

Human Centric Systems Engineering:

“Tackling the Wicked Problem.”

Joanne Thoms



Top Level Research Question:

Q. How could systems engineering seek to engineer the cognitive aspects of an autonomous system⁽¹⁾ such that we, at least, maintain human effectiveness?

Do we understand what the human's contribute?

(1): An Autonomous System is a system that contains machine components with advanced decision making capabilities.

Leading to Key questions for this Work:

- 1, How could a systems engineer recognise and capture the human cognitive contribution in a system?
- 2, Can we use this technology to understand how changes in one part of the system could impact the potential cognitive contribution of other parts of that system?

Contents

- Changing our Viewpoint on Systems
- An Engineering framework
- An Engineering Process

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Changing our Viewpoint on Systems

Definition of a System

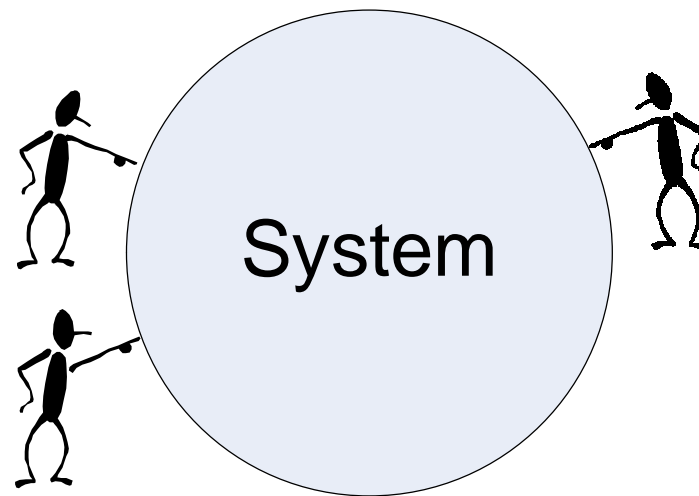
“A system is

that body which is considered as functioning unit,

which is formed of many often diverse parts

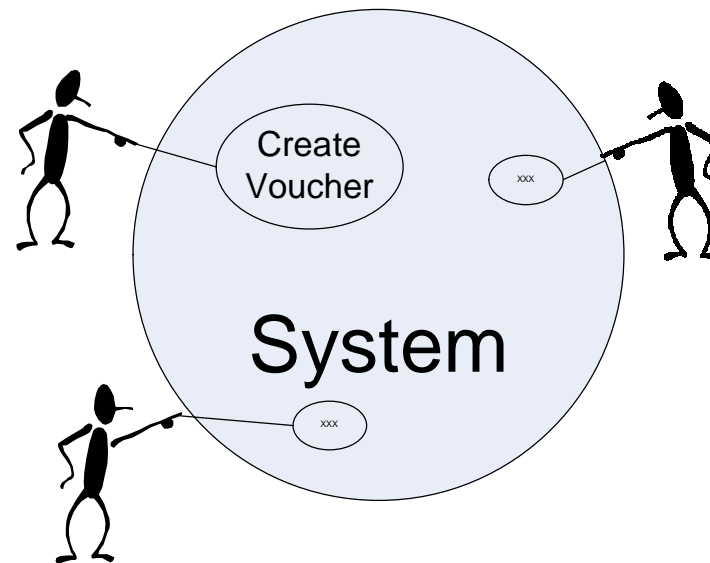
that achieves a purpose. “

A System



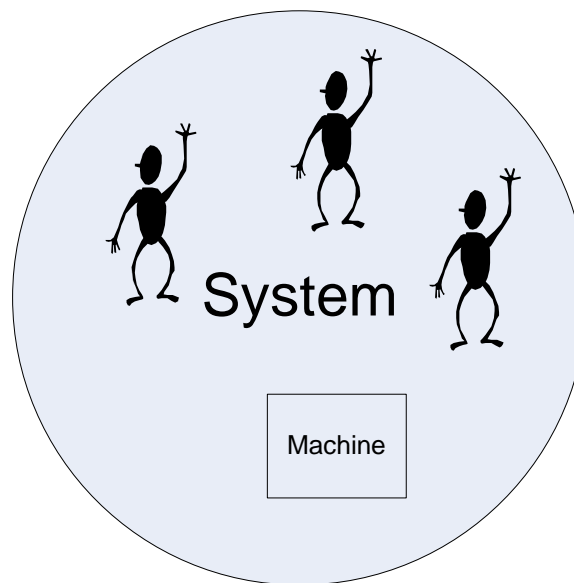
*99.9% of Systems require human interaction to achieve their purpose.
But humans are complex so we choose to place them outside the system*

Capturing the Human interaction: Use Cases



*Problem: This model does not capture the human/human interaction
= System Information flows*

Placing the Human contribution within the system bounds



Problem: What aspect of the humans should we capture?

An
Engineering Framework

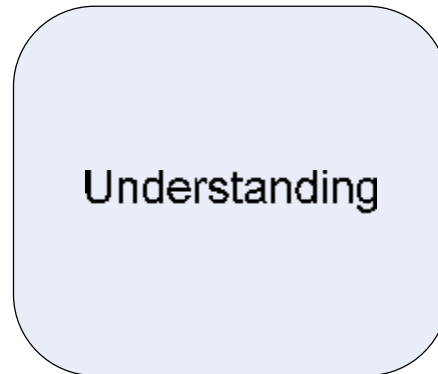
to capture the
cognitive contribution

Recognising the Human Cognitive Attributes: Awareness



The ability to conceive or perceive the current operational context..

