

Optimise

Issue 3
July 2019

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Heads for the
Clouds

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Assurance for the
Rail Industry

10 Improved
Productivity through
Systems Engineering

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for the Software & Systems
Engineering Community*



SYSTEMS ENGINEERING FOR INFRASTRUCTURE, MAINTENANCE & ENGINEERING DEVELOPMENT IN THE RAIL INDUSTRY

— CONSULTANCY | SERVICES | TRAINING | TOOLS —

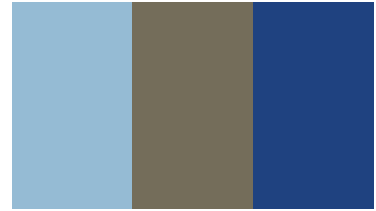


Improved Efficiency and
Competitiveness through Systems Engineering Excellence

SYSTEMS INTEGRATION | REQUIREMENTS MANAGEMENT

SUPPLY CHAIN MANAGEMENT | STANDARDS & SAFETY COMPLIANCE

SYSTEMS ASSURANCE



Letter from the MD

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Summer 2019: Issue 3

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Systems Engineering...the Rail-way!

Don't work in Rail? This magazine is still for you!

Dear colleagues and customers,

The customer successes we have seen in our Systems Engineering business come, in some part, from the fact that we work with a range of different organisations across varied industries giving us unique insight and expertise which we then feed back into customer projects.

During the first half of 2019 we saw an increased demand for our services within the Rail Industry- we have been helping high profile players implement tools and practices to manage, implement and accelerate huge infrastructure projects.

As such, we have themed this latest issue of OptimiSE around sharing best practices and insight from the Rail Industry and hope this makes for an enjoyable read.

My personal thanks go out to our guest writer for this issue, Gordon Woods, who has written an interesting article about how Requirements Management is the key to Progressive Assurance in the Rail Industry (Page 8).

We hope you find Issue 3 both useful and informative. As ever, if you have any feedback about the magazine, or if you would like to contribute an article, please contact the Editor.

Very best regards,

John Hartas

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Dr J S Hartas Managing Director

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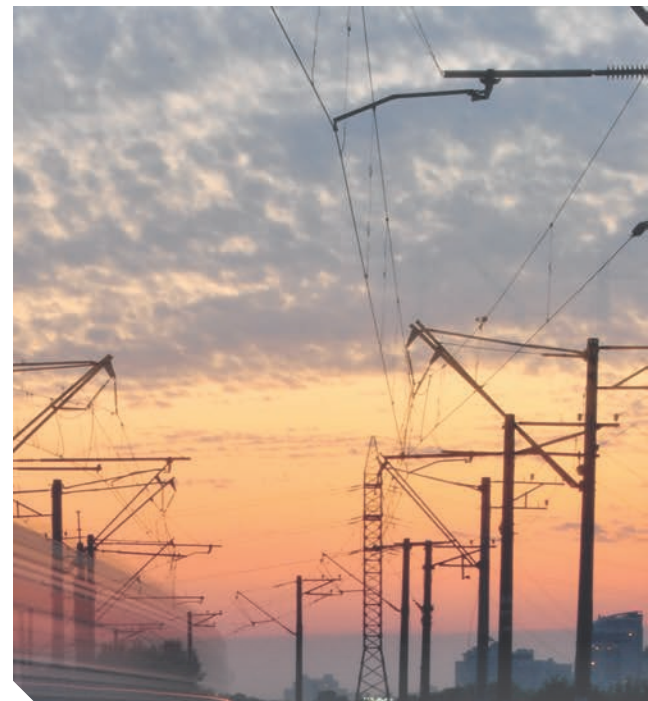
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Guest Article : Gordon Woods

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Gordon Woods has been a consultant for over 30 years providing guidance to companies in almost all areas of Systems Engineering. His experience includes setting up Progressive Assurance databases for the most demanding, technologically challenging, multi-billion dollar projects in defence, rail and aerospace. Recent rail projects include the High Speed Rail, Mass Rapid Transit, Light Rail Transit projects in Malaysia, and Qatar Rail and the Riyadh Metro in the Middle East.

