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Issue 2
January 2019

www.synthesys-systems-engineering.co.uk

SyntheSys
SYSTEMS ENGINEERING

Our new SyntheSys Systems Engineering LinkedIn Showcase page is now live

To see useful content and interesting updates from our Systems Engineering group, such as best practices in Collaborative Lifecycle Management, Requirements Management, and Verification and Validation, please follow our new page - https://bit.ly/2JAC2Ls

follow us on LinkedIn

Letter from the MD

SyntheSys

Best Wishes for the New Year...

As we enter 2019 when many of us look to shed old habits for new, I'd like to begin by building on the sentiment by talking about the year ahead.

Being a supplier of systems engineering software and services, it is impossible for us to ignore the subject of Brexit and its possible consequences. In those uncharted waters, it will be ever more important for organisations to establish and maintain efficient manufacturing, production and engineering infrastructure - and that's where we are facilitating for a range of different organisations.

Dr J S Hartas Managing Director

We hope to continue our work of 2018, which was filled with interesting customer projects that focused on applying our tool-supported systems engineering philosophy to establish efficient and economic processes. One of our notable successes was the work we did for Network Rail, which you can read about on Page 12.

On Page 6 you can read about managing and organising non-functional requirements and, on Page 8, our guest author, Fraser Chadburn, discusses the evolution of Model Based Systems Engineering and SysML™.

We continue to invite those working in the systems engineering community to contribute articles. Email your ideas to info@synthesys.co.uk.

For those new to systems engineering, we are offering a free copy of the 'Systems Engineering for Dummies' E-Book, courtesy of IBM®. Details of how to access this can be found on Page 14.

If, like me, one of your New Year resolutions is to 'read more', follow us on LinkedIn (https://bit.ly/2JAC2Ls) to see useful content and interesting updates from our systems engineering group, such as best practices in Collaborative Lifecycle Management, Requirements Management and Verification and Validation.

I'd like to finalise by sending to our readers my very best wishes for a productive and successful 2019.

John S Hartas
linkedin.com/in/johnhartas

Contents

- ONLINE WEBINAR -

Managing Product Development Complexities in the Travel and Transportation Industry

12.02.2019 | 11:00 - 12:00 (GMT)

Tool Supported Systems Engineering

SyntheSys and IBM® are inviting members of the Travel and Transportation industry to join us for a 1-hour webinar which aims to offer insight into how IBM Watson Internet of Things (IBM Watson IoT™) solutions can and are helping organisations within the industry

To register: https://bit.ly/2D2gW3M

SyntheSys
D I R E C T

SyntheSys News

Technical Consultant, Matt Mendell, Achieves IBM® Technical Certification

Matt Mendell

As an IBM® 'Gold' Business Partner, it is crucial that we have unrivalled knowledge and application experience around IBM Watson Internet of Things (IBM Watson IoT™) tools.

We are delighted to announce that Matt Mendell has recently gained not one, but *two* IBM® Technical Certifications. Following examination, Matt achieved his Collaborative Lifecycle Management (CLM) Technical Sales Mastery award in addition to his Technical Certification in the use of the Rational Quality Manager (RQM) tool.

SyntheSys' Systems Engineering Director, Mark Williamson, commented:

'The certification programme is paramount to ensuring that we, as IBM® Business Partners, can provide value to customers, and our deep understanding of the toolset means *that we can view customer projects in a unique way, so we are thrilled to be able to support Matt throughout this process.'*

These latest achievements add to his already attained DOORS® Next Generation accreditation and give Matt quite a collection of certifications.

For more information about our partnership with IBM®, visit our SyntheSys Direct website http://www.synthesys-direct.co.uk/

SyntheSys Services Available via the Digital Outcomes and Specialists 3 (DOS3) Framework

SyntheSys has been accepted onto the Crown Commercial Services DOS3 register.

Organisations that secure a position on the framework can apply to offer their eligible services in the digital space to government teams via the framework.

SyntheSys services can be found under the 'Digital Outcomes' and 'Digital Specialists' categories.

The main advantage for companies using the service is that they can be assured that the members listed via the Crown website have been pre-qualified to establish their suitability and reliability.