Recognising the Human Cognitive Attributes: Understanding



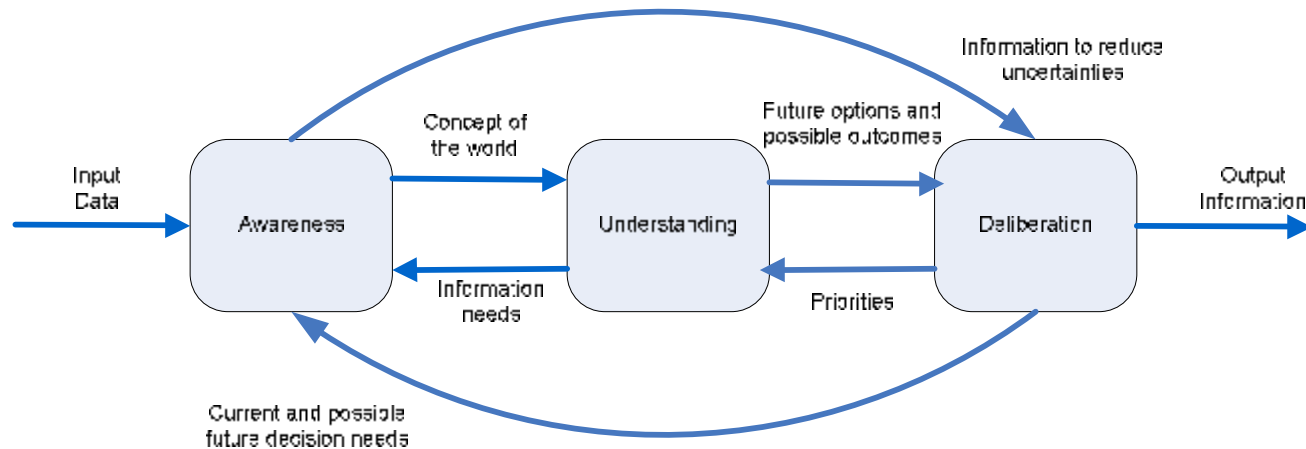
The ability to recognise relationships in the current context and their significance/affordance in light of the system purpose.

Recognising the Human Cognitive Attributes: Deliberation



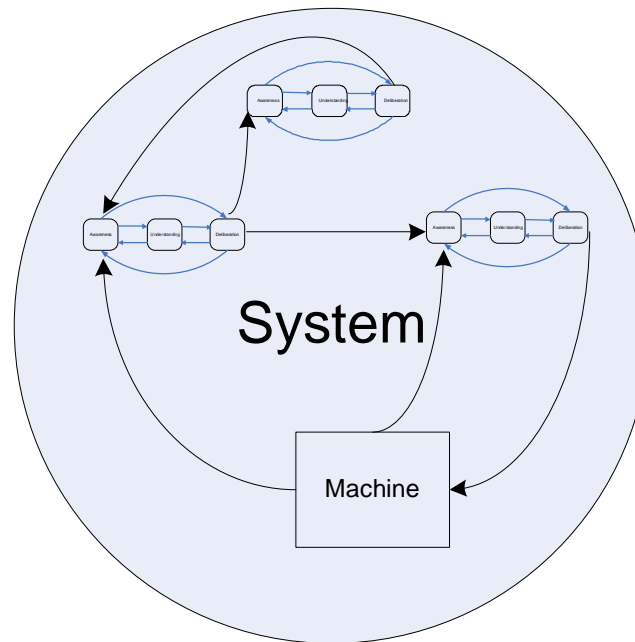
The ability to make suitable choices taking into account the n-dimensions that can alter the temporal and spatial future.

The information Flows between the Three Cognitive Capabilities



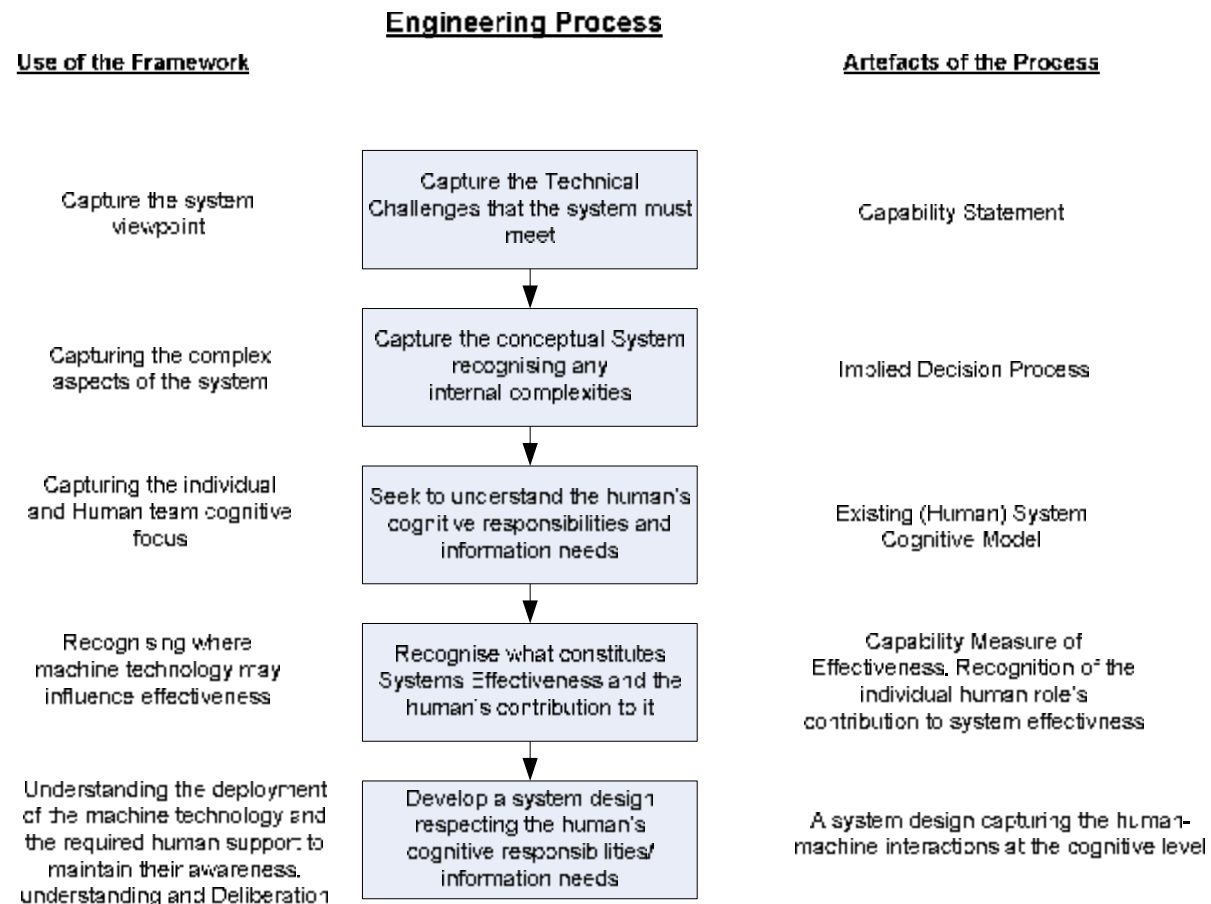
Provides an understanding of the human's information needs and the information they can provide

