29th Annual INCOSE international symposium

Orlando, FL, USA

July 20 - 25, 2019

12 Principles for Systems Engineering Leaders

www.incose.org/symp2019

The authors

Duncan Kemp, CEng FIET

DE&S Fellow for Systems Engineering
Internal Technical Support Team Leader
Chief Systems Engineer
Engineering Group
Abbey Wood South, BS34 8JH
Tel: +44 (0)7966 146 724

Meaghan O'Neil

Director Systems Engineering
Product Risk Management Leader
Bigfoot Biomedical
1561 Buckeye Dr, Milpitas CA 95035

Chief Engineer
System Design and Strategy

Research, "Mesearch" and Action Research

"... theoretical foundation of systems engineering [that] encompasses not only mathematics, physical sciences, and systems science, but also ***human and social sciences****."* SE Vision 2025

"*[Action research]* ***doesn't follow the usual steps of research design familiar in conventional scientific research****"* The Action Research Planner

"Some in the research literature think that being an insider involves a penalty – not being able to see things in a disinterested or 'objective' way. By contrast, we believe that doing research in their ***own sites*** *and to* ***investigate practices that hold their work and lives together*** *in those sites –* ***the practices are*** **enmeshed** ***with those sites****"* The Action Research Planner

Key roles of the SE leader

- Making and sustaining the case for SE
- Establishing the right culture
- Selecting the right approach to deliver SE
- Aligning the SE processes to the wider business
- Growing an effective SE team
- Selecting and using appropriate methods and tools

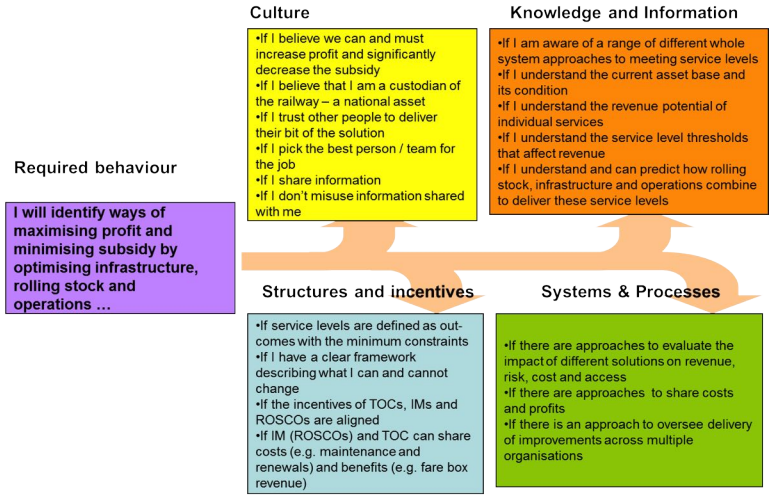
SE needs to be pulled by business needs, rather than pushed on the business

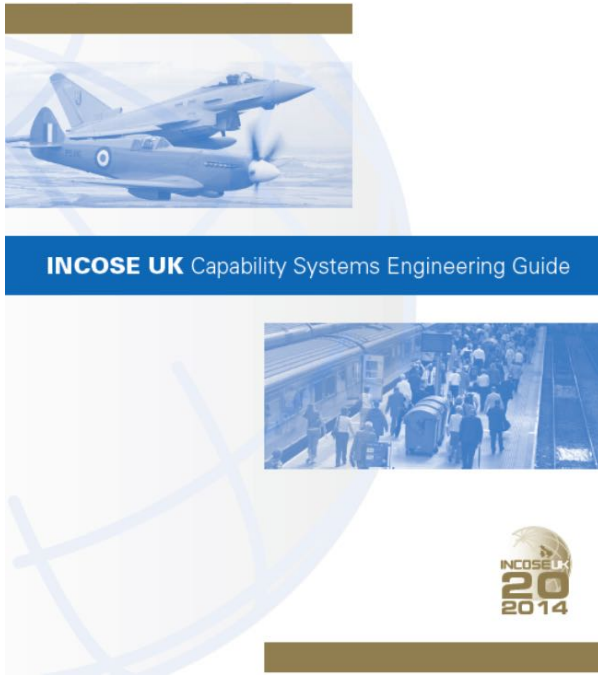
Organisational need	*Potential* SE contribution
Save money	Avoid overspends by better up-front design and planning
Get to market quickly	Avoid delays and rework by better design and planning
Be safe	Design out dangerous situations and have clear traceability from equipment failure up to unsafe states
Improve Performance	Clear traceability of component performance up to system performance
Be innovative	Better understanding of technical risk
Comply with regulations	Clear traceability of design/assurance decisions to regulatory requirements

"reduce costs by … better design and planning, including SE"

