CROSS-DOMAIN SPECIAL

OptimiSE

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Industry News & Events | Software & Systems Engineering Acceleration | Useful Resources

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Letter from the MD

Mark Williamson Managing Director
SyntheSys Technologies

Editorial

Editor: Sarah Thomas
Email: sarah_thomas@synthesys.co.uk

Copy Editor: Penny Morgan
Email: penny_morgan@synthesys.co.uk

Contributors:
Mark Williamson, Dan Quixote
Matt Hirschfield

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Taking Steps into a New Year

May I start my letter by wishing readers a happy new year! The new year is a time for reflection on the old and anticipation for the new, and it is with that in mind that I introduce this latest issue of OptimiSE Magazine. 2021 has been quite a year for SyntheSys Technologies. Perhaps the biggest positive has been the re-introduction of our Covid-safe classroom systems engineering training courses. Online delivery certainly provides a flexible alternative to our classroom courses, and we have been thrilled at how training delegates have adjusted to this online delivery - but it has been a delight to be training in person during 2021.

On which note, I would like to congratulate new Associate and Certified Systems Engineering Professionals (ASEP/CSEP) who have attended our preparation course. The INCOSE certification programme continues to strengthen skills, knowledge, and capability across the systems engineering community.

We have continued to assist our engineering customers to accelerate time to market, reduce risk and automate engineering and manufacturing through the deployment of the IBM® Engineering Lifecycle Management (ELM) suite. The user-base of these powerful tools has grown considerably during 2021 across high growth industries such as automotive, defence and rail. Our most recent highlight is the arrival of Matt Hirschfield, and we have a feature on Page 11 which aims to welcome and introduce Matt.

Our 2022 aspirations are as much about reaching far corners of new markets, as growing our foothold in existing sectors. We would like to continue to contribute to a thriving skills market through training and personal development of not only our own staff, but across the community as a whole.

With so much happening for both us and the community, Issue 8 of OptimiSE is designed as a cross-industry publication where we have features for defence (Page 6), automotive (Page 8) and rail (Page 10). We explore model-based systems engineering, value engineering and what the future holds for the United Kingdom (UK) rail network.

I hope that OptimiSE continues to prove to be useful and enjoyable within the engineering, systems and software development communities. I welcome and encourage you to subscribe to receive future issues directly to your mailbox at http://www.optimisese.co.uk

Very best regards,

Mark Williamson, Managing Director
SyntheSys Technologies

SyntheSys TECHNOLOGIES

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Continued Success for Senior Administrator, Shelley Fisher – Lead Auditor and STEM Ambassador

Since joining the SyntheSys team in August, Senior Administrator, Shelley Fisher, has been taking big strides through her commitment to personal development. It is with that in mind that we celebrate Shelley's recent success having qualified as an ISO9001 Lead Auditor which led to certification as a Chartered Auditor.

The ISO9001 is a quality management system standard which helps organisations ensure that they meet the needs of customers and other stakeholders, whilst meeting statutory and regulatory requirements related to products or programmes. Its general objective is to improve quality and we are continually committed to meeting the requirements of the certification. Developing and nurturing skills and knowledge in this area enhances our commercial and social value.

Shelley is now a qualified Lead Auditor and can assess the capability and effectiveness of our own and our customers' Quality Management System (QMS).

But it doesn't end there. Shelley's background and efforts have led to her becoming a STEM Ambassador. STEM Ambassadors are volunteers from a wide range of Science, Technology, Engineering, and Mathematics (STEM)-related jobs across the UK and Shelley will be committing time to working in North East-based schools to promote STEM subjects.

Shelley commented: "Having worked in manufacturing and engineering environments for many years, certification and continued skills development has always been important to me, both professionally and personally. The Lead Auditor qualification is a real 'stake in the ground' for both myself and SyntheSys. Not only does it strengthen our own internal QMS processes, but it also means that we can consult for customer systems and procedures.