Provides a richer view of the system



An Engineering Process

How do we use it? An engineering process

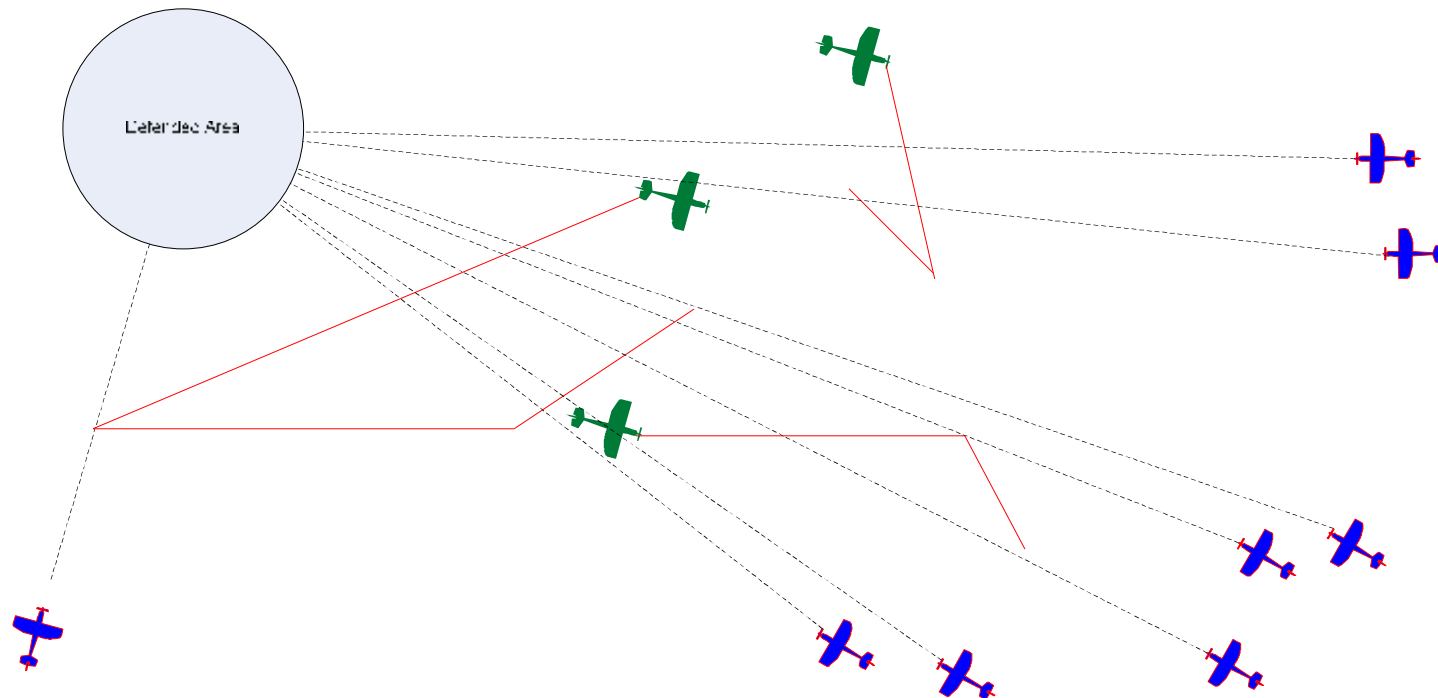


Example Study:

Investigating the
deployment of machine technologies
into an existing human system