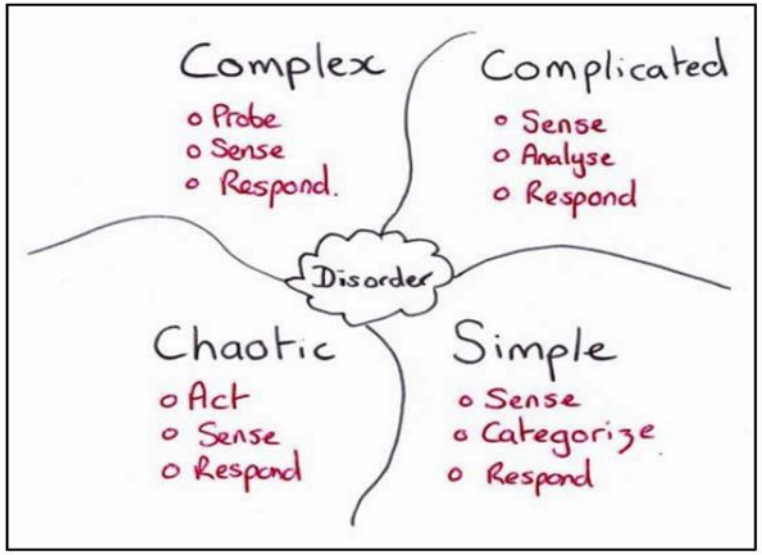
"implement SE … to reduce costs".

An SE capability needs to be a balance of culture, structures, process and people. If they are not aligned and in balance the capability will fail.





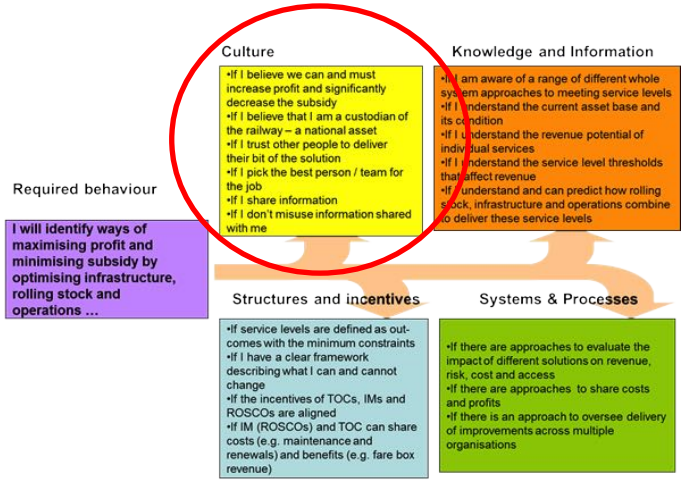
Understand the organization's culture and preferred management style. The SE capability must be capable of dealing with any misalignment between culture and the SE mindset.



	Know what we need to achieve	Don't know what we need to achieve
Know how we are going to deliver	Painting by numbers	Making movie
Don't know how we are going to deliver	Quest	Walk in the fog

		Approach taken to solve Problem			
		Simple	Complicated	Complex	Chaos
Problem Space Characteristics	Simple	Success – tasks done quickly, efficiently and consistently.	Inefficient – over use of process, generation of unwanted documentation and solution potentially over-engineered.	Inefficient – no economies of scale	Inefficient – no delegation, decision maker overwhelmed by detail.
	Complicated	Unsuccessful outcome – as system inter-depen-dencies and emergence not managed	Success – complicated interactions understood, emergence managed and large team coordinated.	Inefficient and possibly failure – as parallel approaches waste resources and subsequent phases engage in expensive rework.	Highly inefficient and probably failure – inter-dependencies unlikely to be understood by decision maker
	Complex	Unsuccessful outcome – stakeholders will diverge, change path will be undirected	Unsuccessful outcome – environment will change faster than the project can deliver. Project will continually restart.	Success – tempo of delivery matches environmental change, emergent behaviour managed.	Unsuccessful outcome – decision maker unable to sense changes in the environment quickly enough
	Chaos	Unsuccessful outcome – mechanistic approach unable to cope with unplanned situation.	Unsuccessful outcome – time taken to understand the problem results in increased instability. Stakeholders 'vote with their feet'	Unsuccessful outcome – parallel approaches insufficiently coherent to stabilise the situation.	Success – situation stabilised.

Build the culture of the SE capability by recruiting people who match the culture, establishing the right measures and incentives and excellent communications.