Becoming part of the STEM ambassador programme has been the icing on the cake and I am passionate about working with young people to promote these enriching subject areas.

I am also looking ahead to other qualifications in health, safety, and the environment. That's all whilst working towards The National Examination Board in Occupational Safety and Health (NEBOSH) degree.''

Well done to Shelley!

If you currently have challenges associated with your internal QMS or are looking to take a more formal approach to quality certification and would like to tap into Shelley's expertise, please contact Shelley by emailing: info@synthesys.co.uk

SyntheSys' Membership with the North East England Chamber of Commerce

Our focus on connecting with growing sector communities is a vital part of how we operate, and we view association memberships as being a critical piece of that puzzle, which is why we are pleased to share that we are now members of the North East England Chamber of Commerce.

The Chamber supports businesses to grow their knowledge, influence and connectivity regionally, nationally and internationally. Its aim is to create an environment where businesses in the North East of England thrive as a collective force. They are a completely independent body owned by members and work with businesses of all sizes and sectors.

For more information about North East England Chamber of Commerce, visit: https://www.neechamber.co.uk/

For more information about the different associations we are members of, visit: http://www.synthesys.co.uk/memberships-and-accreditations.html

North East England Chamber of Commerce

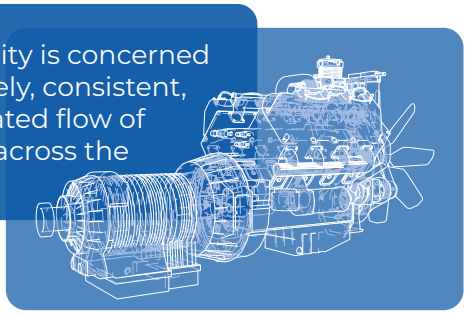
Requirements Management & Model-Based Testing

It's well known that testing of military platforms is high cost, particularly when testing the integration and interoperability of platforms in a live environment.

The application of requirements-based testing, underpinned by a model-based approach during requirements definition, helps to identify issues early in the development life cycle. This serves to minimise costs and risks in the implementation or maintenance of the system, as well as providing a direct correlation between clarified requirements and test cases for validation and verification purposes.

Integration and interoperability of systems and software has long been an area of prevalence, and here at SyntheSys we have first-hand experience of issues platform teams face in terms of introducing new capability, upgrading existing capability and how the integration between the old and the new impacts other substituent systems.

Interoperability is concerned with the timely, consistent, and coordinated flow of information across the network



It's the focus on interoperability which makes way for a standard-based interoperability approach ensuring the consistent implementation of platforms by building them in accordance with underlying standards and specifications.

This is also referred to as a 'network-centric' approach and contrasts with traditional approaches in which platform implementations have been focused on the needs of individual platforms, the so-called 'platform-centric' approach.

The standards-based interoperability approach can only be successful if the underlying baseline of standards and specifications is complete, consistent, and correct. Unfortunately, in some cases, the governing standards are large and complex documents that are evolving under an intricate change management system, with all participating nations contributing and agreeing on changes to the standard.

A further issue is that the structure of the requirements within the standard do not follow best practice in requirements writing techniques. These issues compound to the extent that the interpretation and misinterpretation of the complex requirements for a particular platform is an ongoing problem, leading to non-standard implementations and the creation of interoperability issues.

At SyntheSys, we have applied the principles of Model-Based Systems Engineering (MBSE) to develop dynamic UML (Unified Modelling Language) models of the requirements in the standards and specifications to help ensure their integrity.

As well as being able to provide feedback to the authors of the documents, this visual, functional model enables us to manage complexity and minimise ambiguity.

The adoption of MBSE to represent the requirements gives the capability to dynamically simulate transactions with the appropriate stimuli, exercising the constraints and processing all possible paths through the model. The modelling software tracks the live progress through the model, creating a sequence diagram identifying inputs, outputs and actions. It also provides a model coverage statistic and history of the stimulation and decisions taken in execution.

