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Myths and reality of problem-solving

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Problem-solving

- Systems Engineering and Management are all about problem-solving
- Large and complex problems are broken out into smaller and simpler problems
- Smaller problems are remedied
- Assumption is that once smaller problems are remedied, the large problem will also have been remedied

Research question

- *Are there myths in the problem-solving process that hinder the solving of complex problems and increase the complexity of the problem solving process?*

Problem with meaning of “problem”

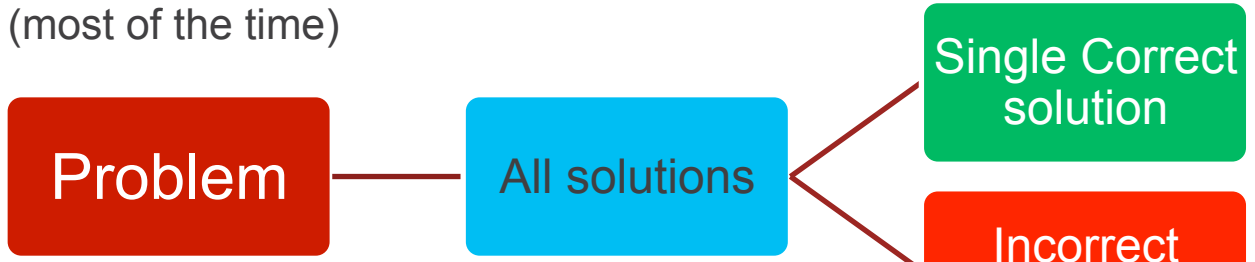
1. A question proposed for solution or discussion (dictionary.com, 2013)

2. Any question or matter involving doubt, uncertainty, or difficulty (dictionary.com, 2013) For example:
   - ***An undesirable situation***. You might hear someone end a sentence with “… *and that’s the problem*” when they mean “… *and that’s the undesirable situation*”
   - ***The underlying cause of an undesirable situation***, usually a failure of some kind.

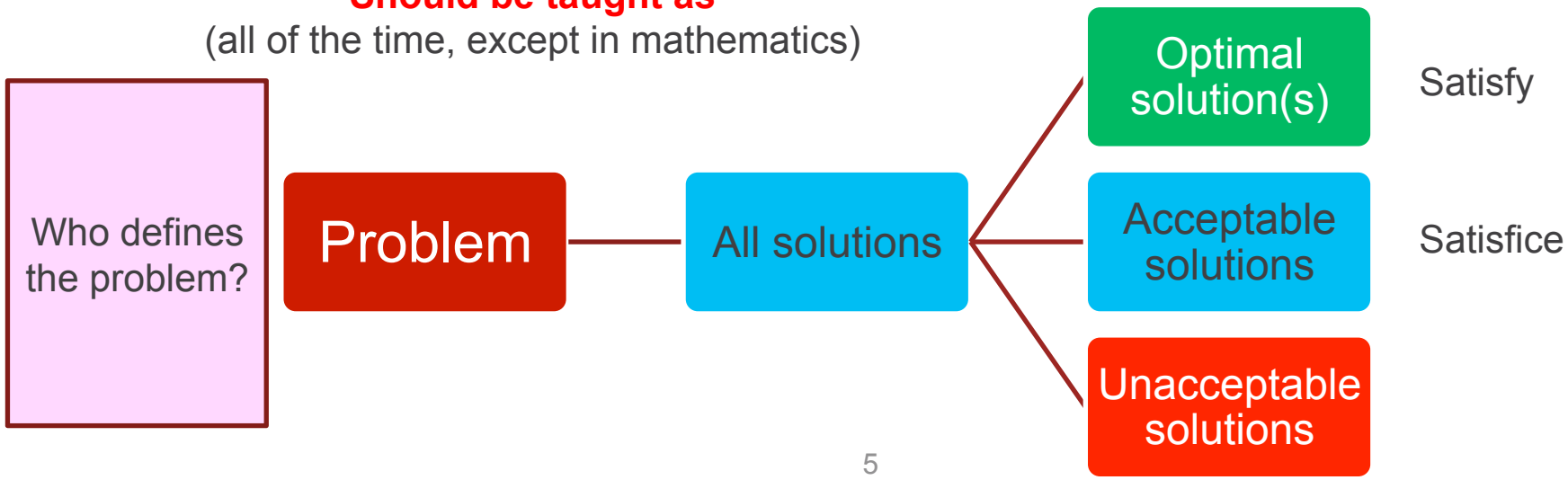
3. The need to determine the necessary sequence of activities to perform the transition from an undesirable situation to a future desirable situation (Schön, 1991)

