INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013

The Engaporean Air-Defence Upgrade: A Framework for a Case Study development project

Joseph Kasser

Topics

- The undesirable situation
- Prior work and lessons learned
- The Engaporian Air Defence System
- Student exercises in each phase of the system development lifecycle (SDLC)
- Summary
- Questions and comments

Undesirable situation

Philadelphia, PA
June 24-27, 2013

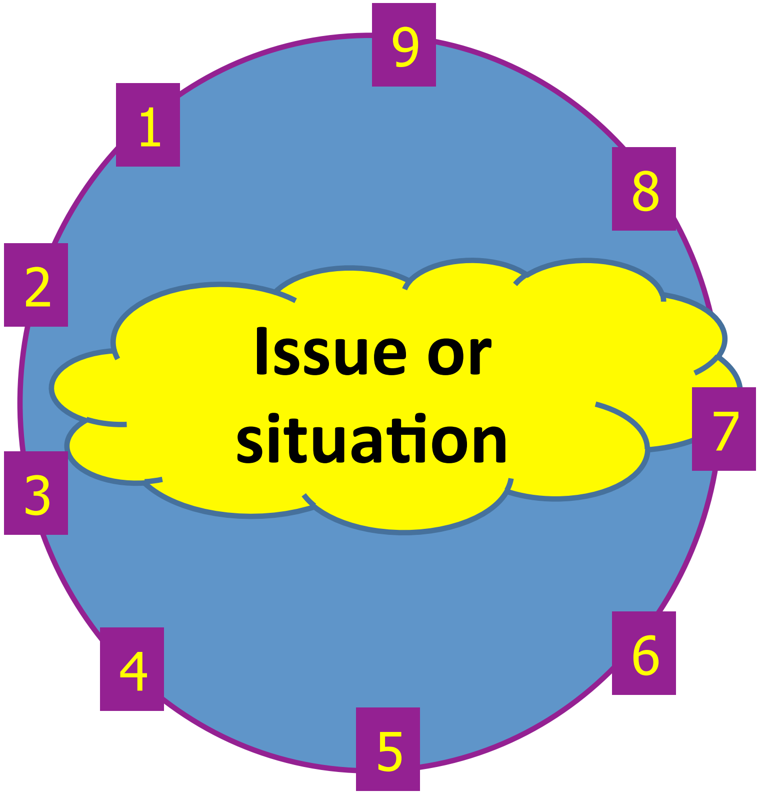
- Case studies make excellent learning tools
- Lack of good case studies
  - Documentation
  - Role-playing
- Learning curve "wastes" time
- Need for case studies
  - Study what happened and why
  - Students make decisions and deal with the consequences

Lessons learned

- SECTS at UMUC cut down on the learning curve
- Existing case studies are unsuitable
  - AFIT
  - Transportation WG
- Need template
  - Similar to templates in MIL-STDs
- SETE and APSEC templates make a good start
- Need to only document external and internal perspectives
  - ABL case in SETE 2013 took off in an unforeseen direction
  - Progressive perspectives provide scope for student exercises

Perspectives perimeter

1. Big picture
2. Operational
3. Functional
4. Structural
5. Generic
6. Continuum
7. Temporal
8. Quantitative
9. Scientific



Engaporian Air Defence System

- Fictitious
- Flexible
- Documentation and role-playing
- Written around the perspectives perimeter
- Covers several areas in the HKMF including Operations and Maintenance
- Outline timeline with scope for elaboration and sharing scenarios