The standards are constantly evolving with new functionality and modifications to existing capability under change control. The model and dynamic execution provide a means to carry out what-if analysis for changes to the standard that can identify knock-on effects and issues not readily apparent from the basic text. Any changes to the requirements under MBSE are therefore easily identified within the model.

We advocate a requirements-based testing approach in which the testing of platforms is carried out against the governing standards and specifications. The models have enabled us to develop a comprehensive set of meaningful interoperability test cases since they clearly identify all decision points and, therefore, where a test case should be produced to address a specific route through the transaction.

These test cases are traceable to both the source requirements, as captured within the requirements management database, and the specific UML diagram that describes that functionality. Impact analysis of a test failure is therefore readily identified against the source requirement.

Mark Williamson, SyntheSys Technologies Managing Director believes that:

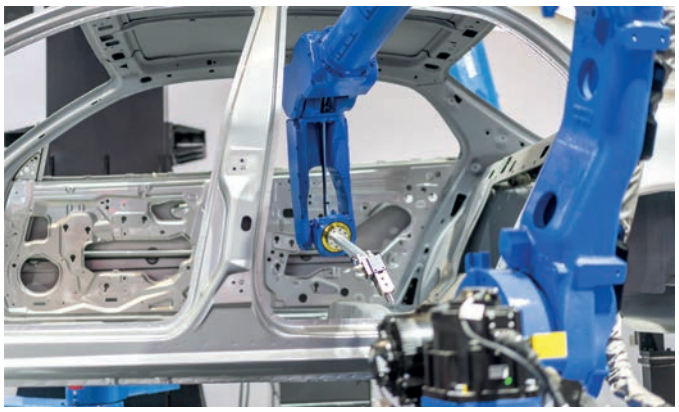
"....the MBSE approach reduces interoperability issues. Together with requirements-based testing, it readily identifies differences between a platform implementation and the standard, enabling those differences to be subject to systematic management."

Engineering for Lean

Optimised Lean, Green, Production Lines

The automotive industry invented Lean manufacturing, and with the advent of technologies for digital and green manufacturing, supply chain integration and transparency, and more widespread automation of the manufacturing process, automotive continues to be a vanguard of clean and heavily optimised product value streams.

But the changing technological and regulatory environment which has enabled many of these changes, brings risks as well as opportunities. Lean manufacturing is heavily optimised, and with capital-intensive production lines, a climate of change can make longer-term investment decisions highly unpredictable in their outcomes.



Brexit and the Covid-19 pandemic have made automotive manufacturers all too aware of the risks associated with unstable resource inputs to their production capacity. Heavily optimised Lean production lines can be greatly disrupted by the slightest interruption to the flow of value. But even as the world – hopefully – approaches a new normal following the worst disruption of these turbulent events, the automotive industry can't entirely relax about the stability of its inputs over the coming decade.

Pressure to innovate in the automotive industry has perhaps never been stronger in its entire history than it is right now. When Agile was developed by the software development industry around the turn of the millennium, it was because the industry had discovered that traditional engineering management approaches could no longer produce a rapid enough time-to-market to serve the pace of innovation; by the time a product was rolled out, technology had improved so much that it was already obsolete.

Agile itself can never be adapted comfortably to industries with complex supply chains, extensive regulatory requirements, high product integration costs and both human and physical capital needs that differ so radically between design and fabrication. But the unstable requirements and rapidly changing customer demands associated with a climate of innovation will put just as much pressure on the automotive industry of the 2020s as it did the software industry of the 1990s. Heavily optimised Lean manufacturing requires stable inputs to remain effective, not just in terms of resources but also in terms of knowledge and engineering objectives. Adapting to a technical environment where that stability is much harder to obtain will require a transformation as dramatic as Agile to the engineering practices of the automotive industry, to enable it to engineer for Lean – provide engineering stability, in other words – in a climate of innovation.