Problems and solutions

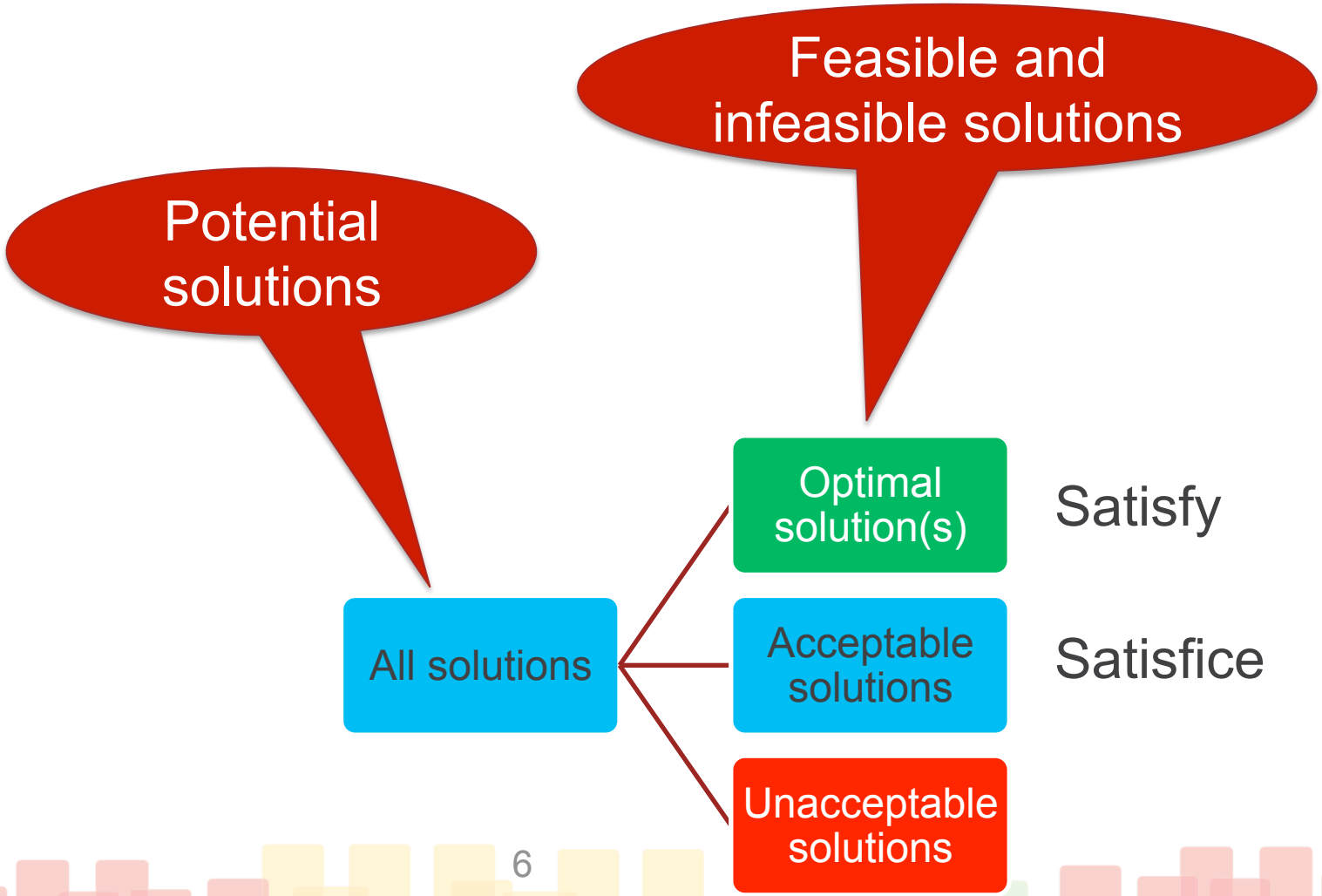
Currently taught as
(most of the time)