He is a specialist in having IBM® Rational® DOORS® 9.x, DOORS® NG and Bentley® ComplyPro administration skills.

He can be contacted on:
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SyntheSys News

SyntheSys Gains Cyber Essentials Plus Certification

SyntheSys is delighted to have been recognised for its proficiency in cyber security, having attained the Cyber Essentials Plus certification. Cyber Essentials is a Government-backed, industry-supported scheme to help organisations protect themselves against common online threats.

The certification provides a rigorous test of an organisation's cyber security systems through detailed on-site vulnerability assessments carried out by independent cyber security experts. In addition to the initial self-assessment, security checks against both internal devices and external facing systems are designed to ensure that IT security systems can withstand potential hacking and phishing attacks.

SyntheSys' Operations Manager, Nikki Haynes, said: "It is widely recognised that today's digital age poses an ever-changing cyber landscape and threat; which is why attaining both levels of Cyber Essentials has been an

important aim for the company from the moment the scheme started.

SyntheSys has always been committed to ensuring appropriate measures remain in place regarding our information security risk, as well as to meet ongoing contractual and supply chain needs. Having started with Cyber Essentials, achieving the next level, Cyber Essentials Plus, demonstrates to our Customers that we have successfully implemented yet another tier of controls in our endeavours to combat these threats.

As the assessment included independent onsite testing to a recognised level, this offers an extra assurance and confidence to anyone working with us that we do indeed take the cyber threat seriously."

If you would like to hear more about the Cyber Essentials Plus certification, or the work we are doing in this area, contact info@synthesys.co.uk

SyntheSys Selected for Latest Government G-Cloud Scheme

SyntheSys has been accepted onto the Government's Digital Marketplace 'G-Cloud 11' Supplier List which further establishes our status as a supplier of cloud-based software.

Many of us use 'The Cloud' every day without realising it, as it has enabled a plethora of internet-based shopping, social media, and government services. For industry, the benefits of using the Cloud to execute software and systems engineering projects in a global 24/7 environment are significant.

Government frameworks are agreements between the Government and suppliers. Buying services through frameworks is therefore faster and cheaper than entering into individual procurement contracts. The G-Cloud framework was developed to ensure government bodies can access best-in-class Cloud solutions.

G-Cloud 11 replaces G-Cloud 10 services in which SyntheSys also participated. The G-Cloud supplier list is split into cloud hosting, cloud software and cloud support

and we are proud to be fully represented in all three categories.

The United Kingdom (UK) Government G-Cloud is a well-respected scheme specifically aimed at easing procurement by departments of UK public-sector bodies.

To maintain high standards, only suppliers who meet a set level are considered for a place on the G-Cloud 11 framework agreement. SyntheSys is able to call on years of experience in this field.

Crucially, G-Cloud provides an easy way for clients to access leading engineering software tools and services, backed by key associated technical support and top-class training from our team.

To access more information on our Government G-Cloud involvement, or to speak to us about your cloud hosting, software or support requirements contact: info@synthesys.co.uk

Transport for London (TfL)

Transport for London (TfL) runs the day-to-day operation of the Capital's public transport network and manages London's main roads. Every day more than 31 million separate journey segments are made across TfL's network.

The services TfL operates include: London Underground, London Buses, Docklands Light Railway, London Overground, TfL Rail, London Trams, London River Services, London Dial-a-Ride, Victoria Coach Station, Santander Cycles and the Emirates Air Line. It is a huge and complex organisation part funded by the Government with the associated public pressures to succeed.

SyntheSys was the successful candidate for winning the TfL two-year contract providing the Hosting environment for IBM® Rational® DOORS® on the cloudbaSE Software as a Service (SaaS) solution.

TfL has outsourced this service for many years because this reduces overheads and is more economic than providing the service in house. SyntheSys won the bid to take over the service.