For more information about the Crown Commercial Services visit: https://www.crowncommercial.gov.uk/s/

If you would like to discuss our specific offerings, please contact info@synthesys.co.uk

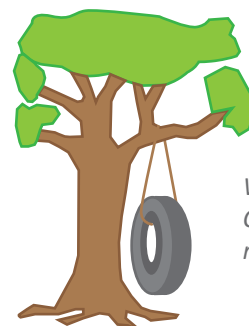# A Field Guide to Non-Functional (& Functional) Requirements

I'm almost certain that you've seen a cartoon based around these illustrations before:

How the Requirements described it

How the Project Team designed it

What the Customer really needed

There is a swing in each of these images – but only one of them meets the customer's needs – the difference lies in the non-functional requirements, specifying not what the solution must do, but how it must be done.

What are they?

Functional requirements describe how a product must behave – they identify its features and functions. Some people describe these as 'capability' requirements. These are the ones that everyone has an opinion on, and they are relatively easy to capture.

Non-Functional Requirements (NFRs) are sometimes described as 'anything about a system that isn't what it does'. They describe the quality attributes of a system, and they impose limitations on the functions of the system, in categories such as:

- Availability
- Capacity
- Data Integrity
- Environmental
- Interoperability
- Maintainability
- Manageability
- Performance
- Recoverability
- Regulatory
- Reliability
- Scalability
- Security
- Serviceability
- Usability

As such, some people call these 'constraint' requirements, though this label implies a somewhat narrow definition.

Even that long list is incomplete by some measures, and different subsets of the 'ilities' (as they are sometimes described) may be relevant in different domains.

Often, when you try to capture these requirements, you will receive them unquantified, or out of context, and much work may be needed to turn a received statement into a useful NFR.

Nobody puts it more succinctly than Scott Adams, in this Dilbert strip:

The abuse of non-functional requirements

Ease of use is a *goal*; but it is also an *emergent property* of a well-specified, well-designed system that understands the needs of its users. Ease of use should be expressed in focused, non-functional requirements that might, for example, describe usability in terms of training requirements for a person in a job role with a documented person specification.

Performance requirements are often poorly addressed in software projects – an issue that becomes more relevant by the day, as complex systems become increasingly software-intensive.

Peter Campbell, a Software Architect and Chief Technical Officer (CTO), wrote about what he calls 'the NFR trap'. Describing a hypothetical project, he says that the non-functional requirements:

'did not describe the level of real-world usage that real users impose on the service. Instead very complicated, hard to understand and detailed requirements were constructed by a smart software architect that didn't get the user context.'

Campbell is writing about a web application, but his point is valid for any multi-user system. This reinforces the need to consult with a wide variety of stakeholders on NFRs, as well as functional requirements, when developing complex systems, but also makes the wider point that NFRs are wasted effort unless performance testing is done with realistic inputs, outputs and operating conditions.

Sometimes a requirement is both functional and non-functional. For example, if a smart customer requires a touchscreen display as an input/output method, this may be required by marketing stakeholders simply because it's what users expect; it may enable certain features and capabilities down the line, but it's also a constraint on how the user-interface can operate, and the way in which it enables users to navigate. Thus, it's important to decide how you will identify functional and non-functional requirements and organise them within requirements sets/documents.

For this reason, and for reasons of context, templates that put functional and non-functional requirements under separate major headings, may be counter-productive – although good visualisation of traceability can mitigate the impact.

Where are they?