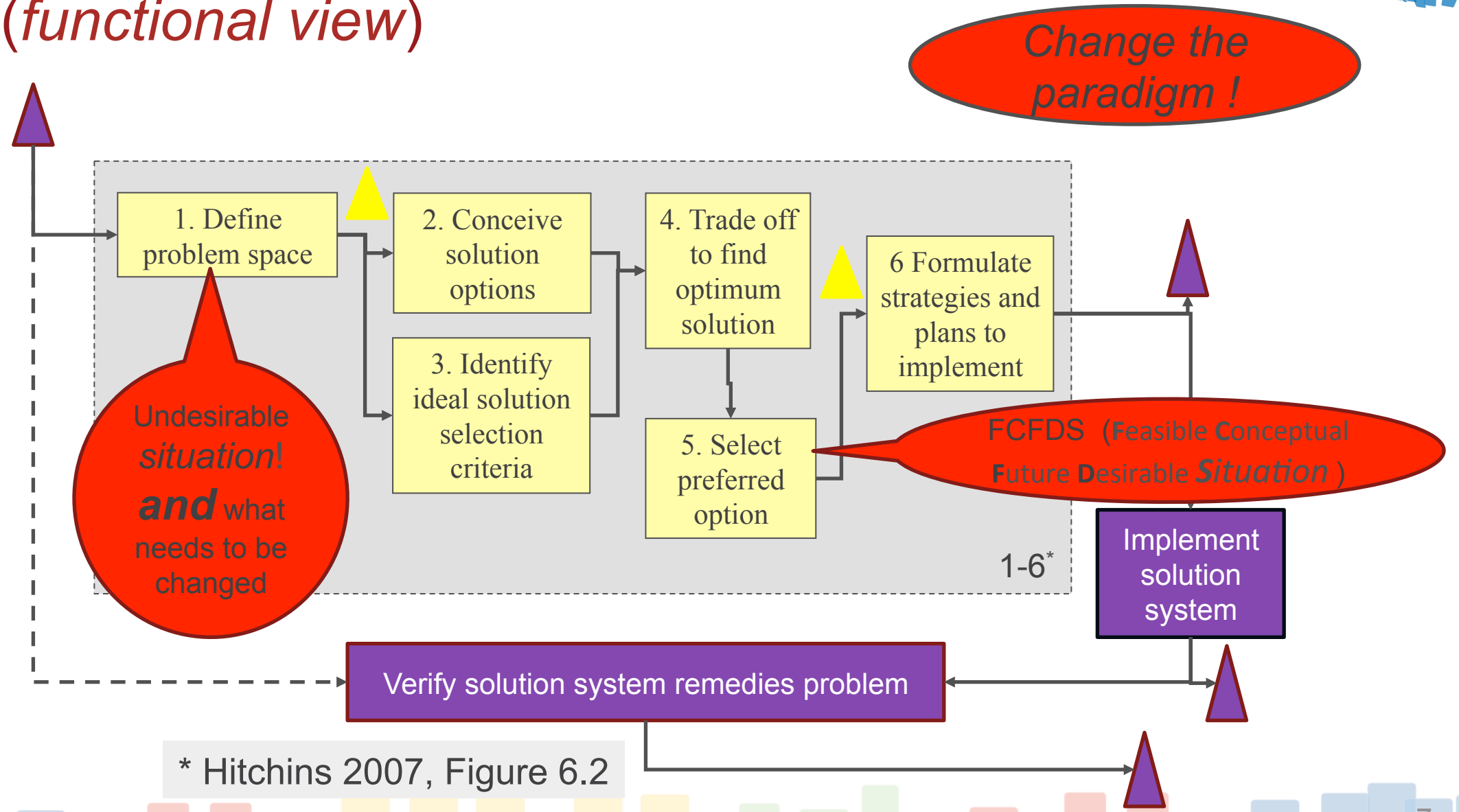
Should be taught as
(all of the time, except in mathematics)



