



Funding for Life: When to Spend the Acquisition Pot

Panel # 22 “Systems Engineering for Project Success” 13 May 2010

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Why does DSTL exist?

- Lead and support the defence science and technology (S&T) community in responding to MOD's current and future needs.
- Act as MOD's S&T agent and provides the single S&T focus.
- Work with industry and academia to increase the S&T impact.
- Work with Other Government Departments to exploit our expertise and knowledge.
- Enhance the safety and security of UK citizens and interests.
- Provide independent and impartial advice.
- Accountable to Government / taxpayer / front line troops



Terrain following in the vicinity of Snowdonia.

The Pentagon, in Washington
© Getty Images



Working conditions in the High Mojave Desert, at Fort Irwin, California

Maximising the impact of science and technology for the defence and security of the UK



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The Acquisition Pot

- UK MoD spends £2.6Bn/year on research and development
- £500m on laboratory research
- UK NAO shows ~50% project overruns are due to late technology maturation
- US evidence shows technology matured prior to Main Gate results in small time and cost overruns
- Paper examines funding profiles as aligned to maturity levels of technology, system and integration readiness



Funding for Life: When to Spend the Acquisition Pot?



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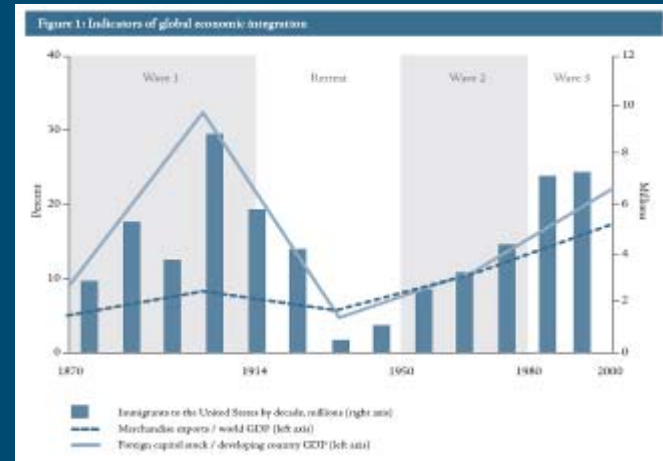
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When is the best time to spend – globally?

- Global economic growth (trend rate of 3-4%) has been driven by globalisation over the last 30 or more years ¹. We now operate in a multi-faceted economic landscape that is intimately interconnected and influential.
- In Sept 2009, the UK Chancellor of the Exchequer forecast that in April 2010 public borrowing would exceed 12% of GDP ²
- UK Spending plans from 2011 will be *“very tough – the toughest for decades”* but refused to outline how this will affect public services, except to say that the Government would *“protect spending on those frontline public services on which we all depend”*.
- In the US, the current focus has been on the US Health systems and associated reforms.
- In the UK, balancing the books and the impending election process has raised the level of scrutiny and resulted in long term plans being put on hold until the political direction and stability have been secured ³



1. International Monetary Fund (IMF) (2008), "World Economic Outlook (WEO) 2008: Financial Stress, Downturns, and Recoveries", October 2008, pp 3 – 44. Retrieved October 16, 2008 from <http://www.imf.org/external/pubs/ft/weo/2008/02/pdf/text.pdf>
2. The Economist, "Britain's sharp budget choices", published on Sep 24th 2009, From The Economist print edition <http://www.economist.com>
3. Ravlin, A.M. and Swahill, I.V. (2004), "Restoring fiscal sanity: how to balance the budget", Library of Congress Cataloging-in-Publication, The Brookings Institution, Washington DC. Chapter 6 "Meeting the Revenue Challenge" by Henry J Arron, William G. Gale and Peter R Orszag, Pg 111 - 127 www.brookings.edu ISBN 0-8157-7781-7

“balancing the books”



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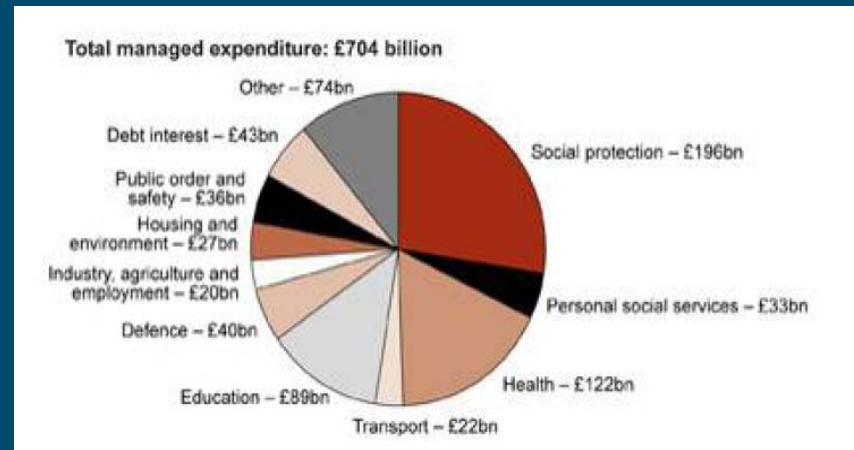
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When is the best time to spend – nationally?