Functional and non-functional requirements appear in the problem and solution domains – in the stakeholder requirements, and all the requirements and specifications beneath.
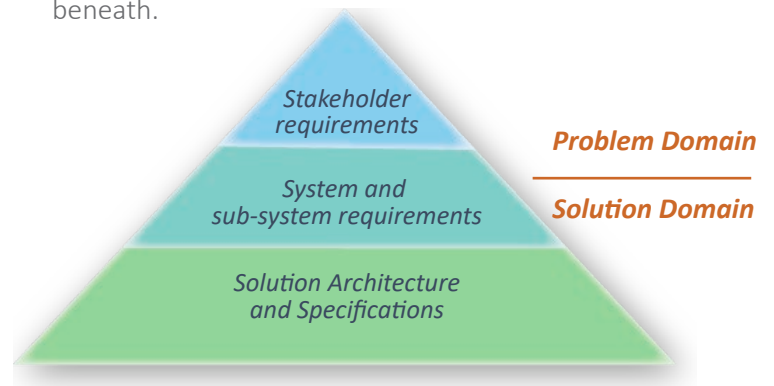
NFRs can originate with internal stakeholders, e.g. an end-user requires the ability to enter a certain number of new records into a database per hour worked. They can also come from external stakeholders, e.g. legislation requiring limits on certain emissions (chemical by-products and waste, radio-frequency emissions, etc.) regarded as harmful. Thus, a thorough stakeholder analysis is critical to developing a comprehensive set of NFRs.

So what are the takeaways?

First, recognise that any requirements set should have both classes of requirement – the absence of one or the other is a red flag in terms of either content availability or organisation.

Have a strategy for distinguishing between the two, and how to capture them. Avoid isolating them in different sections of a document if you can.

Prompt all of your stakeholders for their NFRs. Ask them specifically about some of the 'ilities' to get them thinking in the correct direction.

Richard Hesketh
Principal Consultant

Requirements Management Consultancy, Tools & Services

Requirements Management is widely regarded as the aspect of systems engineering that underpins most of the other processes; a properly organised approach to requirements management provides the structure around which the systems engineering process can operate.

Our systems engineers have a wealth of experience of guiding organisations through the process of implementing sound requirements management procedure.

Visit: www.synthesys-systems-engineering.co.uk/services.html for more information

Fifteen Years of Model Based Systems Engineering with OMG SysML™ - and Still Growing

Model Based Systems Engineering (MBSE) is a growing discipline within Systems Engineering (SE) which returns significant benefits across the entire life cycle over traditional document-based methods. Key advantages are the reduction in the time required to carry out requirements capture and design, establishing systems specifications early, minimising costly rework, improved quality and the improved capability to cope with change. While tools such as Rational® DOORS® allow us to manage textual artefacts, models open up new worlds for expressing ideas. Internationally standardised languages including Unified Modelling Language (UML) and OMG SysML™ enable us to express ideas using a graphical language, supported by books and on-line resources, and a community of engaged academics, trainers, consultants and practitioners.

It's not possible to do modelling without tools to support it.

Model based engineering has existed for over 30 years, driven first from the desire to generate code consistent

with design documentation from structured design methods and the growth of the Object Orientated paradigm in software development. With the development of the OMG SysML™ extension to UML, a consistent profile for extending UML for use with systems engineering was created.

It is over 11 years since 2007 when the SysML™ v1.0 version was finalised (the latest is v1.5 with v2.0 being worked on). By sharing the same base tooling for UML, SysML™ gained rapid and widespread adoption supported by a competitive tool market including Sparx Systems' Enterprise Architect, MagicDraw/Cameo System Modeller (now owned by Dassualt Systeme) and IBM® Rational® Rhapsody® (ex-Telelogic).

Modelling differs from drawing because in a model the drawings all come from the same source (also known as data dictionary). The drawings (diagrams) are representations or views of the model where the elements have their own properties and descriptions and may

be shown in different ways on different diagrams. A model exists whether there are any pictures of it, or not, and multiple reports can be viewed or generated from the same source information, where the views and information is known to be consistent as it comes from the same model.

A modellers role is similar to that of a wedding photographer. As a modeller you're responsible for framing the picture by collecting together the artefacts that make sense together and presenting them to the user to tell a story. Don't underestimate the value that comes from telling the story either. It's not just the fact that you've drawn a diagram, the way that you utilise the diagrams to communicate to people is important. More value comes from using a diagram at the beginning of the project in a design or requirements review where multiple people are present, than creating them for a document at the end. Diagrams paint a thousand words and often just by having a diagram projected in a team meeting you can spark ideas, convey understanding and clarify intent.

Remember, the aim of model-based engineering is not to produce a system engineering model, the aim is to do systems engineering better. For me, model based systems engineering is about people more than tools or method. It's about getting teams and people with different viewpoints and skills to collaborate more effectively.