Potential and feasible solutions



A systematic problem-solving process (*functional view*)



* Hitchins 2007, Figure 6.2

Types of Problems

1. Research problems
2. Intervention problems
3. Level of difficulty of the problem
4. Technological Uncertainty of the problem
5. Structure of the problem

1. Research problems

This type of problem manifests when the undesirable situation is the inability to explain observations of phenomena or the need for some particular knowledge. In this situation, applying the Problem Formulation Template (Kasser, 2015):

- *The undesirable situation* is the inability to explain observations of phenomena or the need for some particular knowledge.
- *The FCFDS is* the ability to explain observations of phenomena or the particular knowledge.
- *The problem* is how to gain the needed knowledge.
- *The solution* is the knowledge often in the form of the supported hypothesis.

2. Intervention problems

This type of problem manifests when a current real-world situation is deemed to be undesirable and needs to be changed over a period of time into a FCFDS. In this situation:

- *The undesirable situation:* may be a lack of some desirable functionality that has to be acquired or created, or some undesirable functionality that has to be eliminated.
- *The FCFDS:* one in which the undesirable situation no longer exists.
- *The problem:* how to realize a smooth and timely transition from the current situation to the FCFDS minimizing resistance to the change.
- *The solution:* the transition process to move from the undesirable situation to the FCFD together with the solution system operating in the situational context.

3. Level of difficulty of the problem Ford (2010) :

1) Easy: problems that can be solved in a short time with very little thought.

2) Medium: problems that:

a. Can be solved after some thought.
b. May take a few more steps to solve than an easy problem.
c. Can probably be solved without too much difficulty, perhaps after some practice.

3) Ugly: problems are ones that will take a while to solve.

a. Involves a lot of thought.
b. Involves many steps.
c. May require the use of several different concepts.

4) Hard: problems usually involve dealing with one or more unknowns.

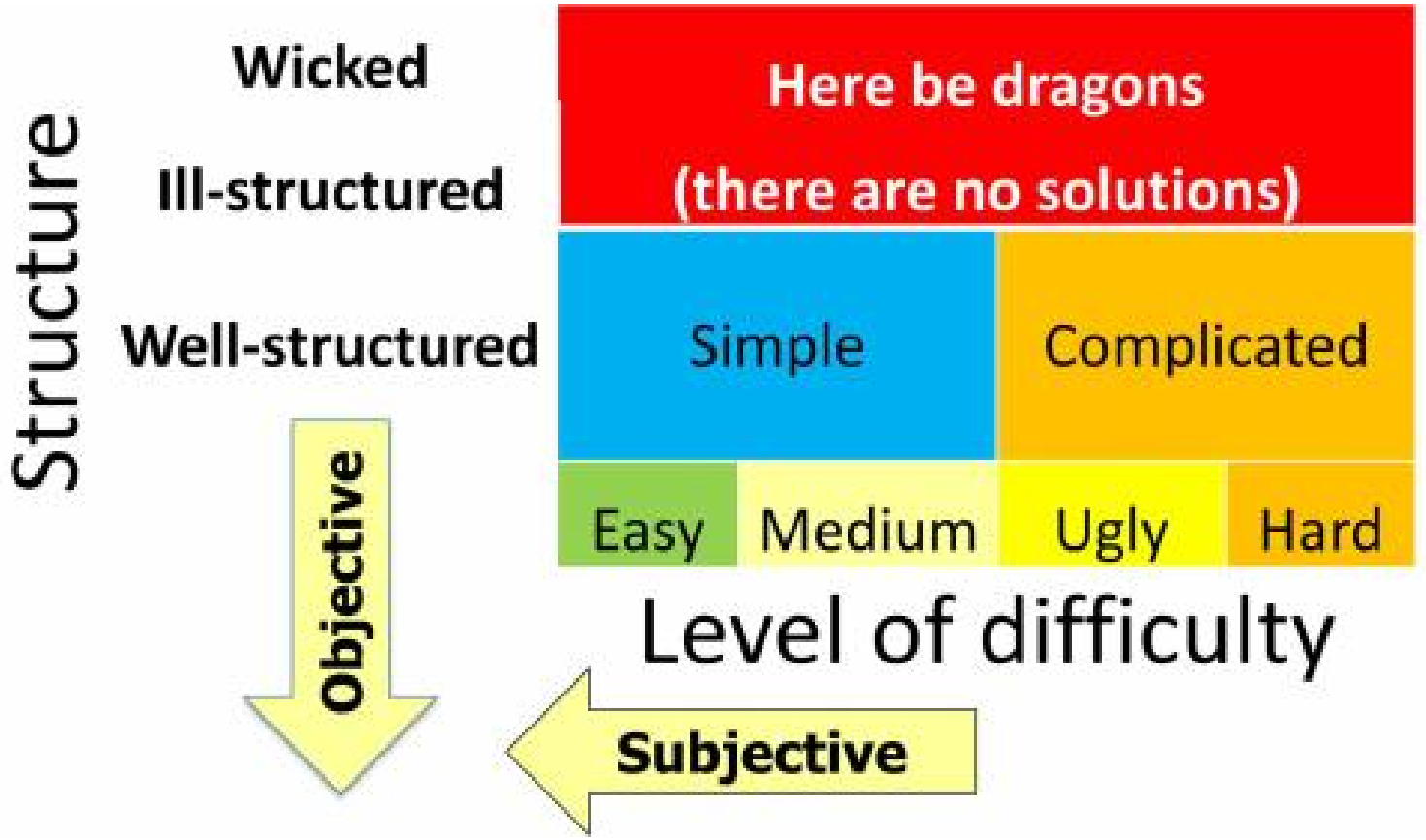
a. Involves a lot of thought.
b. Requires some research.
c. May also require iteration through the problem-solving process as learning takes place(knowledge that was previously unknown becomes known).

