Creating Outstanding Systems Thinkers

Contents

1 Overview

1.1 Description

Systems Thinking and Beyond (Holistic thinking) is a combination of analysis, systems thinking and critical thinking. After an introduction to systems thinking and critical thinking, Participants will learn how to apply holistic thinking in a systemic and systematic manner to deal with structured and unstructured problems.

1.2 Learning outcomes

1. The ability to deal with open ended problems with no unique solutions.
2. Improved problem solving, systems and critical thinking abilities.
3. The ability to go beyond systems thinking in the analysis of a problem and determination of a solution.

1.3 Sources of knowledge

There was a time when most of the classroom time was taken up with the instructor writing on the blackboard and the Participants copying down the information into their notebooks. These days are long gone in the better institutions. The lecture material is prepared ahead of time in presentation graphics format, and the Participants download the material from the module web page. The contact hours between the instructors and Participants can now be spent more productively in both acquiring and applying knowledge. Learning takes place using the following sources:

- ***Lecture -*** each Module in a module may or may not contain a short lecture to set the context.
- ***Suitable readings –*** these provide the bulk of the knowledge to supplement the lecture. The class lecture will supplement the content of the suitable readings, not summarise the knowledge in the suitable readings.
- ***Practical activity –*** these are problem-based learning scenarios. The team members contribute their interpretations of the suitable readings and their prior knowledge and construct learning.
- ***External sources –*** these are any pertinent sources the Participants may choose to contribute. There is a wide body of literature out there and the sources of learning should not be limited to those provided in the course.

The multiple sources of knowledge allow for better transfer of knowledge to Participants with different learning styles.

1.4 Texts

The text book and readings provide greater detail about thinking and analytics.

1.4.1 Printed text book

- Kasser, J.E., Systems Thinker's Toolbox, CRC Press

1.4.2 PDF Text books

- Kasser, J.E., Holistic Thinking: creating innovative solutions to complex problems (HT), Createspace 2013

- Kasser, J.E., A Framework for Understanding Systems Engineering (FUSE), Createspace, 2013
- Kasser, J.E., Perceptions of systems engineering (POSE), Createspace, 2015

1.4.3 Readings

The Holistic Thinking content is state of the art and recent research findings have been published in the text book and in recent and upcoming conference proceedings.

2 The Modules

2.1 Details of Modules

This section contains details of the content of each of the Modules.

Module 0. Introduction and overview

Purpose

1. To introduce the course.
2. To explain the structure of the course.
3. To provide administrative information.
4. To provide an overview of the modules and how they fit together.
5. To discuss the two biggest mistakes students make in essay examinations and how to easily eliminate them.

Knowledge

- You and your objectives?
- Learning outcomes
- Course assumptions
- How the course is taught
- Course knowledge components
- The Modules
- Course format
- Dealing with the exercises
- Balanced classroom
- The two biggest mistakes students make in essay examinations and how to easily eliminate them

Readings 0000 Study guide

- 0002 Introducing knowledge readings, https://www.youtube.com/watch?v=NltGcO2cmJg&t=474s

0003 The balanced classroom (optional)

Reference None

Exercises 0-1 You and your objectives?

Module 1. Thinking and Systems thinking

Purpose

1. To learn about thinking.
2. To learn about and use causal loops.
3. To learn that systems thinking is generally applied but in an incomplete ad-hoc manner.

4. To view issues from different perspectives.
5. To view issues from a standard set (and combinations) of different perspectives and the benefit of doing so.
6. To recognize the need to go beyond systems thinking.

Knowledge
- Thinking
- Systems thinking
- Tools to assist thinking
- Why true understanding requires perceptions from different perspectives
- The myth of open and closed systems
- The distribution of HTPs

Readings
0102 Holistic Thinking Chapter 1: Section 1.1.
0103 Kasser J.E., A theoretical multi-tasking executive function for the information processing model of the human brain, Proceedings of the 3rd International Conference on Applied Human Factors and Ergonomics (AHFE), Miami, FL, 2010
0104 A systemic and systematic approach to finding out-of-the-box solutions
0105 Holistic Thinking Section 4.3: The Holistic Thinking Perspectives updated in Systems Thinker's Toolbox Chapter 10.
0106 Kasser, J.E., Lerner B., Two major misconceptions of systems thinking exposed, British Computer Club Webinar, April 2023 (https://youtu.be/fxZa-qpnAnU)

References
- Systems Thinker's Toolbox for individual tools discussed
- 0150 Basics of Causal Loop Diagrams - University of Saskatchewan (66 PowerPoint slides) https://www.cs.usask.ca/faculty/ndo885/Classes/CMPT858Spring2011/LectureSlides/Lecture%206%20--%20Causal%20Loop%20Diagrams.pdf?fbclid=IwAR3R1es-NVtUI87s9LScREq1bQDXa9sw55rLDGMtfqaGiks16YslFRnCC8Y, last accessed 6/12/2024

Exercises
1-11 List, Concept Map and Causal loops
1-12 Knowledge presentation of Reading 0103
1-21 Causal loops and N2 chart
1-22 N^2 chart
1-31 Examine the classroom from the eight descriptive HTPs identifying aspects
1-32 Knowledge presentation of Reading 0104
1-33 Knowledge presentation of Reading 0105
1-34 Knowledge presentation of Reading 0106

Module 2. Critical thinking

Objectives
1. To introduce logic and reasoning.
2. To introduce and practice critical thinking.