Many in the automotive industry are already looking to systems engineering as a way to adapt to this challenge. Developed by the defence industry and in continuous, evolving use since World War II, the systems engineering process has a long-proven track record of reducing risk in contexts where reliability and performance are a matter of life and death.

Systems Engineering (SE) techniques are fundamentally about finding ways to analyse, model and plan the behaviour of a system as a whole and in its context, above and beyond the details of individual components. By having a suite of processes and tools designed to model and anticipate the structure of a system, projects can have assurance from the start that the right thing is being built in the right way, and that the project will interact appropriately with its context. This drives down cost by reducing the risk of mistakes and unanticipated defects, while simultaneously driving up quality by tying engineering activity more closely to precisely defined stakeholder needs.

In the context of Lean manufacturing and fast-paced innovation, SE can provide the clarity and foresight necessary to minimise the risk of project objectives changing in the course of development. By modelling and planning the product as a system, it is possible to anticipate many such issues much earlier in the development process and, critically, prior to mapping the value stream and to generating significant sunk costs. And when change does come out of the blue, SE methods produce adaptable models and plans which enable engineers to much more straightforwardly assess the impact of those changes on the system as a whole.

Stable Requirements

According to the Project Management Institute's global 2020 'Pulse of the Profession' study, Project Managers (PMs) in the manufacturing industry report poor upfront planning as the primary cause of project failure. In the same study, manufacturing PMs reported that 40% of project budgets are lost in a case of project failure. In all, the survey reported that 13.5% of total project and programme spending in the manufacturing industry was wasted due to poor project performance; more than any other industry.

SE can address these challenges by taking a robust and scientific approach to requirements management that cleanly and specifically identifies ambiguities and gaps in stated stakeholder needs. The best way to get a straight answer is to ask a straight question, and the SE process is very good at generating straight questions, and requires you to ask them of as broad a range of stakeholders as possible.

SE treats the requirements engineering process like formulating a scientific hypothesis. The philosopher of science Karl Popper famously said that for a statement to be considered scientific, it must be falsifiable; you have to be able to tell the difference between a world in which the statement is true and a world in which it is false. Similarly, systems engineers work towards requirements by which it is possible to tell the difference between a system that achieves them and one that does not.

The requirements that result are – among other benefits – clear, verifiable, functional, minimal and consistent. The SE process guides you to as complete a description of the product as possible at the earliest stages of design, and when change does happen at a later stage, gives you a robust and speedy way to fully understand the implications and adapt.

Adaptable Models

An SE approach to requirements keeps focus on the functional description of the asset, the 'use case'; a problem that needs to be solved, or an opportunity to be pursued. The context and environment for the system – its basic inputs and outputs – should be understood as clearly as possible while the system as a whole is still being treated as a black box. In a systems engineering process, only then do engineers start to formally investigate the sorts of systems which could solve the stakeholders' problem.

As well as the direct benefits of specifying project objectives with such a high degree of precision, this approach to requirements also enables systems engineers to construct sophisticated models of products which can anticipate many potential problems before committing to development costs. These models touch on every aspect of the life cycle and are designed to predict the behaviour of a system taken as a whole. A formal SE model is built out of black boxes, taking inputs from users and the environment and outputting stakeholder needs.

Until the finest levels of detail are reached, the model is not concerned with how individual components work, but rather with the structure of a system as a whole; the inputs, outputs and interactions of system elements. It's about recognising that the structure of a system, rather than the specifications of individual parts, are what determines its behaviour as a whole. As such, the models are nearly always built from the top down, with the system as a whole taking inputs from users and the environment, and outputting stakeholder needs. As requirements get clarified and detailed, the model progresses down equivalent layers of complexity, at each stage fundamentally treating subsystems and individual elements as black boxes that transform inputs into outputs. Therefore, the benefits of an SE model are not just confined to presenting a clear, coherent architecture to designers, testers and operators, it also allows the behaviour of the system as a whole to be anticipated prior to proceeding with development, and potential defects to be anticipated and addressed before mapping the manufacturing value stream. SE models, in other words, provide much more stable engineering and knowledge inputs to the development process, allowing Lean practices to optimise the manufacturing workflow much more narrowly.