4.

Table.1 Shenhar and Bonen's project classification by Technology Uncertainty

	Type A	Type B	Type C	Type D
	Low - Tech	***Medium - Tech***	***High - Tech***	***Super – High - Tech***
Technology	All exist	Integrates some new with mostly existing	Integrates mostly new with some existing	Key technologies do not exist at project's initiation
Development	None	Some	Considerable	Extensive
Testing	None	Some	Considerable	Extensive
Prototyping	None	Some	Considerable	Extensive
Requirements	Known prior to project start	Joint development effort between customer and contractor	Strong involvement of contractor	Extensive contractor involvement many changes and iterations
Design cycles	1	1 or 2	At least 2	2 to 4
Design freeze	Prior to project start	1st Quarter	1st or 2nd Quarter	2nd or 3rd Quarter
Changes	None	Some	Many	Continuous
Management and systems engineering style	Firm and formal	Moderately firm	Moderately flexible	Highly flexible

5. The Structure of the problem



All Problem can be resolved?

The reality is that problems are either solved, resolved, dissolved or absolved (Ackoff, 1978)

1. *Solving* *the problem* is when the decision maker selects those values of control variables which maximize the value of the outcome

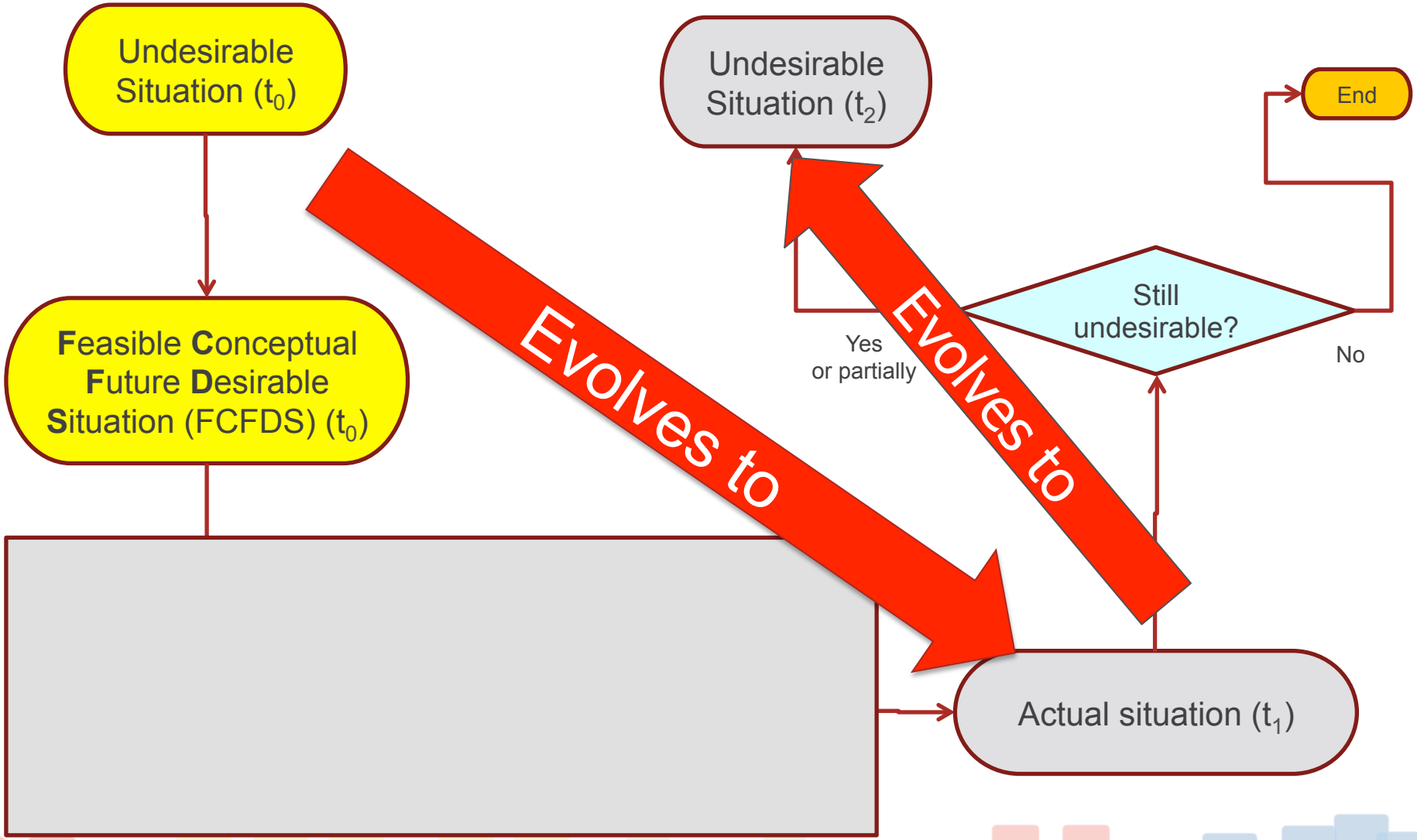
2. Resolving *the problem* is when the decision maker selects values of the control variables which do not maximize the value of the outcome but produce an outcome that is good enough or acceptable

3. Dissolving *the problem* is when the decision maker reformulates the problem to produce an outcome in which the original problem no longer has any meaning.