People access information in many ways. Since I began publishing tips

and tricks videos on YouTube and my blog, I've been surprised by the expansion and international nature of interest. Adoption of MBSE with SysML™ is a truly global phenomenon across the aerospace and defence, industrial systems, railway / transportation, medical and automotive industries. Automotive has seen an extensive growth with Rhapsody® and MBSE adoption across a number of Original Equipment Manufacturers (OEMs) and Tier 1 suppliers across Europe, the United States (US) and Asia. It continues to grow as companies grapple with new ways of doing things to cope with innovation of safe systems for future worlds inhabited by autonomous interconnected systems with electrical powertrains. Much of the need for tooling is driven not just from models but from the need to have more integrated tooling that can support the connection of data between requirements, models, test and work item artefacts.

This is not just about having an integrated toolchain but also coping with configuration management of requirements versions, scalability of life cycle data to huge datasets, and organisational change in order to be able to enact agile planning at scale.
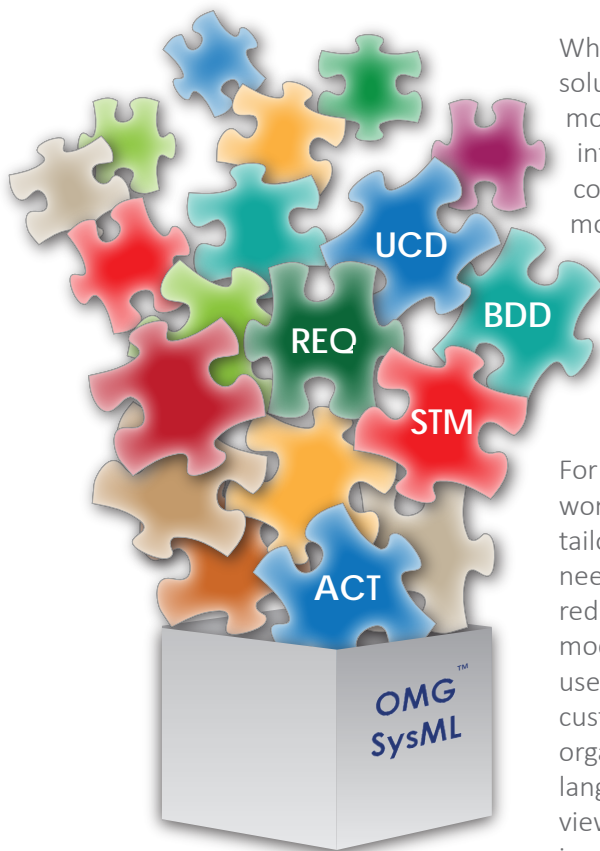
Related to this is the ability to ease access to information by using modern web-standards such as the Open Services for Lifecycle Collaboration (OSLC) and access to secure data through a web-browser such as those accessed by role-based licences in IBM's® Jazz™ platform. IBM's® Jazz™ platform removes technology barriers to getting people to collaborate by providing access through web browser clients capable of wide-area network use. New IBM® technologies such as Rhapsody® Model Manager (RMM is Jazz's™ architecture management application) broaden the scope of Jazz™ into viewing modelling information entirely through a web client, further socialising access to Rhapsody® SysML™/UML and other models (AUTOSAR and UPDM) to a range of secondary stakeholders by removing the need for users to have installations of Rhapsody® to review modelling and other life cycle artefacts.

While some organisations adopt point solution products for aspects such as modelling, being able to achieve an integrated toolchain in a truly collaborative life cycle presents more compelling organisational opportunities and unique challenges. This is where deep tools knowledge can help to make effective deployment decisions.

For me, it remains a very exciting world. Part of this excitement is tailoring modelling tooling to fit the needs of the target audience, reducing the perceived complexity of modelling to new and different end users through Rhapsody® tool customisation and helping organisations understand or tailor the language to fit their own world viewpoint. What has been most inspiring perhaps, is welcoming a new and enthusiastic generation of automotive engineers into the systems engineering community. A generation that is excited by what modelling offers, grappling with very real challenges of overwhelming complexity and safety-critical development by using models to

left-shift their organisation's understanding; truly innovating new and differentiated products through the identification and resolution of requirement, architectural and interface definition issues early in the life cycle when they're much cheaper to fix.