Knowledge
- Definitions
- Critical thinking

Exercises
02-01 The participants will apply the template for critical analysis of arguments.
02-02 Knowledge presentation of Reading 0202
02-03 Knowledge presentation of Reading 0203

Readings 0202 Holistic Thinking Chapter 5: Critical Thinking.
0203 A Framework for Understanding Systems Engineering (FUSE), Createspace, 2013, Chapter 10: Systems engineers are from Mars, software engineers are from Venus.

Module 3. Holistic thinking (going beyond systems thinking)

Objectives
1. To understand how the internal, external, progressive, quantitative and scientific holistic thinking perspectives and critical thinking relate to each other.
2. To recognize the need to go beyond systems thinking.
3. To show how holistic thinking can result in innovative solutions to problems.
4. To practice holistic thinking in planning implementation of solutions.

Knowledge
- Systems
- Nature of systems
- Basic system behaviour
- Emergence
- Hierarchies of systems
- Storing information in the HTPs
- Active brainstorming
- Idea storage templates
- Examples when holistic thinking resulted in innovative solutions to problems (Case studies);
  - Royal Air Force (RAF) Battle of Britain Air Defence System (RAFBADS)
  - LuZ SEGS1
  - NASA Goddard Space Flight Center Pacor Panic Attack
  - FESMA innovative approach to processing survey results
  - Innovative solutions to research problems

Exercises 03-11 Traffic light waiting time exercise
03-12 Knowledge presentation of Reading 0302
03-13 Knowledge presentation of Reading 0304
03-21 Active brainstorming
03-22 Knowledge presentation of Reading 0303
03-31 Sorting ideas into ISTs
03-32 Knowledge reading (case studies)

Readings 0302 Holistic Thinking Chapter 6: Holistic Thinking.
0303 Holistic Thinking Chapter 11: Innovative insights and solutions.
0304 Why you should be using systems thinking to solve problems, https://www.youtube.com/watch?v=wXj-lCYSmGk

Module 4. Problem solving

Objectives
1. To understand the need to, and difficulty of, identifying the correct problem.
2. To understand the consequences of not identifying the correct problem.
3. To understand the need for short term and long-term solutions

and why they might be different.
4. To distinguish between different types and classifications of problems.
5. To review and elaborate on the problem-solving process.
6. To introduce the Problem Formulation Template.

Knowledge
- Problems and problem-solving
- The problem-solving process
- Classification of problems
- The Problem Formulation Template

Exercise
04-11 The problem-solving process as an N^2 chart
04-12 Knowledge presentation of Reading 0402
04-21 Formulating problems using the Problem Formulation Template

Readings
0402 Holistic Thinking Chapter 9: Problems and solutions.

Module 5. Decisions and decision making

Objectives
1. To understand the nature of, and make, and make different types of decisions.
2. To understand and use different decision-making tools.
3. To be able to evaluate decision making tools and determine the one most suitable for a decision.
4. To make decisions.
5. To understand the nature of objective and subjective decision making.

Knowledge
- Uncertainties and risks
- Decision traps
- Subjective trade-off methods
- Quantitative and qualitative decisions
- Decision tree analysis
- Indirect techniques
- Tabular methods and Multi-attribute Variable Analysis
- Value functions and utility curves
- Decision outcomes

Exercise
05-11 Selection of students' next course
05-12 Knowledge presentation of Reading 0502
05-21 Determining and using selection criteria to decide between two different Unmanned Aerial Vehicles (UAV) is to be selected for a mission
05-22 Knowledge presentation of Reading 0503

Readings
0502 Holistic Thinking Chapter 8: Decisions and decision making
0503 Kasser, J.E., Why selecting the wrong course on systems thinking, systems engineering or project management could cost you $1,000s more than the fee, July 2021, https://youtu.be/DTTrobYjLqg

Module 6. Remedying simple and complex problems

Objectives
1. To explain complexity.
2. To explain the difference between simple and complex problems.