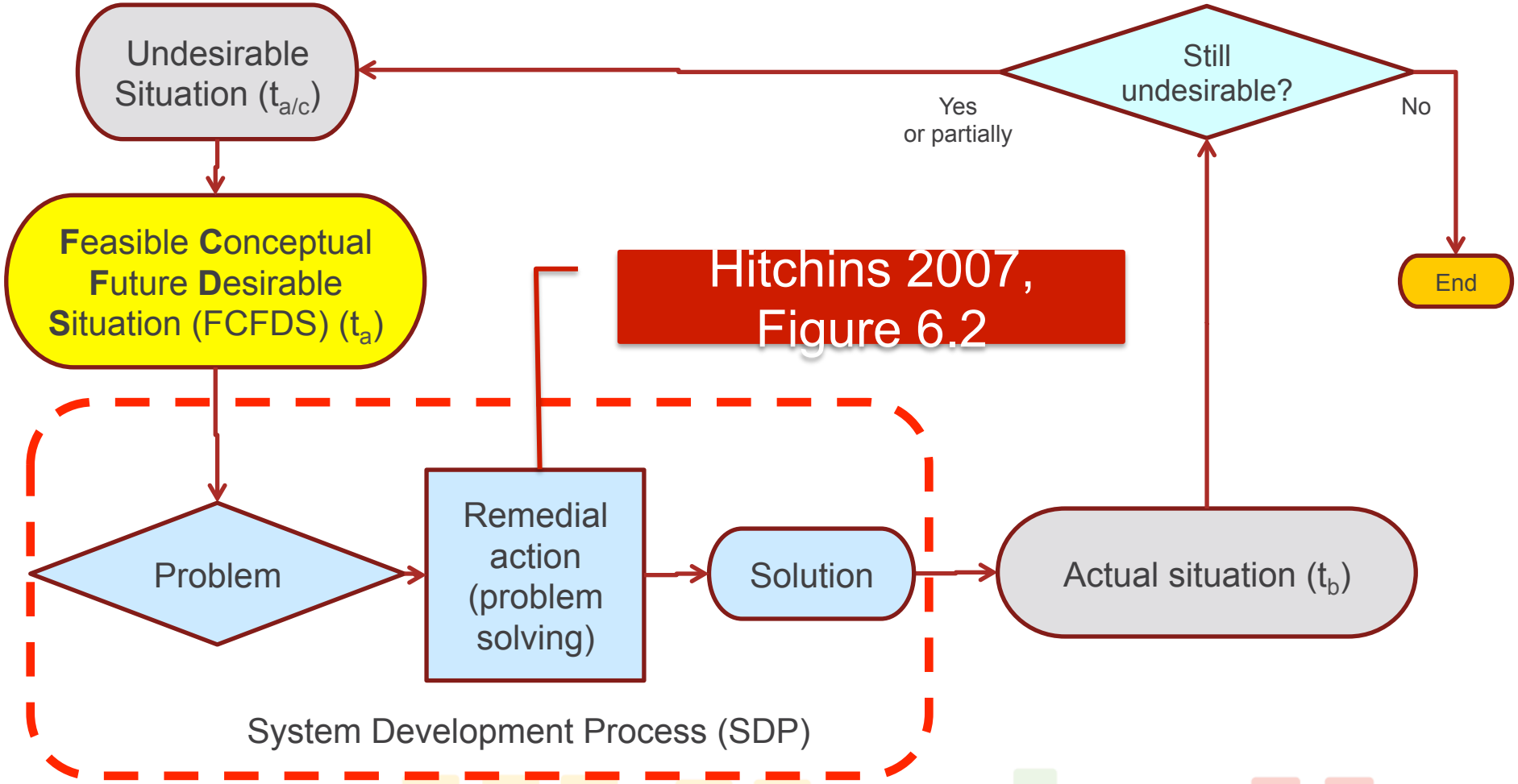
4. Absolving *the problem* is when the decision maker ignores the problem or imagines that it will eventually disappear on its own.

Problem-solving process (functional view)