- Global economic context places more pressure on all dimensions of UK government funding,
- UK Defence spending is £40bn, which represents 5.6% of the £704bn total ¹
- Defence planning is a long term activity
- Success related to the stability of the aims and contributory components
- In the current global and national climate, it is not a good time to spend, however
- ... to maintain capability in defence and other sectors, spending has to be sustained to ensure stability and maintenance; some projects are committed by still under development and some projects are further down the in-service and support stage



¹ The Economist, "HM Treasury 2010-11 Near Cash Projections" published on Mar 18th 2010, From The Economist print edition <http://www.economist.com>

Defence spending has to be sustained to ensure stability and maintenance



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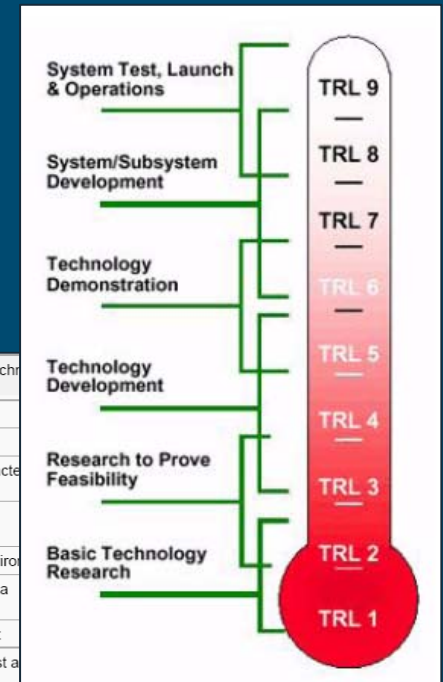


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Technology, System and Integration Investment

- Examine costing profile as related to three system measures of readiness:
 - Technology Readiness Levels (TRLs)**
 - can be used to determine the current component maturity
 - System Readiness Levels (SRLs)**
 - project management tool to capture evidence, and assess and communicate system maturity
 - Integration Readiness Levels (IRLs)**
 - System of System (SoS) integration level
- Measurements are interrelated but independent sets of assessment ^{1, 2}

National Aeronautics and Space Administration (NASA) Technology Readiness Level	
1. Basic principles observed and reported	TRL 1
2. Technology concept and/or application formulated	TRL 2
3. Analytical and experimental critical function and/or characteristic proof of concept	TRL 3
4. Component and/or breadboard validation in laboratory environment	TRL 4
5. Component and/or breadboard validation in relevant environment	TRL 5
6. System/subsystem model or prototype demonstration in a relevant environment (ground or space)	TRL 6
7. System prototype demonstration in a space environment	TRL 7
8. Actual system completed and 'flight qualified' through test and demonstration (ground or space)	TRL 8
9. Actual system 'flight proven' through successful mission operations	TRL 9



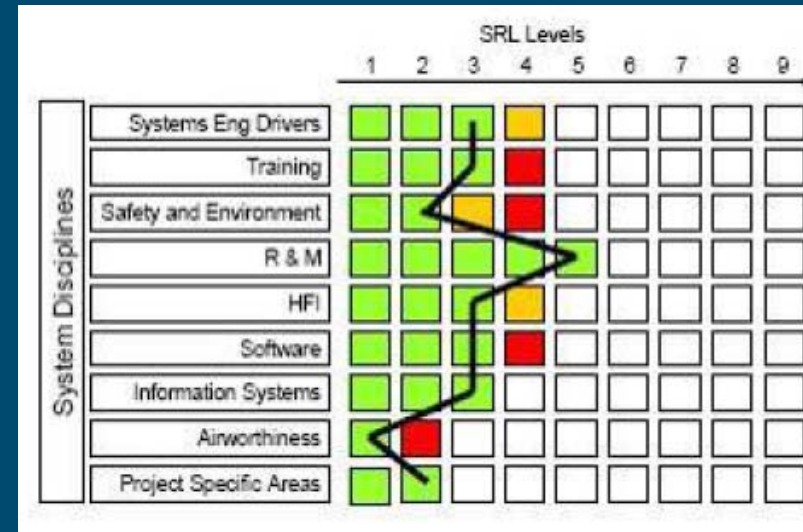
¹ "Systems Engineering Leading Indicators - Enabling Assessment of Acquisition Technical Performance", Paul Montgomery and Ron Carlson, Naval Postgraduate School

² "System Capability Satisficing in Defense Acquisition via Element Importance Measures" Brian Sauser, Jose Ramirez-Marquez, David Nowicki, Weipiong Tan, Romulo Magnaye, Matin Sarfaraz, Stevens Institute of Technology; and Abhi Deshmukh, Texas A&M University

Project maturity at technology, component, sub-system and whole system levels

System Readiness Level (SRL) matrix

- Projects track their maturity through the nine SRL steps
- Across all relevant system disciplines
- Red, Amber, Green (RAG) notation.
- Simple self assessment tool
- Produces a 'signature' rather than an absolute SRL figure.
- Linked to a specific time in the life of the project, and so represents a snapshot of maturity.