Force Threat Evaluation and Weapons
Assignment

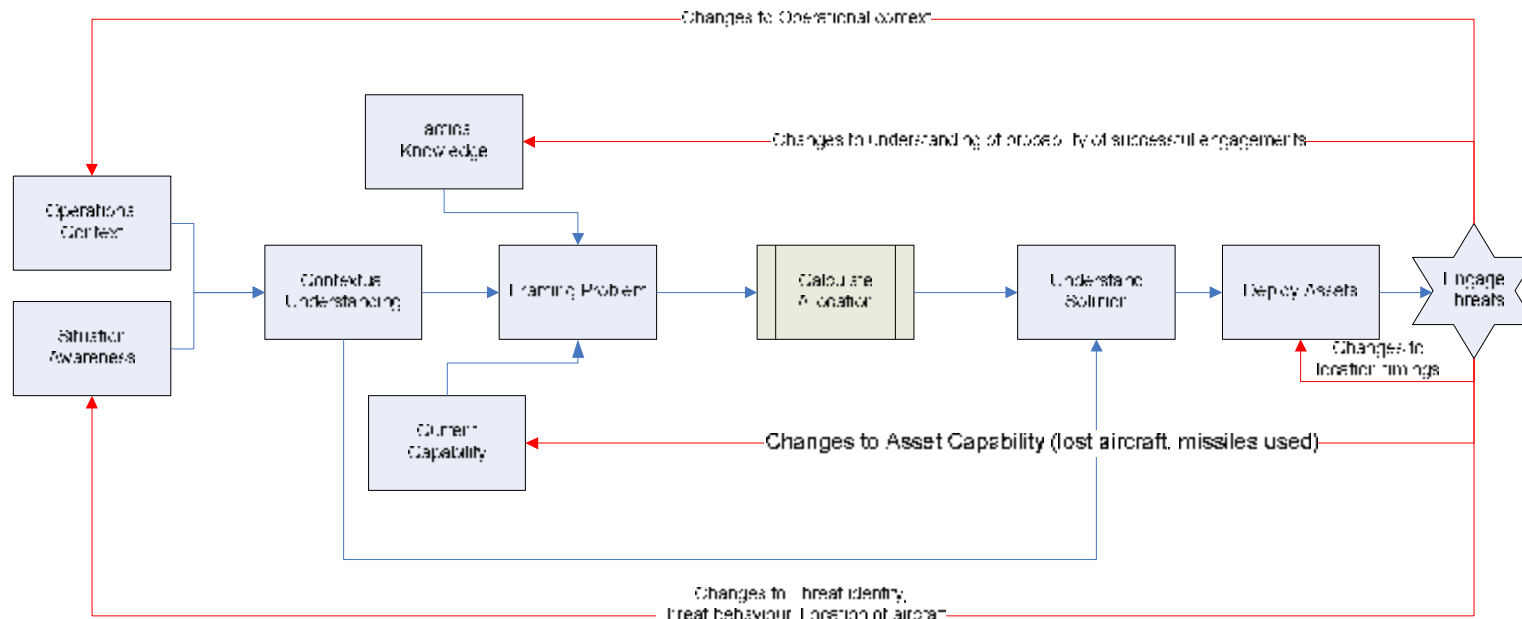
Example Application: FTEWA



Use of Imperial College's Stochastic optimisation for real-time air defence management..

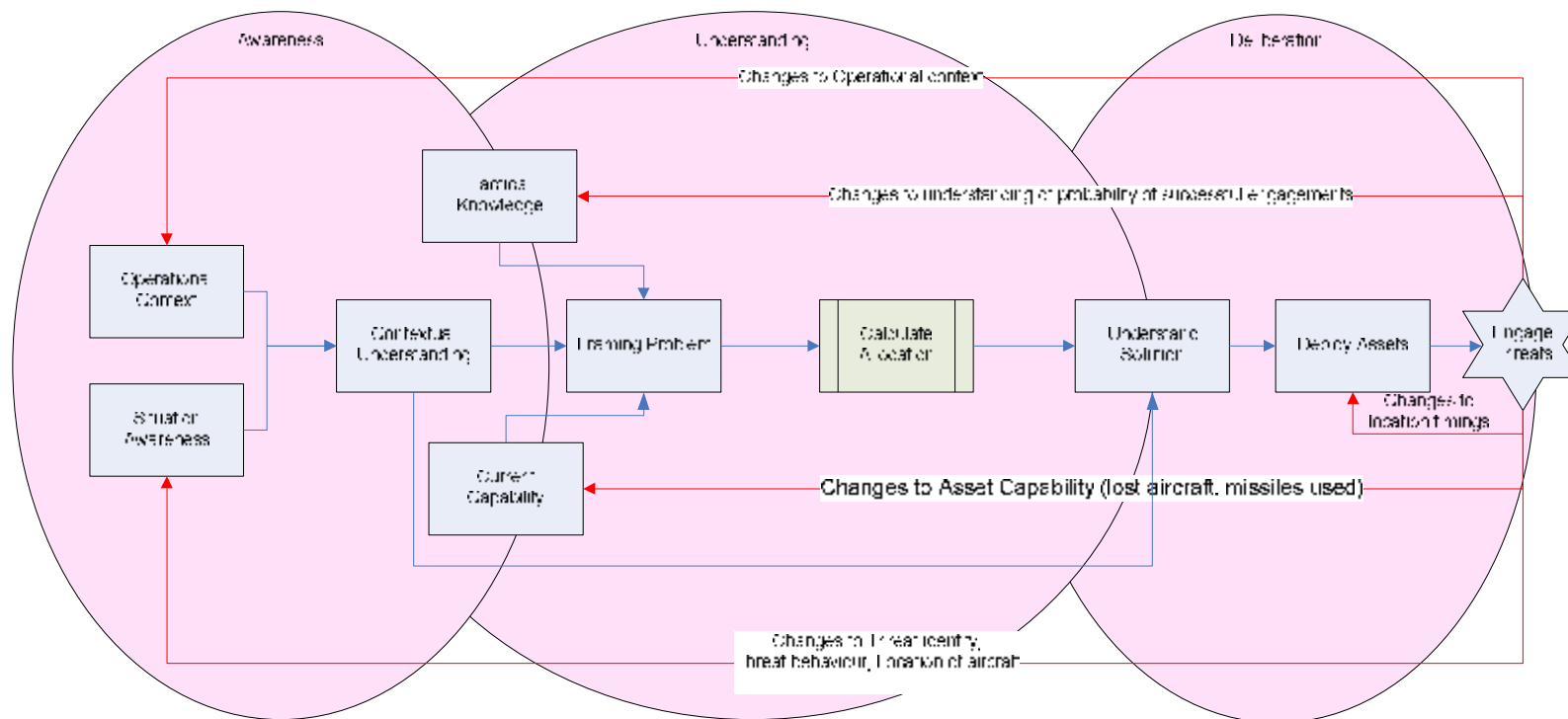
Characterise the System

Capture the Technical challenges and constraints that the system must meet.