Fraser Chadburn

Fraser's blog with tips and tricks on Rhapsody® is: www.mbsetraining.com (there are over 50 short videos on common topics that have come up in his training).

Fraser Chadburn is an independent consultant and trainer with over 20 years of modelling experience in systems and software development, including representing Artisan Software Tools as the product manager during the finalisation of OMG SysML™. As an expert in model based engineering, he has experience across a range of contrasting sectors including defence, aerospace, telecoms, and automotive. Employed as a technical specialist on IBM® Rational® Rhapsody® by Telelogic / IBM® between 2008 and 2015, he delivered over 50 workshops and courses on Rhapsody®, DOORS® and Jazz™ tools for complex systems and software.

Since leaving IBM® in 2015 he has been working as an independent consultant focused on tool simplification and automation of MBSE methods with Rhapsody®, and delivery of affordable SysML™/UML training to clients across the UK, Europe and USA. He maintains a blog and YouTube channel focused on Rhapsody® tips and tricks, and works closely with SyntheSys.

Improve your Competitiveness through Systems Engineering Training

"There is a strong direct relationship between past experience and the likely success of future projects."

This is one of the conclusions from a Carnegie Mellon® survey [1] on the effectiveness of systems engineering, but it confirms what many people know intuitively. The survey was carried out on projects identified with the aid of The United States' National Defense Industrial Association (NDIA), the Institute of Electrical and Electronic Engineers (IEEE), and the International Council on Systems Engineering (INCOSE).   The primary purpose of the survey was to identify systems engineering best practice on projects, collect performance data on these projects, and identify relationships between the application of these systems engineering best practices and project performance, but they also looked at how other factors might influence performance. Experience of similar projects was one of those factors. The survey found that experience is an even more important factor in challenging projects. Challenging projects include those that deal with complexity, are innovative, or push the boundaries of the state of the art. The survey results show that experience is critical to an organisation's success in a competitive environment. Experience can only be acquired quickly by buying services or by recruiting, but sustainable experience can often be achieved only through organic development. The start of the process is always training, whether this be through private study and experimentation or in a formal classroom or lecture theatre environment.

Reference:
[1]- "The Business Case for Systems Engineering Study: Results of the Systems Engineering Effectiveness Survey", Joseph P Elm and Dennis R Goldenson, November 2012, Carnegie Mellon® University. Available at:
https://resources.sei.cmu.edu/asset_files/SpecialReport/2012_003_001_34067.pdf

Training & Mentoring
As active members of the INCOSE community, we have a portfolio of different Systems Engineering Training solutions which cater for a variety of different industry challenges from Automotive to Defence. Our specialist training includes:

Requirements Capture & Management
With years of experience in requirements writing SyntheSys is currently delivering a long-term training program to a major automotive company in requirements writing.

Systems Engineering Foundation
Our Systems Engineering Foundation course has been designed to provide a high-level foundation to the principles and practices of systems engineering.

The course is aimed at those whose role heavily integrates with a software or systems development process and is suitable for both engineers and non-engineers at all levels. The course content is aligned with the INCOSE Systems Engineering Handbook and provides an introduction and overview of the processes required for successful systems engineering delivery of projects. Presented by an experienced systems engineering practitioner, the course examines the role and benefits of applying systems engineering principles within your organisation.

INCOSE Certified Systems Engineering Practitioner (CSEP) Accreditation Preparation Course
A five-day course which equips students with the knowledge and structure of the INCOSE Systems Engineering Handbook, and its constituent processes to prepare for the CSEP examination. The course combines real-world scenarios with theory, presented in the INCOSE Systems Engineering Handbook, to provide students with a unique learning experience which will enable them to comfortably sit the INCOSE CSEP examination.
Presented by a fully accredited, qualified CSEP instructor, the course examines the role and benefits of applying Systems Engineering principles within an organisation. We teach students how to apply this theory and how to use the correct terminology to convey this process and complete a series of exercises which will prepare them for the exam.