Note:

Each box on the matrix represents a Key Output for that system discipline. The colours represent:

Green: full achievement of the required outputs

Amber: some shortfalls in the required outputs

Red: significant shortfall in the required outputs.

Presents a snapshot of project maturity based on system readiness levels

Wall Matrix of Readiness Levels

- Wall matrix view of TRL, SRL, and IRL
- Any project, of any complexity can be evaluated using the wall matrix construct.
- Need to assess “time now” wall matrix assessments as related to the costing lifecycle

IRL LEVELS	1	2	3	4	5	6	7	8	9
SOS INTEGRATION	Yellow								
SRL LEVELS	1	2	3	4	5	6	7	8	9
SYSTEMS ENG DRIVERS	Green	Green	Yellow						
TRAINING	Green								
SAFETY AND ENVIRONMENT	Yellow								
RELIABILITY AND MAINTAINABILITY	Yellow								
HUMAN FACTORS INTEGRATION	Green	Green							
SOFTWARE	Green								
INFORMATION SYSTEMS	Green								
CERTIFICATION	Yellow								
PROJECT SPECIFIC AREAS	Green								
TRL LEVELS	1	2	3	4	5	6	7	8	9
COMPONENT 1	Green	Green							
COMPONENT 2	Yellow								
COMPONENT 3	Green	Green	Green						
COMPONENT 4	Green	Yellow							

← IRL

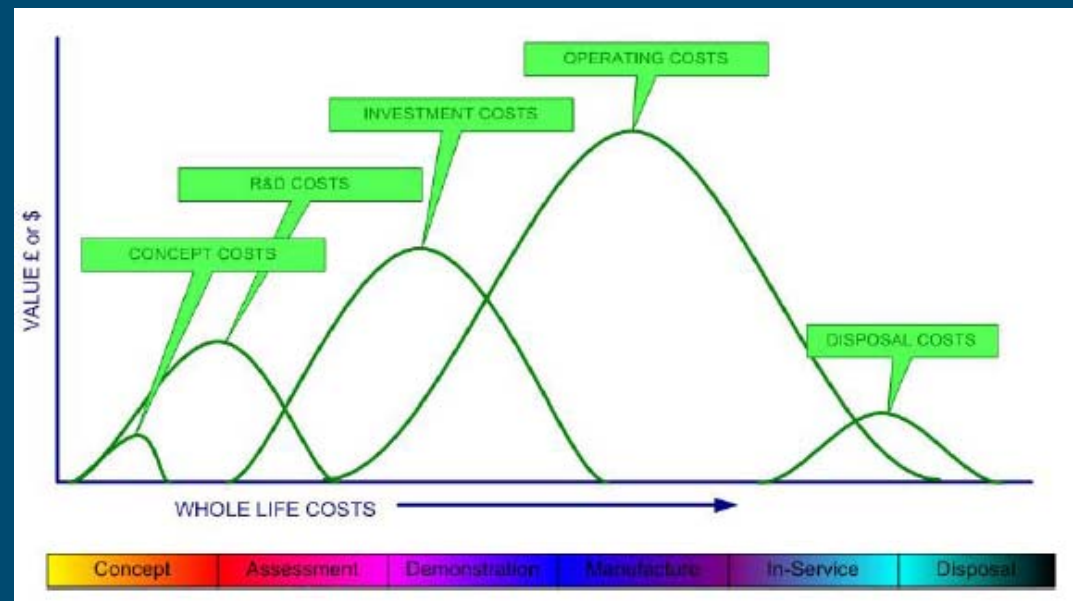
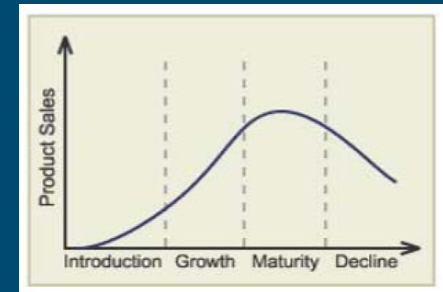
← SRL

← TRL

Presents a snapshot of project maturity based on a combination of readiness levels