A Customer View

Graeme Pate who is a Systems Engineer at TfL, spoke to us about the complexities of managing systems engineering programmes at this level, and why development tools are paramount to success.

He said...

"The complex nature of TfL's major projects means that robust requirements management is essential to success. DOORS® is an integral part of the requirements management process on our most complex projects, providing baselining, configuration control and the ability to link related information to each other. This facilitates an efficient impact assessment and configuration control process and is far superior to other less integrated products. Verification and validation processes are also made easier by having a clear, controlled and traceable set of requirements and ultimately leads to a simplified project completion and closeout."



Heads for the Clouds

Managing Complexity

Mark Williamson, from SyntheSys Systems Engineering said:

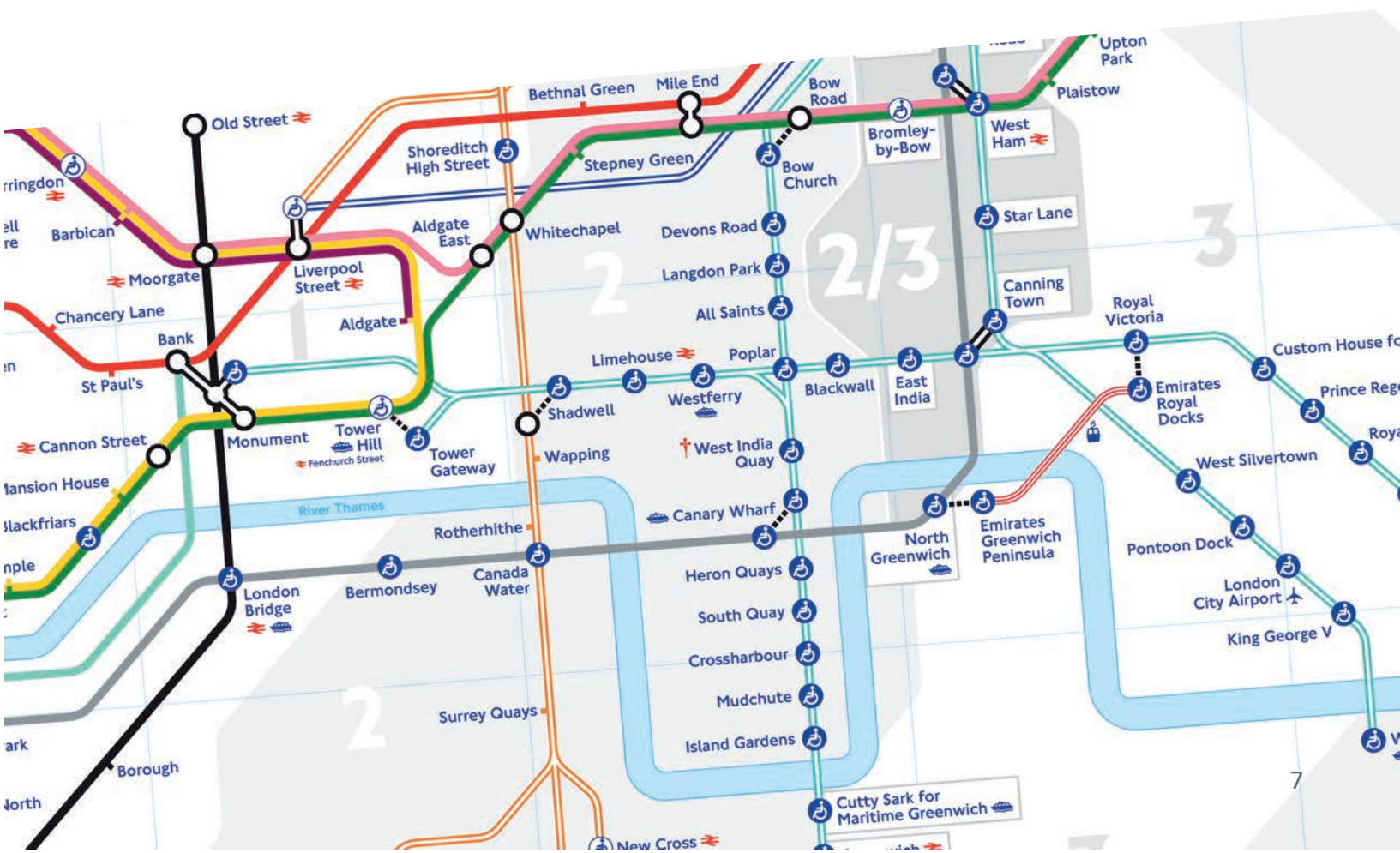
“Instead of having licences and environment managed internally which would involve the costs for staffing and internal system support costs, TfL has chosen SaaS and bring their own licences to cloudbaSE. The Cloud solutions are the way forward when managing data and files in the future. Our cloudbaSE environment provides a secure and compliant environment with a flexible approach.”