A Single Source of Truth

SE is also notable for taking a whole-life cycle view of the product, providing engineering governance processes for everything from business and mission analysis through to maintenance and disposal. As such, SE tools are designed to provide a single source of truth about a project, with an integrated and adaptable repository of project information serving requirements, design, workflow management and quality activities.

All teams involved in making and maintaining the product at every stage of its life cycle can participate in that shared project definition, both inside your organisation and when you have to collaborate with suppliers. If SE processes are followed and SE-specific tools are utilised, that information is retained in a modular way, with requirements, designs and workflows for individual components easily separable from the project as a whole. Information is retained, and its value maximised, not just within a single project, but from one project to the next.

For the Lean automotive manufacturer, SE tools, and the single source of truth they maintain, can provide a vehicle for process and product standardisation readily adapted to value stream mapping, Six Sigma standards of quality, and compliance with Advanced Product Quality Planning (APQP) processes. This stability persists not just throughout the product life cycle, but between one project and the next. The best way engineering can support the Lean manufacturing process is by keeping inputs stable and predictable, such that manufacturing processes can be more fully optimised to the precise demands of a particular product.

In an age of automotive innovation, SE processes and tools could be the best way for manufacturers and suppliers to secure that stability in a climate of rapid change.

If you have found this article useful, and would like to hear more about how your organisation may use systems engineering to better accelerate time to market, manage risk and improve quality visit: www.synthesys-technologies.co.uk or contact us on: cet@synthesys.co.uk

Engineering and the Williams-Shapps Plan

"With this accelerated transition to requirements being driven from the centre, suppliers will accordingly need to step up their transition to a more integrated approach to engineering."

Although it hasn't exactly happened the way it was planned, anyone who has been following the Williams Review has expected that major changes were coming in the way passenger rail is operated in Great Britain.

As was widely anticipated, the now-named Williams-Shapps Plan proposes a move toward Merseyrail-style concession contracts for operators, with a new independent "guiding mind" for the rail network. Great British Railways (GBR) will take over many of the functions of Network Rail, the Rail Delivery Group and the Department for Transport, as well as assuming financial risk from the operators, taking the lead on an overall coordinated strategy and contracting operators directly against performance targets for efficiency and passenger service.

Most rail engineering work assumes decades-long life cycles for the assets it produces and maintains, and the ability of engineering to respond directly to the present crisis in the rail industry is of course limited. But the structural changes we are seeing in the industry now, or something like them, are going to persist for decades to come. Engineering, like every other aspect of the rail industry, is going to have to account for this new reality in planning its way out of the Covid-19 pandemic.

The impact of a change in the passenger-facing operating model might seem to have only rather abstract implications for engineering, but as the stakeholders change, so too will the requirements. Future rail engineering will have to adapt to a different set of priorities, both with respect to the greater degree of central coordination applied to the rail network, and with respect to the changed incentive structure of the operating companies.

Rail engineering has been dealing with increasing system complexity for some time, from projects like the Digital Railway, as well as greater pressure from stakeholders on safety, accessibility, and decarbonisation. But with this faster-than-expected transition to greater central coordination for the network, these pressures for greater complexity will both accelerate and change in character. Rail systems will need to collaborate better, as rail strategy becomes directed from the centre and more focused on the integrated performance of the network as a whole. And even insofar as parts of the rail network can be treated as independent systems, more direct incentives on operators to improve efficiency and passenger service will doubtless also translate into more demanding requirements for engineers.