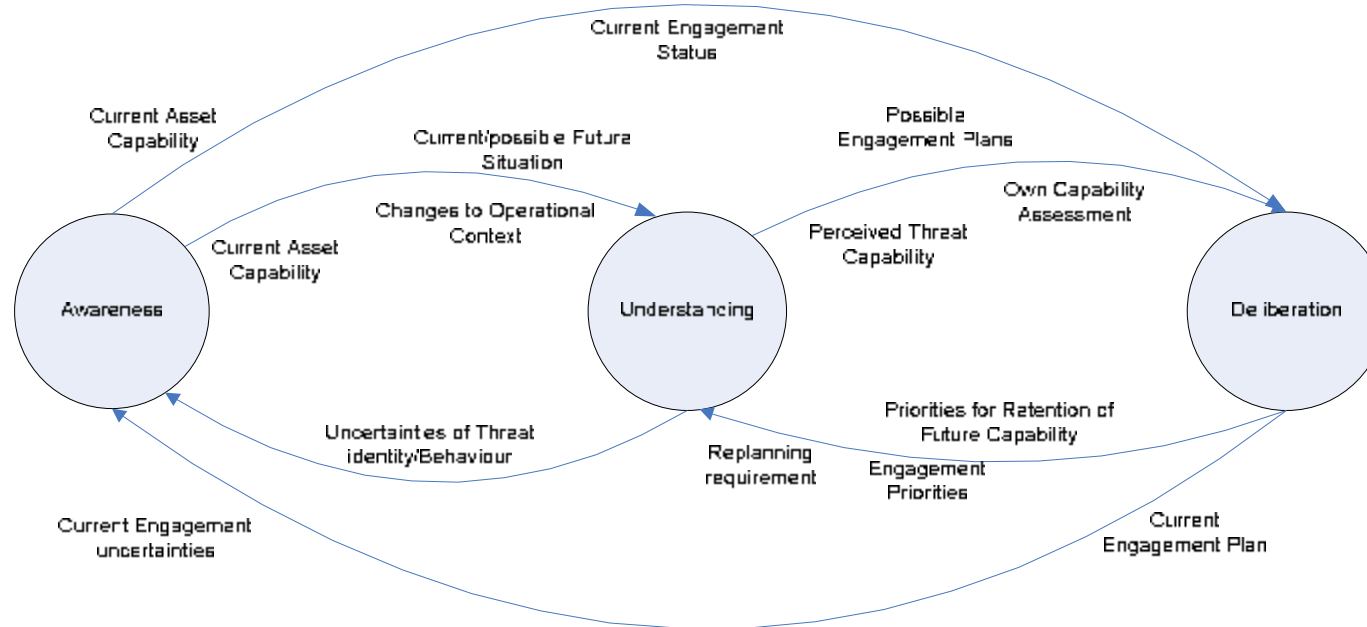
Characterise the System

Map to cognitive capabilities.