Utilising cloudbaSE, on Scale

The Bring Your Own Licences system means that companies who already have licences can utilise those exact licences within the Cloud

and create a level of flexibility above on-premise software.

This saves time because applications can be brought into use faster and the infrastructure can be adjusted rapidly to meet varying demand; the application can be made available to a user with internet access anywhere in the world and it is also very easy to increase and decrease both licensing and performance as needed.



Progressive Assurance in the Rail Industry

Article by Gordon Woods

Gather together 100 Requirement Managers and Requirement Engineers in a room and ask them to characterize a good requirement and you will get 95 different points of view. And you may even get disagreement on the fundamental terms of Verification, Compliance, Conformity and Validation. Do the same with electrical/electronic engineers with a circuit diagram and 95% will be able to tell you what the electronics are designed to do and whether the circuit will work as intended.

Why is this? It is not that the electronics engineers are better trained or more intelligent. I believe it is because we use natural language in Requirements. And words are always open to interpretation.

This article will take a look at some of the pitfalls that are commonly encountered in the mega rail and metro infrastructure projects. If you see these bear-traps (and I am sure that if you haven't yet, you will at some point) then this should raise, to use a common railway metaphor, a Signal Passed at Danger (SPAD).

How Many Requirements?

This is without doubt in my mind the commonest SPAD. According to IBM® *"Poor requirements management is among the significant contributing factors in the failure of a project."*¹ and as a result, this can lead to an over-reaction.

We might typically have the order of 40,000 requirements on a metro or Light Rail Transit (LRT) project. This is far too many and has likely come about for one (or possibly both) of the following reasons:

1. The requirements have been passed on from project to project – with possibly additional requirements to cater for an engineer's own experience; or
2. an attempt to prevent a repetition of previous mistakes.

If there are too many requirements and they are over-engineered, then you get bogged down with proving that every requirement has been met. Consequently, you end up with identifying only the important "tracked requirements" for the ones that are to be Verified and Validated just because it is impossible to deal with so many.

Another type of over specification is the ubiquitous "... shall, as a minimum:" or "...shall include but not be limited to:" followed by a bullet list of items. Both examples are, of course, unbounded and this means that additional items which the contractor knows nothing about could be imposed. If you see these types of requirements, then this is a SPAD alert!

Why are Interfaces Important?

So often requirements are considered as contractual and therefore the domain of procurement and the legal department.

Worse still, they are used as contractual boundaries mixing up requirements defining what a Contractor should do for the project with how they should do it. Each contract is drawn up in advance without considering duplication of requirements or involving the interfacing parties. This is contrary to best practice where both parties are involved in the interface design.

Furthermore, it leads to yet more interfaces as a recent report² into Crossrail highlighted *"In many instances, progress on one contract depended on the progress of others, leading to a proliferation of commercial and operational interfaces and, inevitably, friction.... as the separate major contracts got under way, the leadership struggled to manage these interfaces. Costs soared and delays lengthened."*

Moreover, on any rail infrastructure project, the management of the 'system to civil' and 'civil to civil interfaces' has to take cognisance of all the requirements, not just the interface requirements, especially with the external Stakeholders such as power, water, and the blue light organisations. Ignore this and you risk silo development, as each contractor defends their own position. This risk averse position stifles any innovation or cost saving measures.