IBM Watson Internet of Things (IBM Watson IoT™) Tool and Application Training
As an IBM Watson IoT™ Gold Business Partner, SyntheSys provides a unique blend of application knowledge, experience and a flexible delivery mechanism, which provides customers with the right software solution and a deeper understanding of the tools to ensure maximum benefit. Our ability to work with IBM® to distribute Watson IoT™ software is built on a firm foundation of industry know-how and extensive knowledge of the IBM Watson IoT™ tools which enables us to distribute the tools in a value-added way. Our broad expertise of IBM® Rational® DOORS®, DOORS® Next Generation (NG), Rational Team Concert™ (RTC), Rational® Publishing Engine (RPE) and Rational® Quality Manager (RQM), makes us best placed to offer a value-added service throughout the IBM Watson IoT™ community. Our offerings stretch much further than deployment of technology. We offer training courses which teach students on the implementation, application and acceleration of IBM Watson IoT™ software products.

SyntheSys provides coaching, mentoring, and formal training courses to organisations to help them improve their processes and introduce software tools. Please contact us to find out more.

2019 SYSTEMS ENGINEERING TRAINING DATES CONFIRMED

CERTIFIED SYSTEMS ENGINEERING PROFESSIONAL (CSEP) PREPARATION TRAINING

PREPARE TO PASS THE CSEP CERTIFICATION EXAM

11 - 15 FEBRUARY
13 - 17 MAY
14 - 18 OCTOBER

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GAIN A HIGH LEVEL FOUNDATION TO THE PRINCIPLES AND PRACTICES OF SYSTEMS ENGINEERING

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4 - 5 JUNE
3 - 4 SEPTEMBER
3 - 4 DECEMBER

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OR CONTACT
TRAINING.SYS-ENG@SYNTHESYS.CO.UK
+44 (0)1947 821464

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SyntheSys Supports Network Rail IT in DOORS® Upgrade Project

SyntheSys completes an upgrade of IBM® DOORS® and Rational® Publishing Engine (RPE) at Network Rail

SyntheSys was invited by IBM® to take on the contract. Network Rail has a long history of using DOORS® in major engineering projects and in its Information Management division.

In 2016, the company found that its DOORS® 9.2 environment was approaching end-of-life for IBM® support purposes, so the software required updating to version 9.6.1. During the lifetime of the DOORS® 9.2 deployment, there were also significant enhancements to RPE – Network Rail opted to upgrade IBM®'s powerful document generation tool to version 2.2.1, which was current when software versions were selected for deployment.

The scale of the project was significant, with some hundreds of user accounts and approximately 100 gigabytes of data, historic and current. Network Rail also took the opportunity to merge two DOORS® databases to simplify support and operations – this required a careful review of the databases' shape and size, and careful DOORS® Extension Language (DXL) scripting to robustly combine the users and data, whilst preserving access rights.

SyntheSys worked with senior Network Rail DOORS® users, Network Rail Information Technology (IT), IBM® and a third-party which supplies several add-ons to DOORS®. A programme of works was designed, which included a full-scale rehearsal of the database merge and upgrade of the software in two test environments. Server infrastructure was specified by SyntheSys for each of two test environments, to which all new or updated software must be deployed and assessed before it is permitted to be deployed to the production environment. System testing was executed by SyntheSys, and user acceptance testing by Network Rail users and their representatives.

The project identified several changes required in third-party add-ins to DOORS®, and SyntheSys worked with the supplier to specify and test these. During the project, SyntheSys was also asked to review the management of access rights on the database, and to suggest enhancements.

Principal Consultant Richard Hesketh, coordinating and executing the work by SyntheSys, said:

"Upgrades, even of commercial off-the-shelf systems, are rarely straightforward at this scale. Several things were key to the success of this project: the experience of our people in previous DOORS® projects at Network Rail; deep knowledge of the IBM® software, and our ability to peel back the layers of a large-scale, complex deployment and understand how best to update it to match current and anticipated needs. Close cooperation and good communication with the users and their representatives helped to smooth the path to implementation."

SyntheSys' Flying the 'STEM' Flag by Sponsoring the 'S Prize'

It's no secret that Science, Technology, Engineering and Mathematics (STEM) subjects provide the foundations of future innovation. Engaging young people to become inspired by these subjects and developing the talents that are needed, are a key to ensuring a thriving knowledge-based economy as part of our country's place in future, global markets.