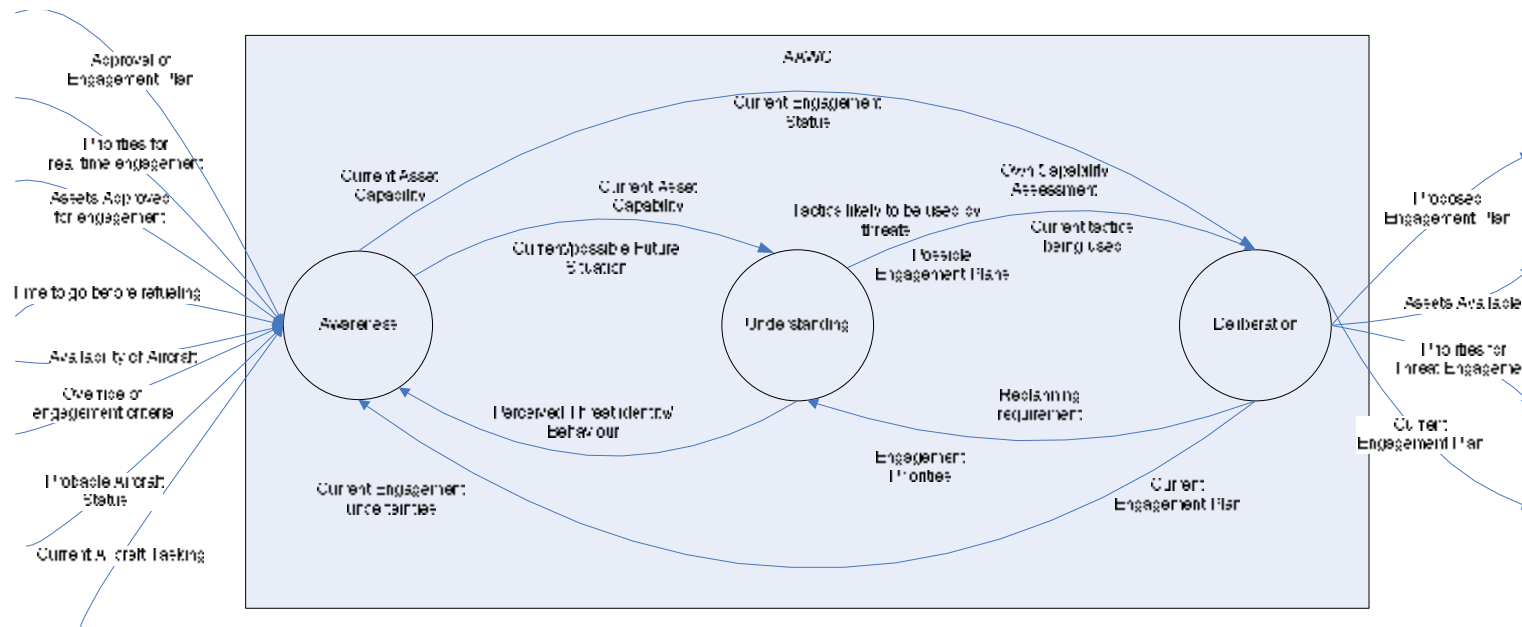
Characterise the System

***Capture as a Cognitive system,
capturing the complex relationships.***



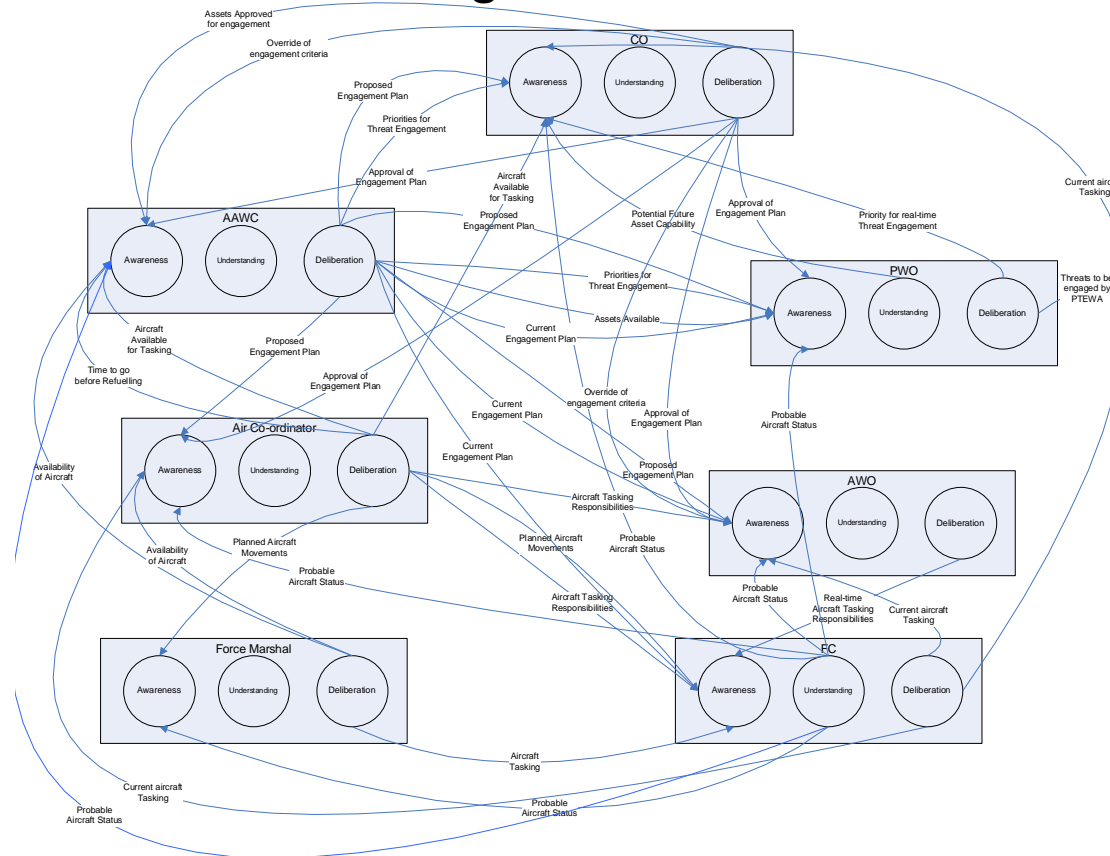
Capture the individual human and cognitive focus

Seek to understand the human's cognitive responsibilities and information needs.



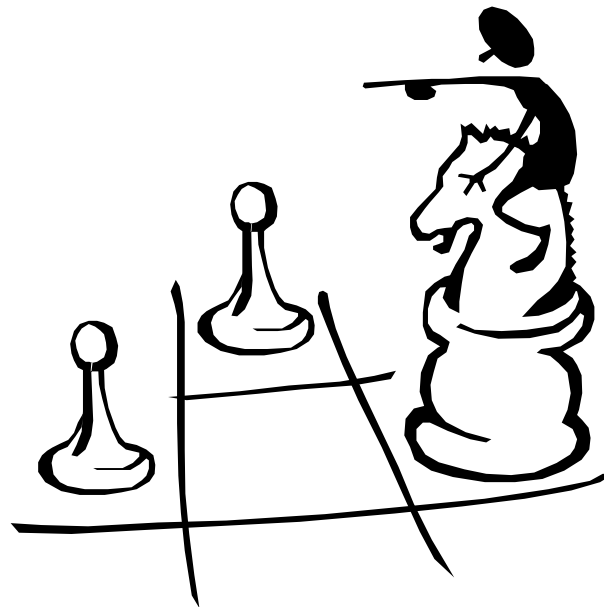
Capture the individual human and **team** cognitive focus

Join the individuals models together to form the team model:



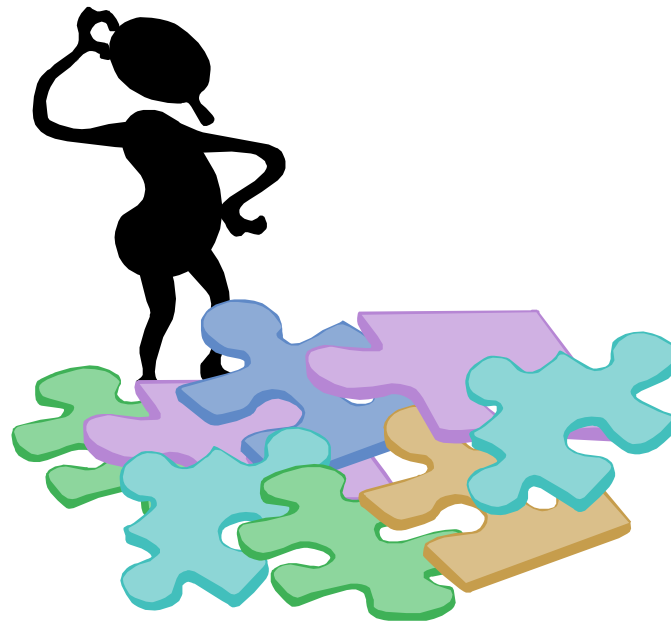
Recognise where new technologies may influence effectiveness

Recognise what constitutes system effectiveness and the humans contribution to it.



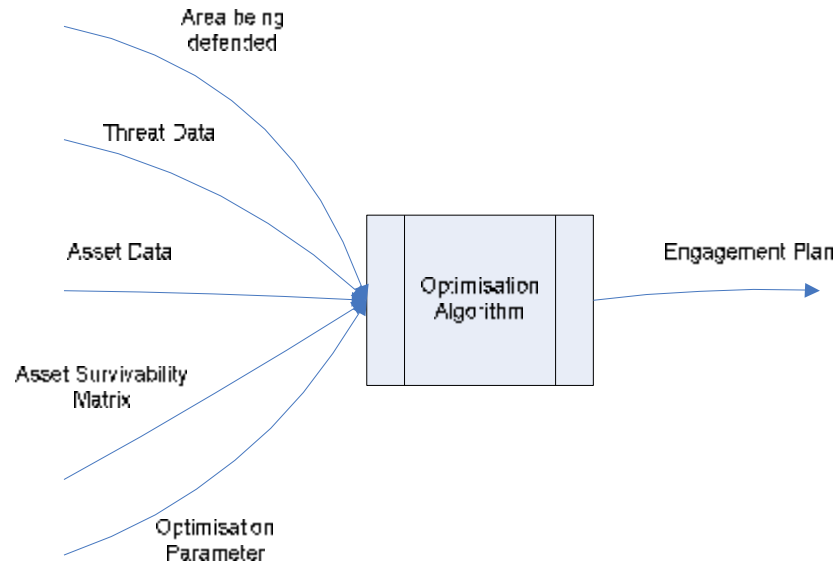
Understand the implications of the deployment of the technology

Develop a system design respecting the human's cognitive responsibilities/information needs.....



