systems design 5	Building a new plant, mergers and acquisitions, planning (product, quality assurance, compensation, etc.) 6	Decision support systems, business intelligence
Unstructured	7	Negotiating, recruiting an executive, buying hardware, lobbying 8	New technology development, product R&D, social responsibility planning 9	Decision support systems, expert systems, enterprise resource planning, neural networks, business intelligence, big data

Figure 5.2 in Gray et al, Management Information Systems

Recap

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Different types of problems and different types of decisions are typically found at different levels in the organisation, from operational to strategic. Information systems can offer support at each of these levels

Summary

- Solving problems is fundamental to all organisations, but the principles of problems and problem solving are universal
- All problems have stakeholders who are a vital part of identifying the problem and solving it
- Problems can be characterised in terms of their structure and complexity
- Ackoff's classification: puzzles, problems and messes
- Some problems have a straightforward solution, but messes (or wicked problems) may only be able to be managed
- Information systems involves a variety of problem solution strategies and techniques

References

- Figures on slides 37, 63are copied from Figure 5.1 and 5.2 in Gray, H. et al (2015), Management Information System, First Australasian edition. Wiley
- Example on slides 46- adapted from Gause, D.C. & Weinberg, G.M. (1990) 'Are Your Lights On? How to Figure Out What the Problem Really Is' (e.g. http://www.amazon.com/Are-Your-Lights-On-Problem/dp/0932633161)