OptimiSE

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

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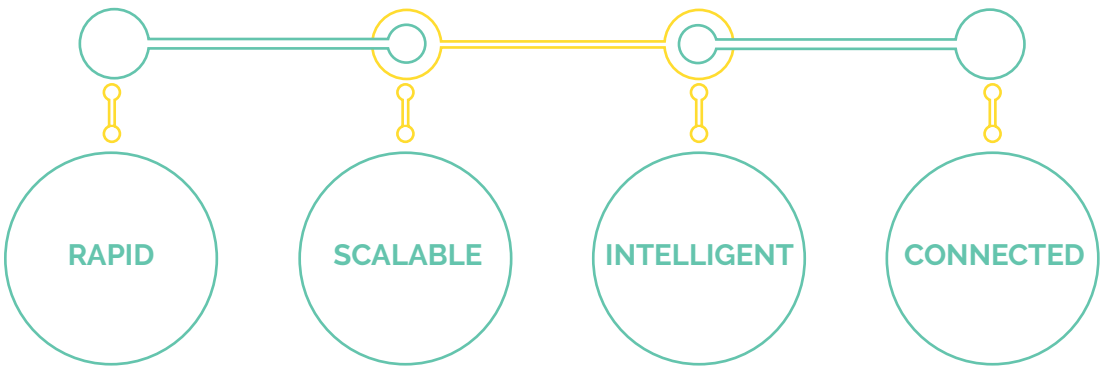
SyntheSys TECHNOLOGIES

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.



Letter from the MD

Mark Williamson Managing Director
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"Optimism does not wait on facts. It deals with prospects."

Faced with an extraordinary and constantly changing environment, many of us are feeling the pressures of the ongoing pandemic. As such, I'd like to introduce this latest issue of OptimiSE with the above, fitting quote from Norman Cousin which sets our sights on better days to come. Out of this unusual situation has come opportunity to adapt and grow, and here at SyntheSys Technologies, we have certainly been busy responding to this changing landscape. With that in mind, I'd like to take the opportunity to send ongoing best wishes to our customers, suppliers and other valued stakeholders.

I hope that this issue of OptimiSE provides some dynamic light reading as we continue to focus on the role that systems engineering plays within high-growth sectors such as Automotive, Rail and Energy.

This latest magazine shines a light on how Agile and Systems Engineering can be used in tandem, to great effect by engineering development teams, please see Pages 6-8 for the full feature. We also continue to explore the 'Complexity' theme on Page 9 where we look at how the rail industry can use proven systems engineering methods for managing highly complex projects.

I am also delighted to introduce our latest 'Meet the Team' feature on Page 11 which shares more insight about Principal Consultant, Matt Muller.

At a time when collaboration and communication is more important than ever, if you or your organisation would like to contribute an article to a future issue, please do not hesitate to contact us via the editor.

I hope that OptimiSE Magazine continues to prove to be useful and enjoyable within the engineering, systems and software development communities.

Very best regards,

Mark Williamson

Managing Director
SyntheSys Technologies

SyntheSys TECHNOLOGIES

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SyntheSys Maintains Cyber Essentials Plus Accreditation

SyntheSys is committed to minimising our information security risk as well as meeting our ongoing contractual and supply chain needs, which is why we are pleased to announce that we have recently passed our latest assessment in recognition of our commitment to cyber security.

We see the Cyber Essentials Plus certification scheme as vital in demonstrating the way we protect our business and our customers. The certification process tests an organisation's Information Technology (IT) systems through detailed vulnerability assessments, carried out by independent cyber security experts, to ensure that IT systems can withstand the most common cyber threats.

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

Speedy Success for Porter Sport Racing

NB: Information correct as of October 2020

The UK automotive industry is a vital part of the UK economy worth more than £82 billion turnover and adding £18.6 billion value to the UK economy. SyntheSys has been providing engineering services to the automotive industry for several years which is why we were thrilled to hear of an interesting and unique opportunity to get involved with local motor car racing team, Porter Sport Racing, via an exciting sponsorship arrangement.*

Tom Porter, 25, from Gateshead established Porter Sport Racing in 2019 after his interest in vehicle manufacturing and production led him to a world of motor sports racing. Tom is currently competing in the Celtic Speed Scottish Mini Cooper Cup.

Tom commented:

''It's great to have SyntheSys on board for my debut season in the Celtic Speed Scottish Mini Cooper Cup. After a disrupted start to the season due to the ongoing pandemic it's great to finally be out on the track racing in the Mini. We managed to complete two pre-season test days to shake the car down and check for any issues as well as dial in the set up on the car. The car performed fantastically on both days thanks to LUX Motorsport with their set up expertise.

So far, we have completed two race weekends and are looking forward to the rest of the season with SyntheSys on board.''

SyntheSys' Managing Director, John Hartas commented:

"It's not very often that such a vibrant opportunity to support young talent presents itself in our business areas and we are thrilled to be involved with Porter Sport Racing. The precision and commitment involved in preparing and competing in these races is commendable."

If you currently work in the automotive sector and would like to hear more about the role systems engineering can play in complex automotive engineering development programmes, please email cet@synthesys.co.uk or telephone +44 (0) 1947 821 464.