Understand the implications of the deployment of the technology

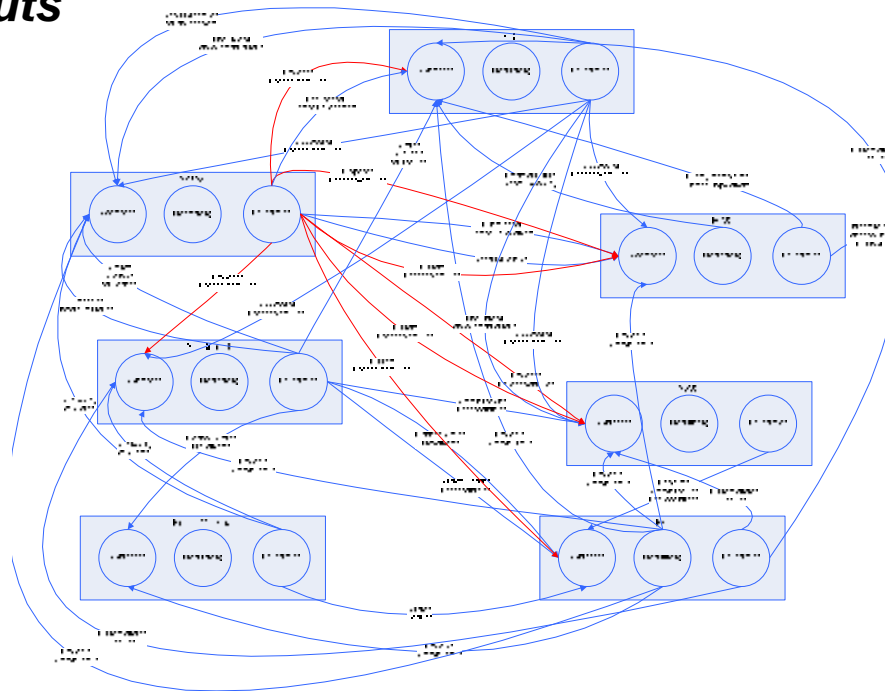
Recognise the machine technologies data requirements:



Understand the implications of the deployment of the technology

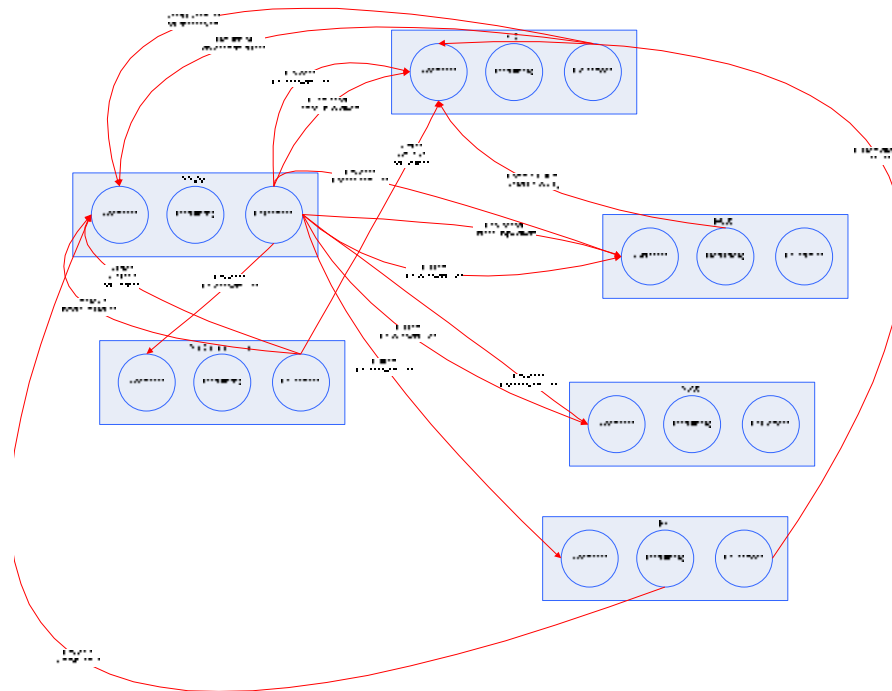
Identify them in the human team model.

E.g. The inputs



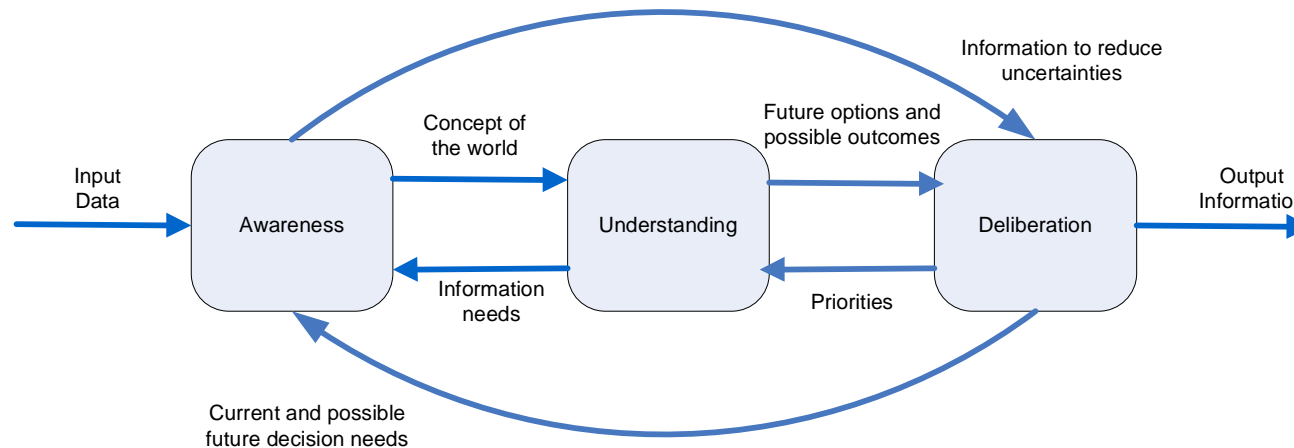
Understand the implications of the deployment of the technology

Simplify the model by removing all flows that should not be effected.