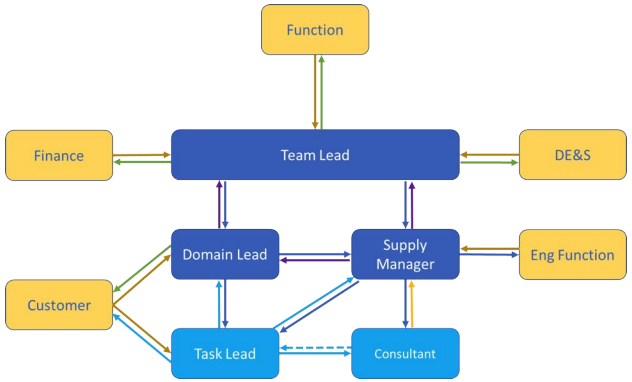


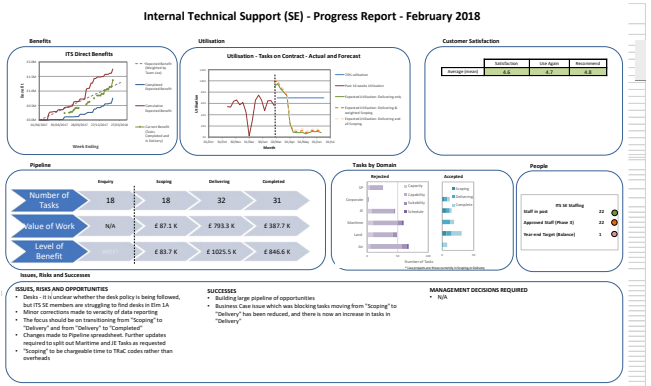
Leadership team objectives (Team Lead / Deputy)

#	What	Why	How	Support required
1	Develop and communicate team strategy	To ensure that the ITS SE team continues to meet the wider DE&S needs / direction / strategy	Maintain x-matrix **TL** Ensure service delivery plan is up to date **DTL** Monitor external environment for strategic threats and opportunities **TL** Resource and agree internal improvement tasks **DTL** Communicate strategic priorities and situation to enable team members to make optimised local decisions **TL**	**Everyone** to communicate issues, risks and opportunities to the leadership team **Everyone** to review and understand the x-matrix and service delivery plan **Supply managers** to deliver SQEP resources for internal improvement tasks
2	Monitor portfolio of tasks (client and internal)	To ensure that tasks are delivering as expected	Undertake domain portfolio reviews **DTL lead / TL attend** Undertake internal task portfolio review **TL** Inform supply side of issues, risks and opportunities **TL > DTL** Take control action as necessary **TL > DTL** Oversee the Quality Management process **TL**	**Domain leads** to discuss their updated portfolio status
3	Monitor health / morale of team	To ensure that the team is happy, capable of delivering current and future needs and capable of sustained delivery	Undertake team health reviews (i.e. stress scores ++) **Both** **Team Lead** act as client for internal improvement tasks **Deputy Team Lead** act as sponsor for internal improvement tasks	**Supply Managers to** discuss their team health status
4	Manage external stakeholders	To ensure that stakeholders are supporting (or don't disrupt) the team's effectiveness now and in the future	Develop and maintain the stakeholder management plan **TL** Planned and ad-hoc meetings with key stakeholders **TL** Resource and agree internal tasks **DTL**	**Domain leads and Supply Managers** to support development and maintenance of the stakeholder management plan
5	Provide visible leadership	To provide a visible, responsive and caring leadership presence	Arrange **(DTL)** and lead team away days **TL** Attend sub-team meetings **Both** Be present on the floorplate **Both**	

What do our stakeholders want?

- **Finance**
  - Opex savings
  - Cost recovery
- **Engineering function**
  - Cost savings
  - Capability growth
  - Support wider ITS growth
- **Clients/DTs**
  - Quick response
  - Quick on task
  - Quality delivery
- **Us**
  - Interesting work
  - Variety of tasks
  - Supporting armed forces