Systems engineering has already become an important tool for certain parts of the Great British (GB) rail network and has, in the last decade, been fully embraced by infrastructure owners like Network Rail and Transport for London (TfL) as a critical component of the sophisticated engineering necessary to deliver a more complex, interconnected, and digital rail system. Even before these major structural changes to the industry, rail suppliers were starting to wake up to the idea that participating in systems engineering processes with those major contractors could help them work more closely with their stakeholders and deliver better, more complex systems, that integrate more closely with the broader understanding of the network and its systems.

With this accelerated transition to requirements being driven from the centre, suppliers will accordingly need to step up their transition to a more integrated approach to engineering. Systems engineering techniques are fundamentally about finding ways to analyse, model and plan the behaviour of a system as a whole and in its context, above and beyond the details of individual components. By having a suite of processes and tools designed to model and anticipate the structure of a system, projects can have assurance from the start that the right asset is being built in the right way, and that the project will interact appropriately with its context.

Systems engineering has developed a wide range of processes and tools for modelling and simulation, requirements analysis, scheduling, and all parts of the life cycle, tailored to better manage the development of complex systems. In particular, systems engineering takes a robust and scientific approach to requirements management that cleanly and specifically identifies ambiguities and gaps in stated stakeholder needs.

The requirements that result are – among other benefits – clear, verifiable, functional, minimal and consistent. And, critically, they are managed using tools which can integrate those requirements across every part of the network, with seamless supplier collaboration and the ability to see in requirements and models, how any given system is expected to interface with the network around it.

As the rail operating model changes, more requirements will be ultimately derived from the central coordinating body, and more of what is expected of rail systems will require seamless, integrated coordination with the network around it. Stepping up progress toward systems engineering use could be the right way to engineer the railway out of this crisis, and beyond, to the challenges of the future.

To read more about the Williams-Shapps review, visit: https://www.gov.uk/government/collections/the-williams-rail-review

If you have found this article useful, and would like to hear more about how your organisation may use systems engineering to better embrace change, visit: www.synthesys-technologies.co.uk or contact us on: cet@synthesys.co.uk

MEET THE TEAM

WELCOMING MATT HIRSCHFIELD

PRINCIPAL ENGINEER

During an exciting time of growth, SyntheSys Technologies is thrilled to welcome Matt Hirschfield to the technical team. Matt joins us as a Principal Engineer and brings depth of knowledge around our IBM® Engineering Lifecycle Management portfolio offering.

Expertise on the implementation, configuration and enhancement of IBM® Engineering Lifecycle Management tools

Delivering high-value training to high-growth industries

A knack for making the complex seem easy through technical manuals and documentation

ABOUT MATT

Matt has a strong engineering background, with his most recent experience sitting within the Aerospace industry, where he worked to administer the IBM® Engineering Lifecyle Management tool suites for multiple projects with an emphasis on Requirements Engineering. Matt's work will centre around customer deployment, maintenance, training and project enhancement.

SPECIALITIES

- Requirements Management
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- Training Delivery

CONTACT MATT: CET@SYNTHESYS.CO.UK | CONNECT ON LINKEDIN: https://bit.ly/34gXCj8

SUPPLY CHAIN MANAGEMENT

Ensure your Supply Chain Benefits from a Single Source of Truth to Lower the Cost of Producing and Distributing Goods and Services

Common amongst most supply chains is a huge amount of data, and the challenge for manufacturers and engineering businesses is cultivating, sharing and managing this data so that it is useful and shared throughout the supply chain. It is also crucial that suppliers are contributing to a common system of work, and can easily communicate at Tiers 1, 2 and 3.

To tackle this complexity, it's vital that engineers have a 'single source of truth' which flows throughout the supply chain. Our Collaborative Engineering Management approach focuses on how Commercial Off The Shelf (COTS) tools can optimise supply chain performance to lower the cost of producing and distributing goods and services.