Take a human centric perspective:

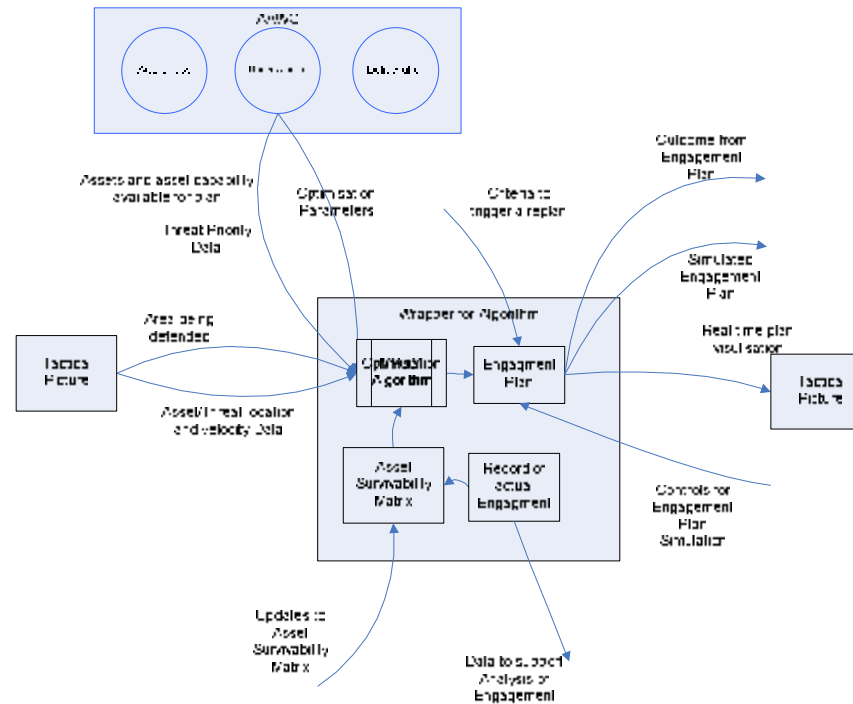
For each of the human roles investigate how the technology could impact/influence their Awareness, Understanding & Deliberation



Detect & Detail Mismatches, Look to find possible solutions

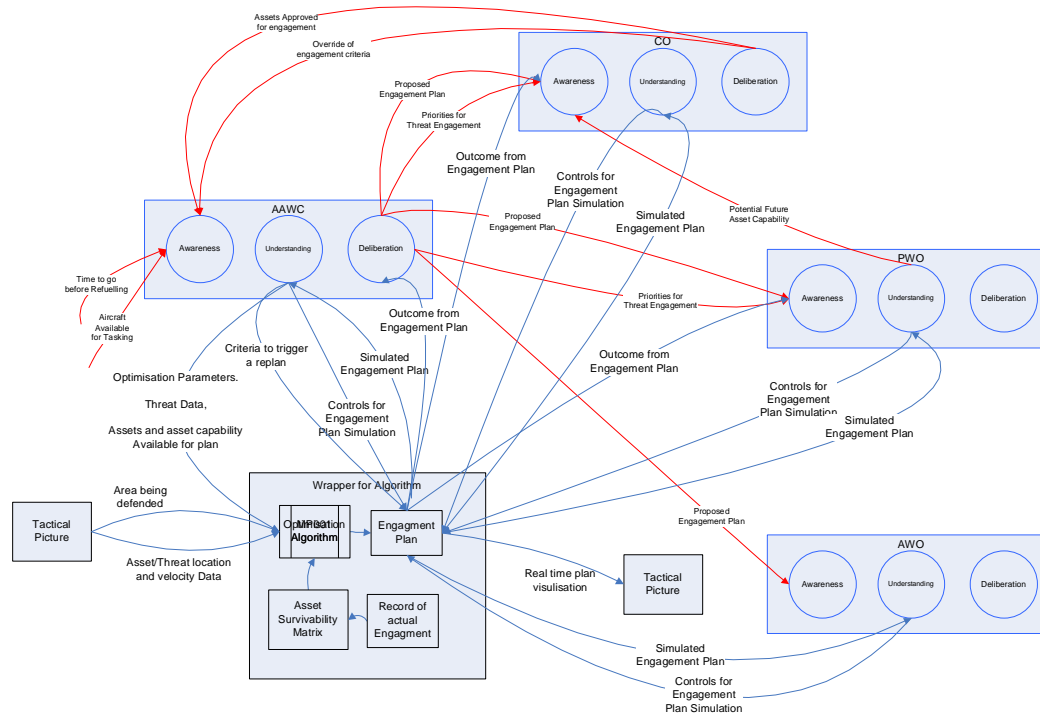
Take a human centric perspective

Investigate enhancements to the machine technology that would meet the human requirements.



Understand the implications of the deployment of the technology

Map the enhanced machine technology to the human team model, to understand Human Machine Information Exchange challenge:



Back to Traditional Systems Engineering..

Provide the Rich System Model to the System/Software Engineers to generate the non organic system element design

Provide the Human Factors team with the Human Centric Interaction Requirements with which to develop the HCI

.....

Outcome:

Enables us to understand the cognitive (decision) aspects of a system:

- As a conceptual cognitive system.
- For individual Roles
- As a human team view.
- As a rich system view, including machine technologies.

Provides the basis for investigating:

- Changes to the human team
- Deployment of advanced machine decision technologies.

Questions?



Outcome:

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