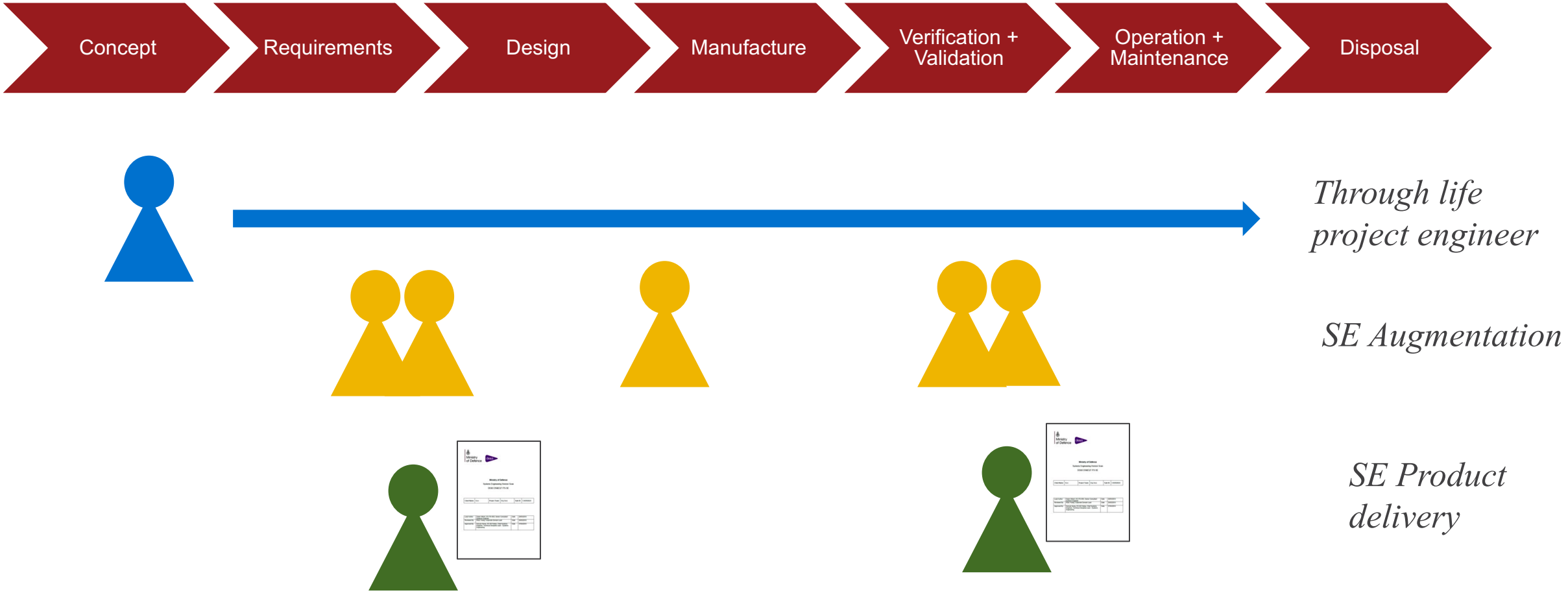




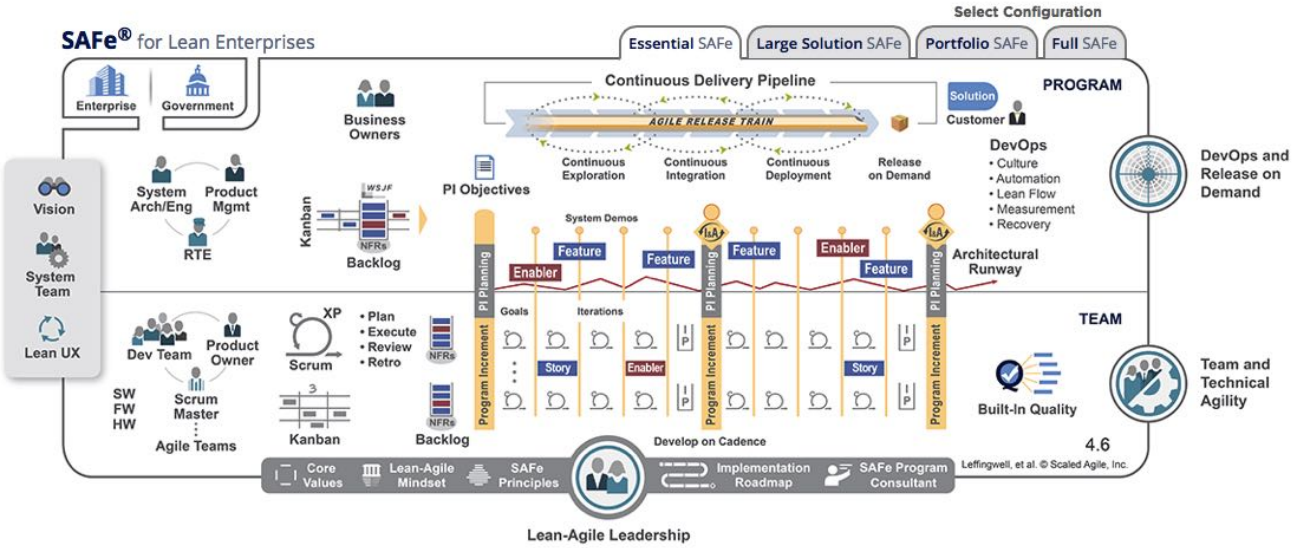
Communications needs to be consist and compelling using analogies and telling stories of the ‘heroes and villains’

The Battle of Britain story was *the* most important application of Systems Engineering in the 20th Century

Decide the appropriate team structure: embedded project engineers, SE augmentation or SE product delivery. Get the right balance between in-house employees and external contractors



Align the SE processes to the wider organizational processes.