SyntheSys has been playing its part in contributing to STEM initiatives with the Whitby-based firm's Managing Director, John Hartas, recently getting involved in a dynamic initiative at a local school.

John, who is a STEM Ambassador (www.stem.org.uk), was thrilled to initiate Caedmon College's 'S Prize'. Youngsters from the college battled for the prize, amazing everyone with their extensive knowledge of subjects ranging from how plastic in the ocean affects marine life, to mysterious Dark Matter.

John said: "The submissions we received were as documents, PowerPoint presentations, a model of a volcano (that actually erupted), and a computer game. All the submissions were of a really high standard and the judges were greatly impressed."

The winner of the Key Stage 3 prize was a joint team formed by Joshua Harland and Connor Betts.


Their submission was on the Life Cycle of a Star and included a computer game they invented.

The Key Stage 4 prize went to Rebecca Morgan for her submission in the style of a scientific paper on Dark Matter. Rebecca said her project overall was based on the questions and confusion about Dark Matter which, in her opinion, is one of the biggest mysteries in any modern day scientific field. She said: "I was inspired to write about this topic as no one truly knows what Dark Matter is yet, so I decided that since it is going to be one of the most talked about topics in science for many decades to come, I would want to be informed of potentially one of the biggest scientific breakthroughs of the century."

The prize for Key Stage 5 was won by Emma Sharpe for her submission on the effects of plastic pollution on our oceans. Emma said that taking part in this project had inspired her to be more conscientious about recycling, and in future, she hopes to take part in activities such as beach cleans in order to help keep our oceans free of plastic.

It is now hoped that the awards will become an annual event.
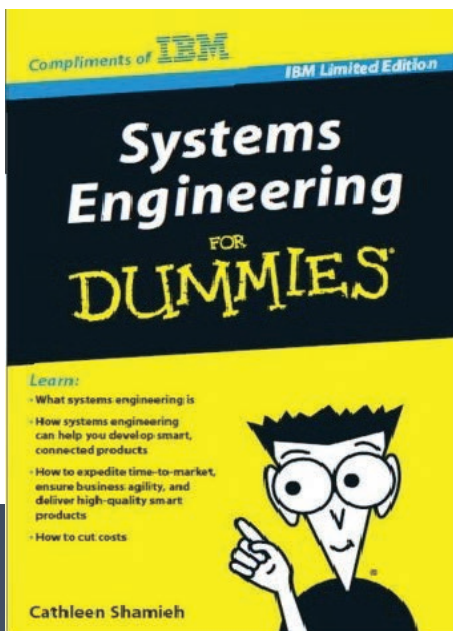
Free Resource

Systems Engineering for Dummies

Courtesy of IBM® we are able to offer readers this clear and concise foundation level publication which is a key resource to add to any desktop or company library.

Learn at a glance:

- What systems engineering is
- How systems engineering can help you develop smart, connected products
- How to expedite time-to-market, ensure business agility, and deliver high-quality smart products
- Perhaps more importantly, how to cut costs

Systems Engineering For Dummies, is an IBM® Limited Edition E-BOOK explaining what systems engineering is and how it can help you harness the complexity inherent in developing smart, connected products.

If you are looking for ways to expedite time-to-market, ensure business agility, and deliver high-quality smart products while cutting costs, this is the book for you!

**To download
the FREE E-BOOK visit:**

http://resources.synthesys.co.uk/cloudbase/systems-engineering-for-dummies.pdf

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SyntheSys Systems Engineering Services

We provide systems engineering services, products and training to government and industry, to establish efficient and economic processes that, in turn, enable them to deliver the highest quality products to their respective customers and end-users.

✔ Systems Engineering
   Consultancy & Services

✔ Requirements Management
   Services

✔ Systems Engineering
   Training & Mentoring

✔ Tool-supported Systems
   Engineering Methodology

Embedded or Callout Service

INCOSE Certified Systems Engineering Professionals (CSEP)

Integrators of Industry-leading Development Tools

"Tool Supported Systems Engineering"

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