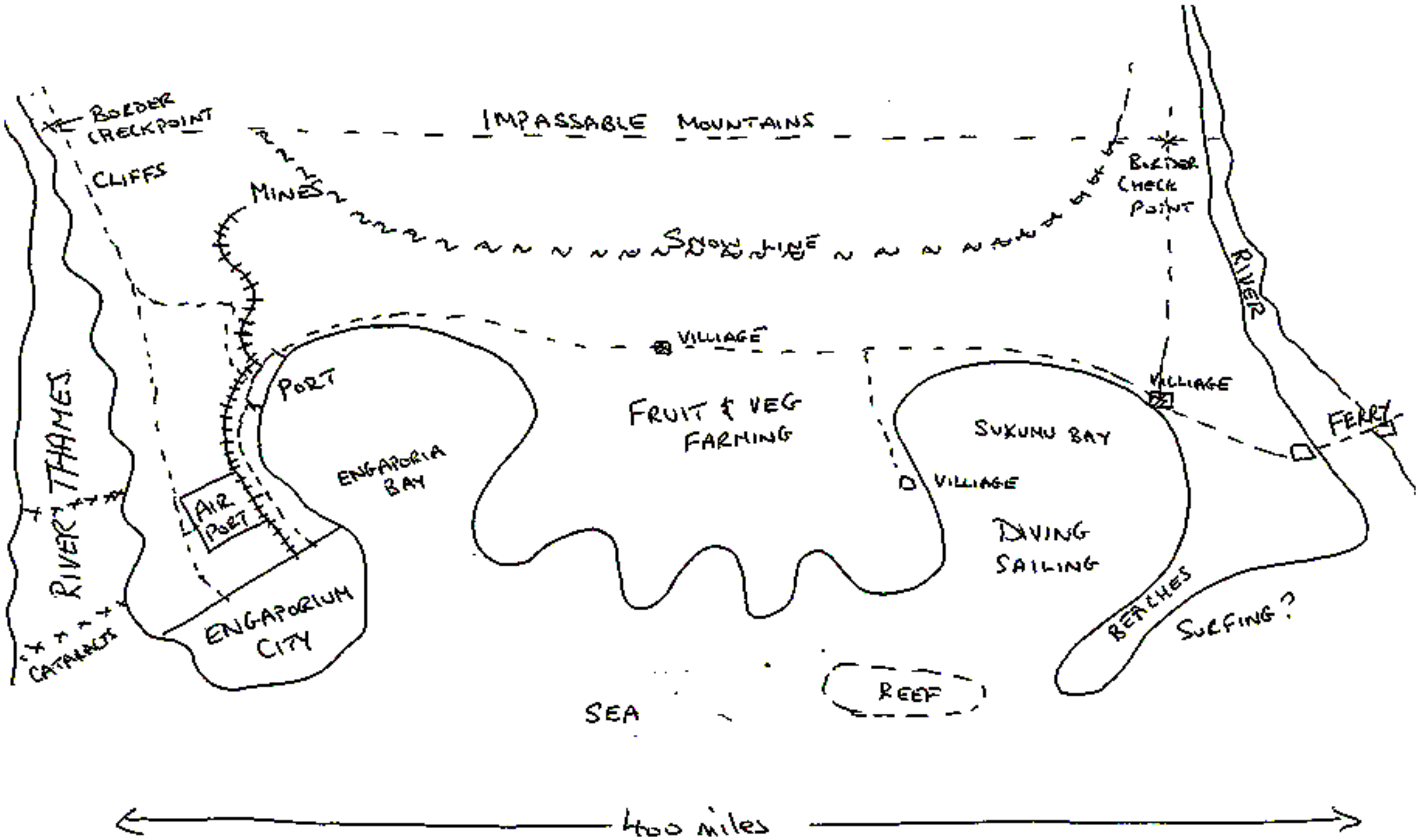
The Hitchins-Kasser-Massie Framework (HKMF) for understanding systems engineering*

INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013

Layer of Systems Engineering \ Phase in the Life Cycle		Needs identification	Requirements	Design	Construction	Unit testing	Integration & testing	O&M, upgrading	Disposal
Socio-economic	5								
Supply Chain	4								
Business	3								
System	2								
Product	1								
		A	B	C	D	E	F	G	H

* Kasser and Massie, 2001

Engaporia



BORDER CHECKPOINT
IMPASSABLE MOUNTAINS
CLIFFS
MINES
SNOW LINE
BORDER CHECK POINT
RIVER
VILLAGE
PORT
FRUIT & VEG FARMING
VILLAGE
SUKUNU BAY
FERRY
RIVER THAMES
AIR PORT
ENGAPORIA BAY
VILLAGE
DIVING SAILING
ENGAPORIUM CITY
CATARACTS
BEACHES
SURFING ?
SEA
REEF
400 miles

Topics

- The undesirable situation
- Prior work and lessons learned
- The Engaporian Air Defence System
- **Student exercises in each phase of the system development lifecycle (SDLC)**
- Summary
- Questions and comments

Early stage systems engineering

- Undesirable situation
  - do not know if the air-defence system needs upgrading
- Problem
  - determine if the air-defence system needs upgrading, and if so,
  - initiate a project to perform the upgrade.