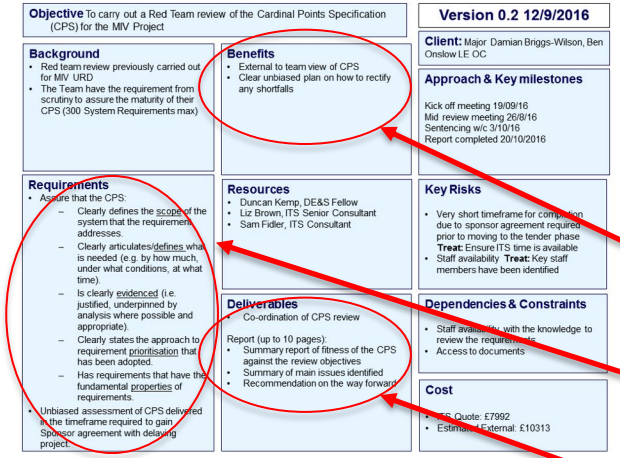
https://www.scaledagileframework.com/

Tailor the production of SE products by applying SE to each SE task: who are the stakeholders, what does the product need to do, how will we judge success?

Scoping

Accept & Close

Execute & Monitor



Objective To carry out a Red Team review of the Cardinal Points Specification (CPS) for the MIV Project

Version 0.2 12/9/2016

Client: Major Damian Briggs-Wilson, Ben Onslow LE OC

Background
- Red team review previously carried out for MIV URD
- The Team have the requirement from scrutiny to assure the maturity of their CPS (300 System Requirements max)

Benefits
- External to team view of CPS
- Clear unbiased plan on how to rectify any shortfalls

Approach & Key milestones

Kick off meeting 19/09/16
Mid review meeting 26/8/16
Sentencing w/c 3/10/16
Report completed 20/10/2016

Requirements
- Assure that the CPS:
  - Clearly defines the scope of the system that the requirement addresses.
  - Clearly articulates/defines what is needed (e.g. by how much, under what conditions, at what time).
  - Is clearly evidenced (i.e. justified, underpinned by analysis where possible and appropriate).
  - Clearly states the approach to requirement prioritisation that has been adopted.
  - Has requirements that have the fundamental properties of requirements.
- Unbiased assessment of CPS delivered in the timeframe required to gain Sponsor agreement with delaying project.

Resources
- Duncan Kemp, DE&S Fellow
- Liz Brown, ITS Senior Consultant
- Sam Fidler, ITS Consultant

Key Risks
- Very short timeframe for completion due to sponsor agreement required prior to moving to the tender phase **Treat:** Ensure ITS time is available
- Staff availability **Treat:** Key staff members have been identified

Deliverables
- Co-ordination of CPS review

Report (up to 10 pages):
- Summary report of fitness of the CPS against the review objectives
- Summary of main issues identified
- Recommendation on the way forward

Dependencies & Constraints
- Staff availability with the knowledge to review the requirements
- Access to documents