Never Assume the Obvious is True

At the opposite end of the spectrum from contractual silos is the project where decisions are never made. This could be because the lines of authority are not established early on, or where decisions are left to the Operator to sort out after Entry into Service. The worst case is when the consultants at the start of the project are not the ones at the end of the project. This lack of responsibility leads to complacency for the first set of contractors and exasperation for the last set.

Whatever the cause, the lack of Operator involvement at the early stages of a project is another significant SPAD. The Rail Industry is not alone in this and there are countless instances in other sectors where a lack of participation by the user until the time of delivery has caused significant problems- even project cancellation.

Bringing it Together in a 'Single Source of Truth'

It should be dawning on the reader about now that Requirements should never be considered in isolation. And it follows that a requirements database such as DOORS® should not be used solely for requirements. The most powerful set up will be an integrated development of Requirements, Hazards, Assumptions, Interface, Change and Evidence registers. The advantage is, of course, that it is federated and acts as a 'Single Source of Truth' with change history recorded to make an automatic audit trail. Comments can also be applied against each artifact so there is no need for a separate document review sheet or similar.

¹<https://www.ibm.com/blogs/internet-of-things/iot-cloud-requirements-management/>

²Rod Sweet (2019) Damned if they did: A defence of Crossrail, Construction Research and Innovation, 10:2, 32-38, DOI: 10.1080/20450249.2019.1621583

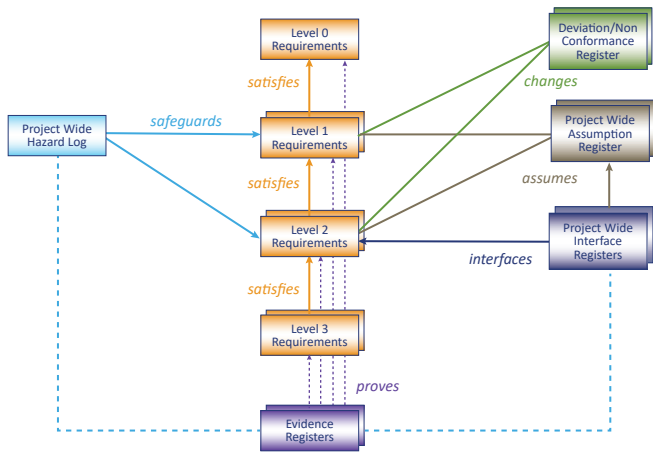


Figure 1: Typical Data Model

This has to be set up correctly using a data schema along the lines of Figure 1 showing the traceability pathways. Almost all requirement management tools can display these relationships as navigation links so that a user can quickly move up and down the links. The better ones such as DOORS® Next Generation (NG) may also provide overall graphical representations and drag and drop functionality to create and remove these links.

Perhaps the most important relationship is the linking to the external documents that provide the evidential information. In any Rail infrastructure project, there are literally millions of documents, procedures, design documents, simulations, drawings, test evidence etc., that are held within a separate document repository / Electronic Document Management System (EDMS). Full traceability from the highest requirement set, down to the evidence itself is required, noting that the same evidence can be used multiple times. In addition, Validation and Verification for a Requirement or Hazard mitigation should only be permitted if the documents that are providing the evidence are at an approved status.

This dictates bi-directional traceability between the Requirements Management tool and the EDMS. DOORS® 9.x, DOORS® NG and ComplyPro can all provide this functionality; DOORS® 9.x and DOORS® NG can have dynamic links using Open Services for Lifecycle Collaboration (OSLC).

The same applies to traceability links to the design models although, unlike the defence or power industries, I have yet to come across a Rail Infrastructure project that uses Model Based System Engineering (MBSE) for design at all levels.

A Case of the Right Tool

Holding the information is paramount, but we also need additional features that will organise and manage the tens of thousands of artefacts. Separation into logical containers, control of variants by reuse of requirements, the ability to collapse headings, and zoom capability are all vital components.