3. To explain how to remedy complex problems.
4. To explain how to remedy wicked problems.

Knowledge
- Complexity
- Managing complexity (complex problems) by
- Using an actual number for "large" in the definition of objective complexity?
- Separating objective and subjective complexity help remedy complex problems
- Reasons why can some people tackle complexity successfully while others cannot
- The nine-system model

Exercise
06-11 Mission and support subsystems
06-12 Knowledge presentation of Reading 0602
06-21 Application of Nine-system Model
06-22 Knowledge presentation of Reading 0605

Readings
0602 POSE Chapter 16 The nine-system model
0603 Holistic Thinking Chapter 12: Creating your own innovative solutions to complex problems
0604 How many objects does a system have to contain to be a complex system? , 2020, https://youtu.be/w7IKXnQE5nY
0605 POSE Chapter 18: Guidelines for creating a system

Module 7. Tools and applications in project management

Objectives
1. To show how systems thinking and beyond (STAB) tools can improve project management (increase probability of a successful project).
2. To explain a few systems thinking and beyond tools for project management.

Knowledge
- The project lifecycle
- The Systems Approach The Systems Approach to Planning
- Three streams of work
- PAM chart
- Ways of showing prevention
- Work packages
- Improving project status reporting with Enhanced Traffic Light Charts
- Improving monitoring of technical performance by using CRIP charts
- Exercises

Exercise
- Application of tools

Readings
0790 The Systems Approach to Planning, 2015, https://www.youtube.com/watch?v=JNT4Rc7R8xg
0791 Improving project status reporting with Enhanced Traffic Light Charts (ETLC), 2016, https://www.youtube.com/watch?v=fwM_9otO0F0
0792 Improving monitoring of technical performance by using CRIP charts, 2015, https://www.youtube.com/watch?v=5AUafacJ5AU

Module 8. Tools and applications in systems engineering

Objectives
1. To show how systems thinking and beyond (STAB) tools can

improve systems engineering (increase probability of realizing a system compliant to requirements).
2. To explain a few systems thinking and beyond tools for systems engineering.

Knowledge
- The system lifecycle
- Attribute profiles
- TIGER Pro and requirements
- KISS
- Principle of hierarchies
- Zone of ambiguity
- Exercises

Exercise Application of tools

Readings 0802 Kasser, J.E., Applying Holistic Thinking to the Problem of Determining the Future Availability of Technology, IEEE Transactions on Systems, Man, and Cybernetics: Systems, Volume 46, Number 3, 2016. https://www.youtube.com/watch?v=jx3-Jv691Ss

0803 POSE Chapter 15 seven principles for systems engineered solutions

0804 HT Chapter 3 communicating ideas

Module 9. Tools and applications in risk management

Objectives
1. To show how systems thinking and beyond (STAB) tools can improve risk management (increase probability of realizing a system compliant to requirements within cost and schedule).
2. To explain a few systems thinking and beyond tools for risk management.

Knowledge
- Definitions
- Risks based on technological uncertainty
- Risk rectangles and why not to use them
- Risk profiles
- Risks in using poor people (lecture and 0902)
- Risk and opportunity identification and mitigation
- Opportunity identification
- Survivorship bias
- The doomed classroom project (0904)
- Mitigating communications risks (0905)
- The flaw in the 'B' paradigm (0903)

Exercise Application of tools

Readings 0902 POSE Chapter 14.2 A competency model maturity framework

0903 FUSE Chapter 28 Getting the right requirements right

0904 HT Chapter 10, Examples of the application of the systems engineering approach to problem, Section 10.3.1 Developing an optimal classroom teaching and learning environment.

Module 10. Summary, review and closeout

Objectives	1. To summarize and closeout the course.
Knowledge	• Knowledge from all previous Modules.
Exercise	None.
Readings	None.

3 Acronyms

CONOPS	CONcept of OPerationS
COTS	Commercial-off-the-shelf
DCAS	Defense Contract Administration Services
DOD	Department of Defense
DMSMS	Diminishing Manufacturing Sources and Material Shortages
DSM	Design Structure Matrix
dTRL	Dynamic TRL
FCFDS	Feasible Conceptual Future Desirable Situation
GSFC	Goddard Space Flight Center
FUSE	Framework for Understanding Systems Engineering
HTP	Holistic Thinking Perspective
INCOSE	International Council on Systems Engineering
LEO	low earth orbit
MATE	Multi-Attribute Tradespace Exploration
MVA	Multi-attribute Value Analysis
MCSS	MSOCC Communications Switching System
MSOCC	Multi-Satellite Operations Control Center
Nascom	NASA Communications Network
NMOS	Network Maintenance and Operations Support
QFD	Quality Function Deployment
RAFBADS	Royal Air Force (RAF) Battle of Britain Air Defence System
SEAS	Systems Engineering and Services
SLOC	Source Lines of Code
TAWOO	Technology Availability Window of Opportunity
TRL	Technology Readiness Levels