Cost
- TS Quote: £7992
- Estimated External: £10313

Benefits

Requirements

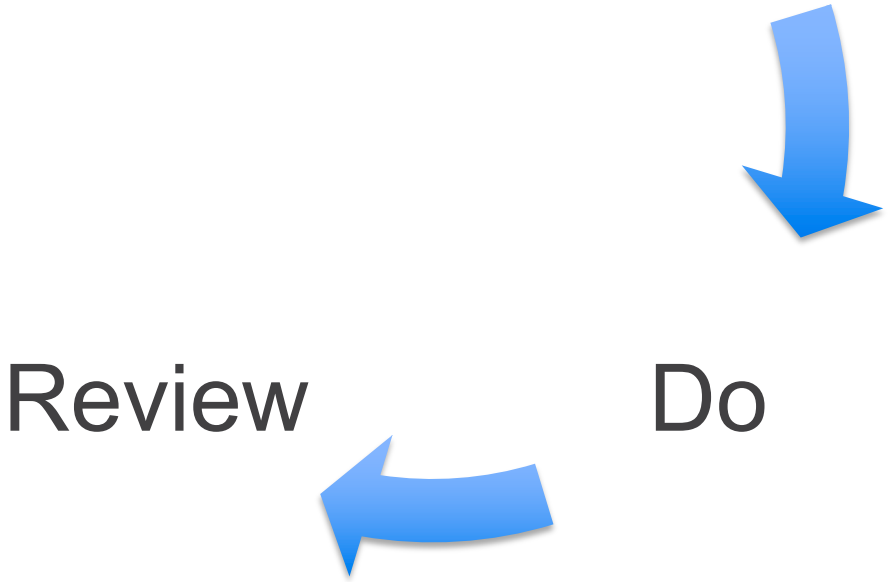
Deliverables

Plan On A Page – what, why, when, how, who, …

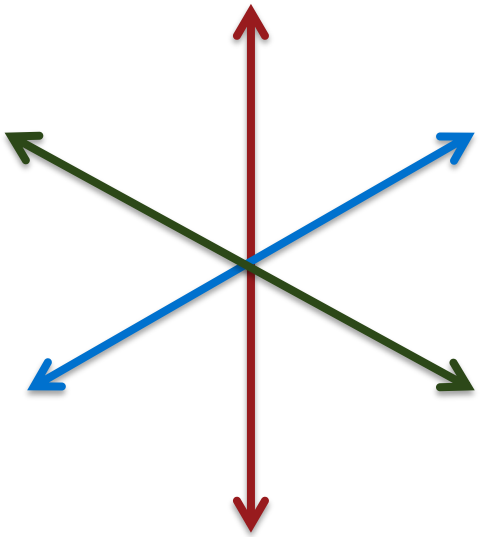
Ministry of Defence

Deliverables as per Plan on a Page

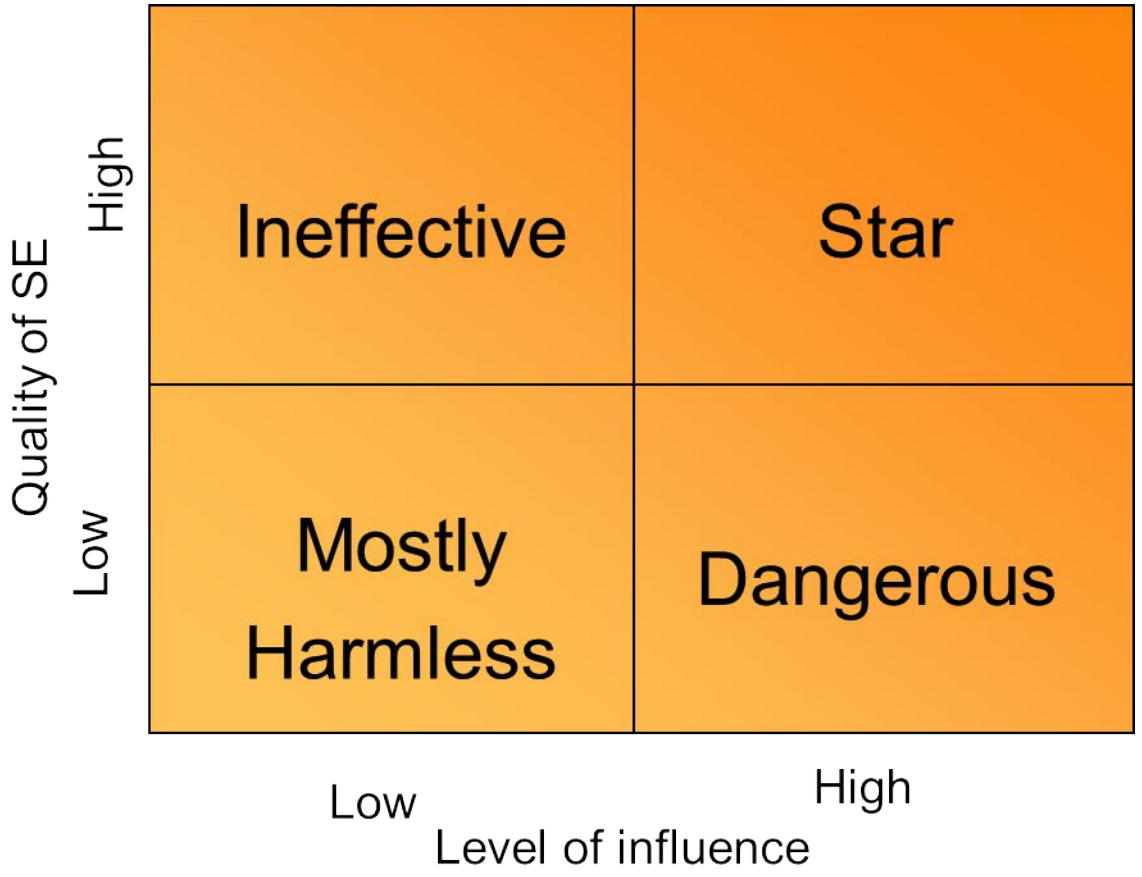
Include a ‘play’ phase before any planning to explore the level of tailoring needed.