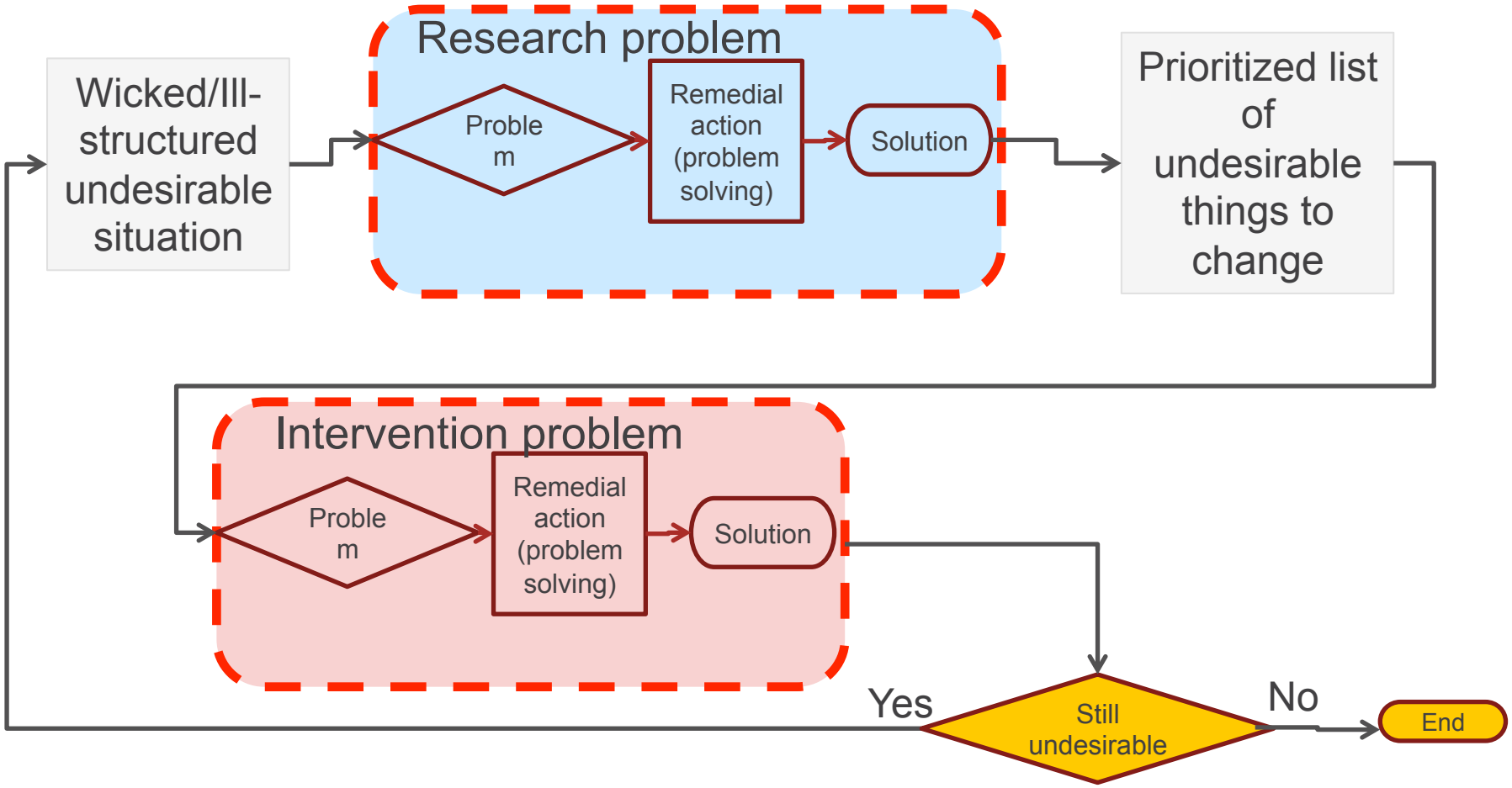
*Practitioner must make sense of an uncertain situation that initially doesn't make sense.



Holistic extended problem-solving process (functional view - multiple pass)



Double-loop problem-solving



Myths and reality of problem-solving*

Myths	Reality
An **ambiguous** meaning of the word "problem"	At least three different meanings in the literature
Single correct solution	**Multiple acceptable** solutions
Problem-solving process covers 1. Start with a problem 2. Solve problem 3. End with a solution	Problem to be explored, and understood **before being defined**
Single pass through the problem-solving process	"Single" is only valid for easy problems; **multiple passes** to evolve the remedy
A single problem-solving approach fits all types of problems	**Different types** of problems require different problem-solving approaches
All problem can be **resolved**	Four ways of **remedying** problems

Contribution of paper

- Changes paradigm
  - Wicked situations
  - Situation is a system
- Identifies the myths and reality of the problem-solving process
- Defines problems in terms of structure and subjective complexity
- Converts dealing with undesirability in wicked situation to well-structured problems
- Uses double loop
  - Extended holistic problem-solving process loop

A set of three-paper

- Kasser, J. and **Zhao, Y.Y.** (2016). “Wicked Problem: Wicked Solutions”, IEEE SoSE 16, Jun.12-16, 2016. Norway.

- Kasser, J. and **Zhao, Y.Y.** (2016). “Simplifying Solving Complex Problems”, IEEE SoSE 16, Jun.12-16, 2016. Norway.

Questions or comments

The systems approach lets you see things differently and produces opportunities