Costing Life Cycle

- All costs arising from owning, operating, maintaining and disposing of are considered ¹
- Nested costing lifecycle
- Profiled against UK CADMID² acquisition lifecycle stages
- Funding contribution timing with relation to the peak affects stage success outcome



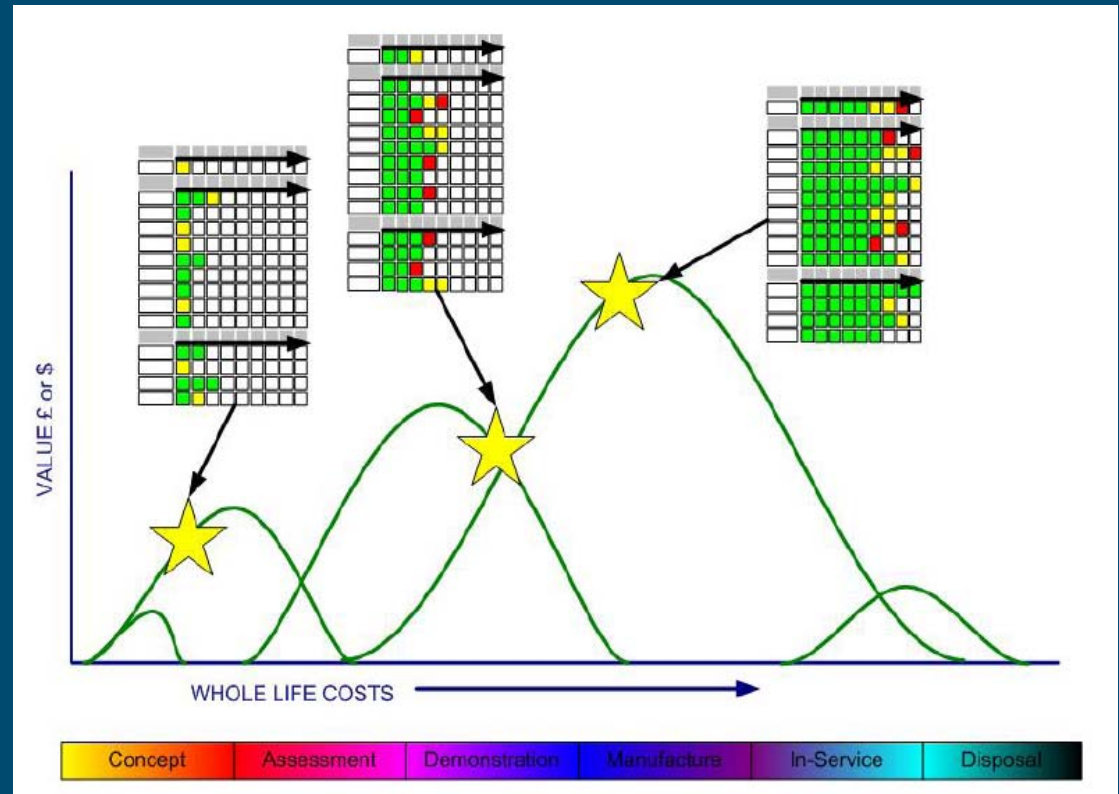
¹ Gorhcells, L. (2000) "The Product Manager's Handbook: The Complete e Management Resource, 2nd Edition, McGraw-Hill, London.

² CADMID - Concept, Assessment, Demonstration, Manufacture, In-Service and Disposal.

Method of project representation, in which all costs arising from a project are considered

Costing Case Studies

- August 2009 and March 2010, twelve projects were researched for source data
- The aim was to provide source data that could be *validated by the authors*, and by a *technical judgment panel* of engineers and scientist proficient with the UK acquisition lifecycles and level assessments
- The projects were assessed against their known timeline, the theoretical costing lifecycle, published costs and associated panel TRL, SRL, IRL assessments
- Each project was assessed at various points in its lifecycle



12 projects were assessed against the costing and the three maturity criteria.

Overview and Conclusions

- **Systems engineers** often serve as technical points of contact throughout the entire system lifecycle - *they are the single point of “project truth”*
- “**Limit point**” was established where investments in a particular stage added benefit to a TRL, SRL, IRL
- “**Optimum investment date**” could not be established using the limited number of studies – *more to follow ...*
- *Conclusion - mapping the optimum investment point against the TRL, SRL, IRL wall matrix could guide the diversion of funds into projects up to key points.*

	TRL point of significance	SRL point of significance	IRL point of significance
CONCEPT	< 3.2	< 2.4	N/A
ASSESSMENT	< 5.6	< 6.5	< 1.8
DEMONSTRATION	< 7.6	< 7.8	< 4.4
MANUFACTURE	< 8.1	< 8.4	< 8.2
IN-SERVICE	N/A	N/A	< 9.0

Individual CADMID stage investment limit points identified – but not “optimised”

[dstl] Questions?

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