Degrees of freedom

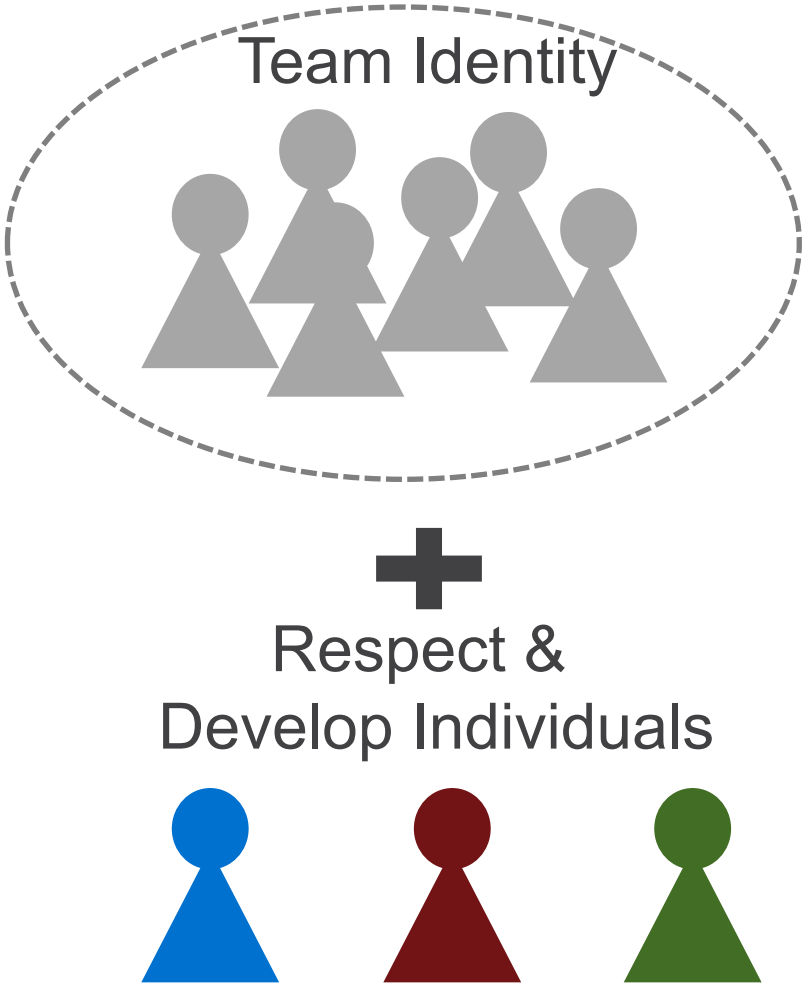


Select Systems Engineers with an appropriate blend of technical and interpersonal skills

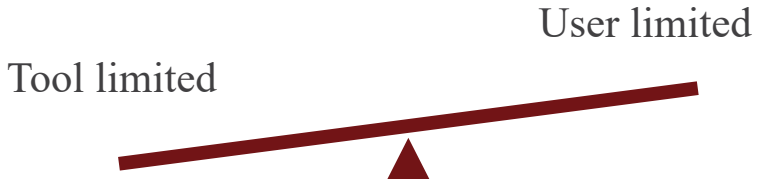


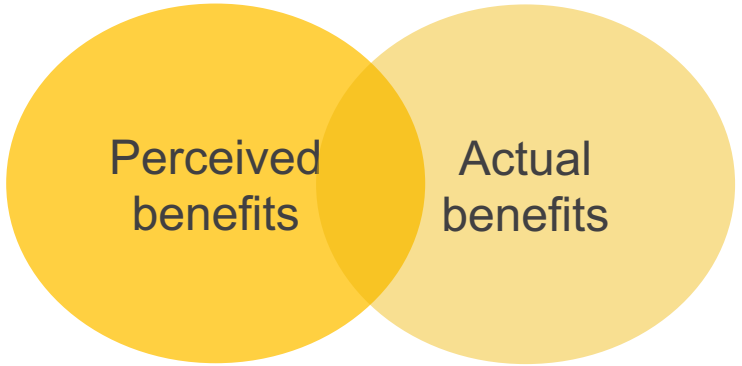
- Technical Skills
- Role experience
- Soft Skills
- Industry/Domain Knowledge