In an ideal world, the Requirements Management tool will be one of the first tools bought and it will be used to write the requirements. Sadly, this is not always the situation in Infrastructure projects. In the vast majority of cases the requirements will be written in Word so pdf becomes the norm. It is therefore critical that a Requirements tool has the ability to import, and export to Word in a circular manner. DOORS® NG has an inbuilt intelligent import feature. We also need to allow for import and export to Excel as not everyone will have access to the tool. And there are still users that will only use Microsoft products.

Where we currently are, what we have done since the last review and what we still need to do, are the basic tenets of any good project management. Metrics always evolve as the project advances. Therefore, ad hoc intelligent metric and analytic reports are essential. We also need baselines to capture moments in time or events. And of course, we need to have comparison of deltas and the management of change.

Best Practice Using the Best Tool

Perhaps one of the best examples of progressive assurance on a Rail Infrastructure project has been the High-Speed Rail project in Malaysia. This was established in early 2018 using DOORS® NG and until the project was postponed in May 2018 was destined to become a flagship project for IBM®.

Every requirement was imported into the appropriate levels (Figure 2) using the excellent import facility of DOORS® NG and attributes allocated. Project wide Hazard logs, Assumptions and Departure (commonly known as deviation or non-conformance) Registers were also included and the status values controlled by workflows. Traceability relationships were established between the registers in a similar manner to Figure 1. This allowed impact views to be created so that every change in every register could be assessed before implementation. The MyHSR Project dashboard consisted of a series of widgets, including shortcut links to specific modules and the project metrics. There was also a personal dashboard for each user that could be tailored for their own specific 'to do' list.

“Good Requirements Management is paramount to ensure that the final product actually matches the Sponsors' intent. Proper verbalisation is key to the success and must start day one. DOORS® NG was our tool of choice.” Stephane Mortier, Engineering Director, MyHSR Corp.

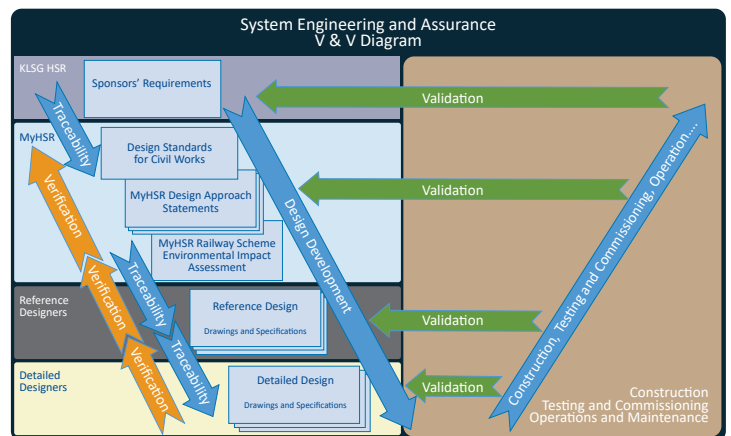


Figure 2: MyHSR Systems Engineering and Assurance 'V' model (courtesy of MyHSR)

Closing Thoughts

There has never been, and never will be, an impartial subjective comparison of two identical projects – one using progressive assurance and one using standard office tools. Simply because no two projects are ever the same and once you have done one, you have learnt from your experience.

What I can say, based on years of experience in putting projects back on track, is that it is all too easy to set up a project to fail.

The wrong tool, or the right tool wrongly set up, can and will ultimately suffocate a project.

Improve your Productivity through Collaborative Engineering Management

“Systems engineering has a significant quantifiable return on investment”

This is one of the conclusions from Eric Honour’s seminal PhD thesis.^[1] Eric’s research was designed to gather empirical research about how systems engineering methods relate to project success. He developed an interview approach and used it to interview project managers and lead systems engineers on 51 completed projects in 16 organisations.

The overall conclusions from the research are that there is a correlation between the application of systems engineering activities and a team’s ability to meet planned programme costs, schedules - and satisfy stakeholder needs.