Layer of Systems Engineering \ Phase in the Life Cycle		Needs identification	Requirements	Design	Construction	Unit testing	Integration & testing	O&M, upgrading	Disposal
Socio-economic	5								
Supply Chain	4								
Business	3								
System	2								
Product	1								
		A	B	C	D	E	F	G	H

Feasibility study (student exercise)

- Summarised the need for defence against the known and estimated threats.
- Produced a number of scenarios of what threats the upgraded air-defence system would have to counter (Operational perspective).
- Identified the operational capability and any additional upcoming capability being acquired or developed.
- Performed a gap analysis between the capability needed to counter anticipated threats and the then-current operational and upcoming capability.
- Showed that:
  - While parts of the current system were state-of-the-art, in general, the air-defence system did need upgrading.
  - There were at least three viable affordable alternative ways to provide the necessary upgrade.

A paradigm (student exercises)

- Identify conceptual solution options
  1. Lighter than air missile platforms (LAMP).
  2. Long range surface to air interception functions (missiles).
  3. Manned fighter interceptor function similar to that used in the RAFBADS.
  4. Short range surface to air interception functions (anti-aircraft guns, missiles).
  5. A combination of the above.

Layer of Systems Engineering / Phase in the Life Cycle		Needs identification	Requirements	Design	Construction	Unit testing	Integration & testing	O&M, upgrading	Disposal
Socio-economic	5								
Supply Chain	4								
Business	3								
System	2								
Product	1								
		A	B	C	D	E	F	G	H

- Develop preliminary CONOPS for the Holistic Engaporean Air Defence System (HEADS)

A paradigm (student exercises)

Philadelphia, PA
June 24-27, 2013

- Determine selection criteria for selecting optimal solution
- SSM and other people intensive problem solving processes
- Weight/prioritize the criteria
- Make decision
- Create detailed functional CONOPS for
  - HEADS mission and support functions
- Prepare and present OCR

Layer of Systems Engineering / Phase in the Life Cycle		Needs identification	Requirements	Design	Construction	Unit testing	Integration & testing	O&M, upgrading	Disposal
Socio-economic	5								
Supply Chain	4								
Business	3								
System	2								
Product	1								
		A	B	C	D	E	F	G	H

OCR (Student exercise)

- In the product or system domain
  - The technical, cost and schedule feasibility.
  - Each of the scenarios.
  - The solution selection criteria and their importance.
  - The trade-offs and selection of the optimal solution.
- In the process domain:
  - The acquisition and development strategy.
  - The type of contract (and the reason for the choice) for the realization phases.

Planning activities (student exercises)

- Produce SEP
  - what current capability would be integrated into HEADS in each stage,
  - when that integration would take place,
  - how HEADS would be realized i a phased manner,
  - the type of contracts to be used,
  - where the government-contracto interfaces would be and
  - what resources would be needed.

Layer of Systems Engineering \ Phase in the Life Cycle		Needs identification	Requirements	Design	Construction	Unit testing	Integration & testing	O&M, upgrading	Disposal
Socio-economic	5								
Supply Chain	4								
Business	3								
System	2								
Product	1								
		A	B	C	D	E	F	G	H

Planning activities (student exercises)

INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013

- The basic realization strategy using the Cataract Methodology:
  - ***Build 0*** would create the HEADS architecture, set up the managemen and engineering processes and disseminate the detailed transition plan.
  - ***Build 1*** would incorporate some elements of the then-current air-defence system into skeleton HEAD architecture.
  - ***Build 2*** would put flesh into the skeleton with the priority of bridging any gaps.
  - ***Build 3*** would complete the HEADS.

Layer of Systems Engineering / Phase in the Life Cycle		Needs identification	Requirements	Design	Construction	Unit testing	Integration & testing	O&M, upgrading	Disposal
Socio-economic	5								
Supply Chain	4								
Business	3								
System	2								
Product	1								
		A	B	C	D	E	F	G	H

Requirements phase activities (student exercises)

INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013

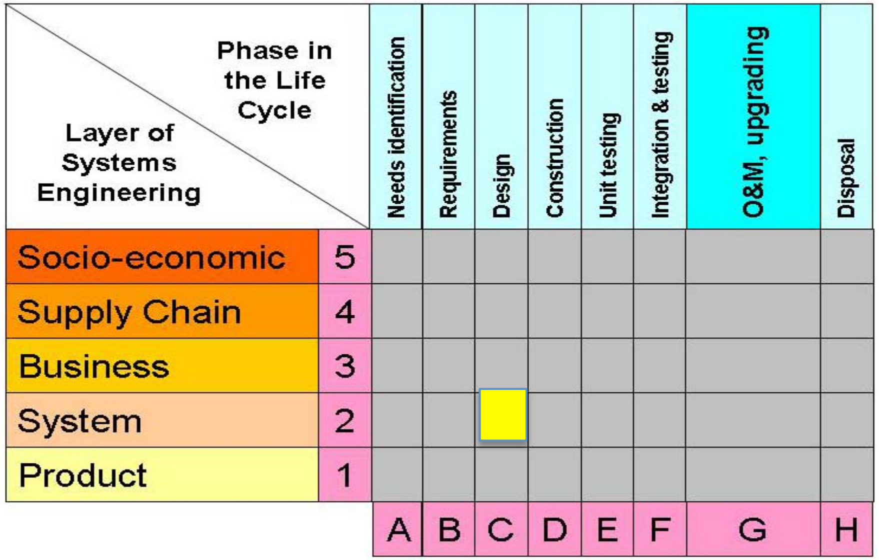
- The project plan (PP).
- A matched set of specifications for the system and its top-level subsystems based on the optimal architectural solution, namely the System Requirements Document (SRD) and the Subsystem Requirements Document).
- The Systems Engineering Management Plan (SEMP).
- The Test and Evaluation Master Plan (TEMP).
- The risk and opportunity management plan
  - identifying process and product risk and opportunities.
- The logistics support plan.
- System Requirements Review

Layer of Systems Engineering / Phase in the Life Cycle		Needs identification	Requirements	Design	Construction	Unit testing	Integration & testing	O&M, upgrading	Disposal
Socio-economic	5								
Supply Chain	4								
Business	3								
System	2								
Product	1								
		A	B	C	D	E	F	G	H

Design phase activities (student exercises)

Philadelphia, PA
June 24-27, 2013

- Two independent preliminary functional/physical HEADS architecture designs incorporating appropriate existing EDF physical elements using the Functional and Structural perspectives.
- The selection criteria for selecting th preliminary and detailed designs.
- Updated versions of previously produced documents.
- Preliminary Design Review.
- Critical Design Review.



Construction and unit testing phase activities (student exercises)

Philadelphia, PA
June 24-27, 2013

- Troubleshooting at the system level
- System level trade-offs
- Change management

Phase in the Life Cycle / Layer of Systems Engineering		Needs identification	Requirements	Design	Construction	Unit testing	Integration & testing	O&M, upgrading	Disposal
Socio-economic	5								
Supply Chain	4								
Business	3								
System	2								
Product	1								
		A	B	C	D	E	F	G	H

System integration and testing phase activities (student exercises)

- Troubleshooting at the system level
- Developing integration concepts
- Developing test concepts
- Planning integration and testing

Phase in the Life Cycle / Layer of Systems Engineering		Needs identification	Requirements	Design	Construction	Unit testing	Integration & testing	O&M, upgrading	Disposal
Socio-economic	5								
Supply Chain	4								
Business	3								
System	2								
Product	1								
		A	B	C	D	E	F	G	H

Holistic thinking activities-1 (student exercises)

Philadelphia, PA
June 24-27, 2013

1. Discuss the "why's", namely the reasons for the "what's" discussed in this case.
2. Design the conceptual alternatives including the LAMP approach.
3. Reverse engineer the importance of the solution selection criteria to identify the contents of the appropriate Engaporean government policies to show the things the government is concerned about and the things it is not?
   – One example is the importance of technology transfer to local industry.

Holistic thinking activities-2 (student exercises)

4. Discuss the SDLC described in this case and map it into those discussed in the systems engineering literature.
5. Identify and display the changes from functional to physical, or "what's" and "how's" through the SDLC?
6. Discuss the differences between the SDLC and the "system engineering process"?
7. Develop the CONOPS for the conceptual solution
8. Define the architecture for HEADS.
9. Develop the DODAF for the HEADS.
10. Develop sub-cases based on sensors, C4ISR and other elements of the system.

Holistic thinking activities-3 (student exercises)

Philadelphia, PA
June 24-27, 2013

11. Develop and discuss aspects of survivability and robustness of the HEADS.
12. Develop and discuss aspects of risks and opportunities in the HEADS SDLC.
13. Discuss the impact the fifth Build on the project.
14. Identify the roles of systems engineers and project managers and discuss where and why they overlap.

Summary

- The undesirable situation
- Prior work and lessons learned
- The Engaporian Air Defence System
- Student exercises in each phase of the system development lifecycle (SDLC)
- **Summary**
- Questions and comments

Questions or comments?

INCOSE International Symposium
Philadelphia, PA
June 24-27, 2013