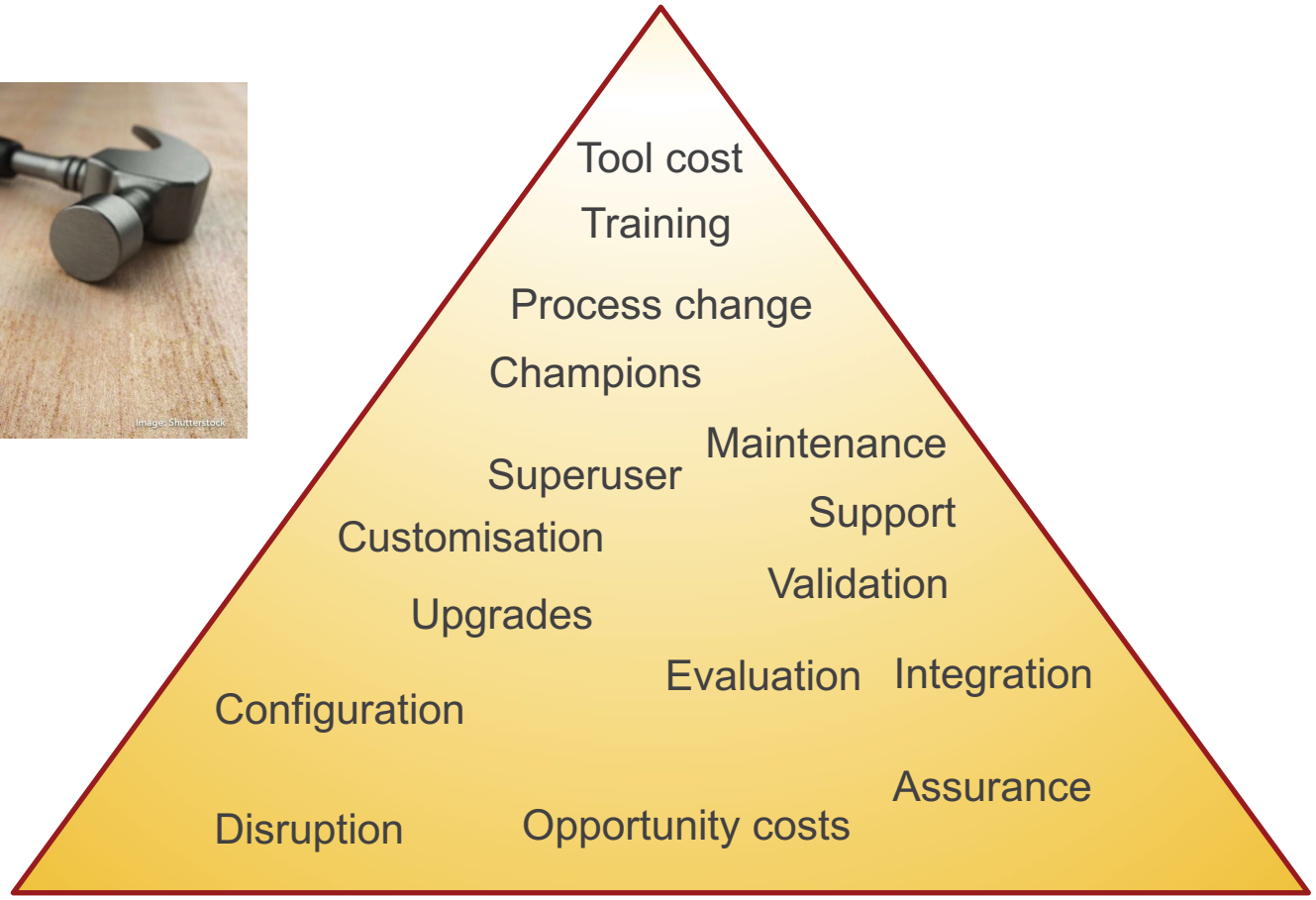
Use a model (such as High Energy Teams) to help everyone understand what they are doing, why they are doing it and how they are doing it?



Methods and tools are critical, but they are only a means to an end. Focus on the end result and implement the simplest to meet that need.







"Tool costs are typically 10% of total costs"

12 principles for SE leaders

1. SE needs to be pulled by business needs, rather than pushed on the business
2. An SE capability needs to be a balance of culture, structures, process and people. If they are not aligned and in balance the capability will fail
3. Understand the organization's culture and preferred management style. The SE capability must be capable of dealing with any misalignment between culture and the SE mindset
4. Build the culture of the SE capability by recruiting people who match the culture, establishing the right measures and incentives and excellent communications
5. Communications needs to be consist and compelling using analogies and telling stories of the 'heroes and villains'
6. Decide the appropriate team structure: embedded project engineers, SE augmentation or SE product delivery. Get the right balance between in-house employees and external contractors
7. Align the SE processes to the wider organizational processes
8. Tailor the production of SE products by applying SE to each SE task: who are the stakeholders, what does the product need to do, how will we judge success?
9. Include a 'play' phase before any planning to explore the level of tailoring needed.
10. Select Systems Engineers with an appropriate blend of technical and interpersonal skills
11. Use a model (such as High Energy Teams) to help everyone understand what they are doing, why they are doing it and how they are doing it?
12. Methods and tools are critical, but they are only a means to an end. Focus on the end result and implement the simplest to meet that need.

29th Annual INCOSE international symposium

Orlando, FL, USA

July 20 - 25, 2019

www.incose.org/symp2019