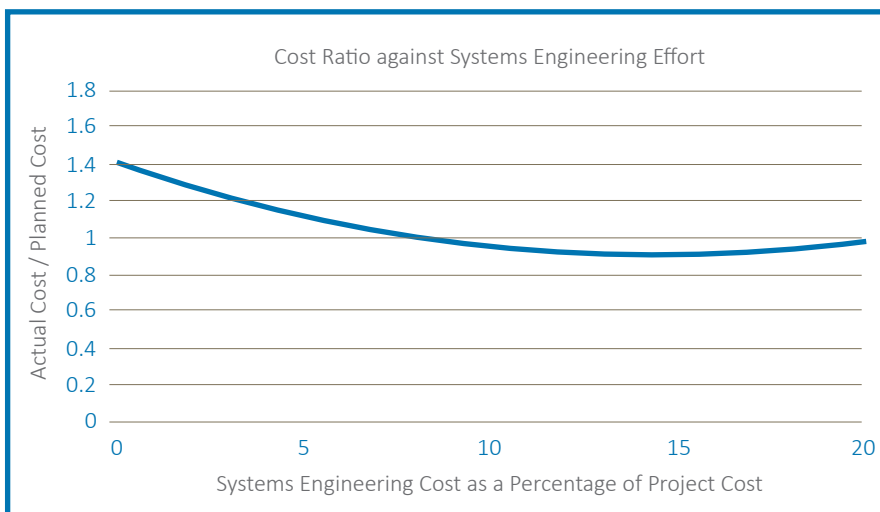
Some of the specific findings are:

- 1 The level of systems engineering effort matters to the success of projects.
- 2 Greater systems engineering effort is associated with projects that have significantly less cost overrun.
- 3 There is an optimum amount of systems engineering for best project success.
- 4 Projects typically use less systems engineering effort than is optimum for best success.

The third and fourth of these findings are of particular interest.

Of the projects that Eric investigated, those that operated with little or no systems engineering effort could experience a return on investment as high as 7 to 1 (i.e. a project cost reduction seven times as great as the added systems engineering cost). The return on investment then decreased to zero when the systems engineering effort reached 14.4% of the total programme cost. Levels of systems engineering effort above this had a negative return on investment (see the figure below). Typically, the projects employed systems engineering at about half the optimum level.

This research shows that there can be significant productivity gains through appropriate application of systems engineering effort in a project.



References:

- [1] “Systems engineering return on investment”, Eric C Honour, thesis submitted for the degree of Doctor of Philosophy, Defence and Systems Institute, University of South Australia, January 2013. Available at: <http://www.hcode.com/seroi/documents/SE-ROI%20Thesis-distrib.pdf>
- [2] “Systems and Software Engineering – System Life Cycle Processes”, ISO/IEC/IEEE 15288, 15 May 2015.
- [3] “The Logic of Social Systems: A Unified Deductive System Based Approach”, Alfred Kuhn, 1974.

Collaborative Engineering Management describes SyntheSys’ approach to systems engineering with expert personnel and appropriate tool support. We have helped many organisations increase their productivity through advice on processes, training and the introduction of software tools.

Please contact us to find out more.

What is a System?

A system is a combination of interacting elements organised to achieve one or more stated purposes.

As defined in ISO/IEC/IEEE 15288 [2].

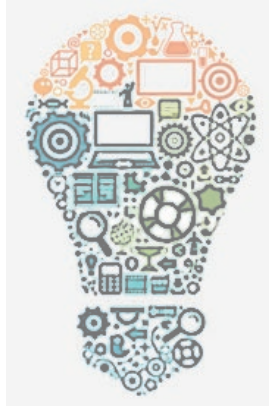
An element is any identifiable entity.

As defined by Kuhn [3].

What is Systems Engineering?

Systems engineering is an interdisciplinary approach governing the total technical and managerial effort required to transform a set of stakeholder needs, expectations, and constraints into a solution and to support that solution.

As defined in ISO/IEC/IEEE 15288 [2].



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Continuous Engineering for Dummies

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