For more information about SyntheSys, visit: http://www.synthesys-technologies.co.uk

To follow Porter Sports Racing on Facebook, visit: https://bit.ly/313RUNb

**According to The Society of Motoring and Manufacturers and Traders (SMMT)*

Agile Systems Engineering

It is hard to say whether increasing complexity is the cause or the effect of man's effort to cope with his expanding environment. In either case a central feature of the trend has been the development of large and very complex systems which tie together modern society. […] The growth of these systems has increased the need not only for overall planning, but also for long-range development of the systems. This need has induced increased interest in the methods by which efficient planning and design can be accomplished in complex situations where no one scientific discipline can account for all the factors. – Arthur D. Hall, A Methodology for Systems Engineering (1962).

Many industries have now reached the threshold of complexity past which traditional methods of project management are no longer up to the task, but aerospace and defence was the first, and Systems Engineering (SE) was the result.

Since it first started to emerge in the 1940s, SE has approached complexity by emphasising the structural elements of a system as a whole as the primary generator of its behaviour. It gives engineers tools to analyse and describe the emergent, holistic properties of a complex system over and above the mechanical details of individual components.

Throughout that period, SE has continued to evolve, refining and developing the processes it recommends for the governance of engineering and project management. As more industries have reached the complexity threshold where more sophisticated engineering management techniques become necessary, SE has reached outside of its original context and demonstrated a relevance in a wide variety of industries and product domains.

It is precisely these types of innovations which now enable SE to take a more open approach to the future, learning lessons from other industries which have reached the same complexity threshold that motivated the development of SE, but reacted to that complexity in very different ways.

Agile software development emerged in the early 2000s in precisely this way. The 1990s were, of course, a time when the proliferation and complexity of software applications grew at an unprecedented rate. Using traditional project management approaches, developing these systems could take years, and in this fast-changing world, by the time the software had been delivered, business needs had often already moved on. Because software development had crossed this threshold of technical complexity, project management needed to better respond to the more complex and ever-changing business needs that it was supposed to be serving.

Pure Agile and pure SE were developed in very different contexts, and are at their best when applied to very different product categories and in different environments. Agile was designed for pure software products, where updates are frequent and inexpensive, integration costs are low, there is no or little reliance on specialised hardware, and fabricators are the same people as the designers. In other words, there is little risk associated with getting it wrong the first time, and because the product value is primarily derived from the cumulative benefits of discrete features rather than the emergent properties of the whole, partially working implementations of an idea will often take customers a lot further than they would in traditional SE domains.

But nonetheless, Agile methods have a proven track record of delivering considerable benefits to projects, even outside of software engineering. These benefits go beyond speed and cost, though of course these are key motivations for applying the methodology, but reach as far as providing better scope control and adapting more readily to requirements change. In their respective traditional industries, Agile methodologies have actually outperformed SE in research with respect to ROI: 7:1 in the case of SE activity[1], and 11:1 in the case of Agile project management[2].

[1] Eric Honour. Systems engineering return on investment, PhD diss, 2013. University of South Australia. https://www.hcode.com/seroi/documents/SE-ROI%20Thesis-distrib.pdf

[2] David Rico, Hasan Sayani and Saya Sone. The business value of agile software methods: Maximizing ROI with just in-time processes and documentation, 2009. FL: J. Ross Publishing. https://www.semanticscholar.org/paper/The-Business-Value-of-Agile-Software-Methods%3A-ROI-Rico-Sayani/e1f8a6a88a92b3c6f5cebb5ba0e50320f0e27115

But, of course, those benefits cannot be expected to straightforwardly translate out of their original intended context. However, cutting edge projects have shown it is possible to access the best of both worlds, with a hybrid methodology that learns the most important lessons of both approaches. Implementing a hybrid Agile Systems Engineering (ASE) could be the next major step forward in our ability to drive value.

Interface Management

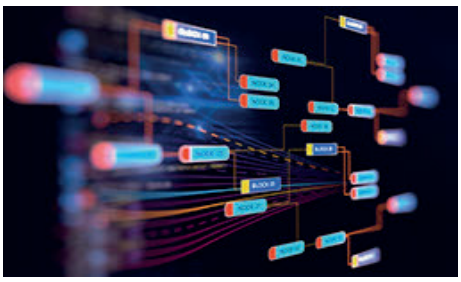
The great virtue of SE methodology is its ability to address the holistic aspects of a system independently of the sum of the parts, and to analyse the ways the structure of the system generates its behaviour beyond the mechanical details of individual components. It is precisely this whole-system view that Agile lacks, essentially because it isn't needed in its traditional domain, where product value is primarily derived from the cumulative benefits of discrete features.

Agile methodologies exceed the capabilities of pure SE in cost, speed and change-readiness terms where individual components can largely be treated in isolation, conforming to clearly specified requirements and where integration with the larger system doesn't have to be a major concern of the development process.

It's worth recalling that most fundamental insight of SE models - the structure of a system is what generates its behaviour. The atoms of an SE model are 'system elements': individual components, which are treated as a black box, in an environment from which they take their inputs. Using a model like this enables a systems engineer to focus on complex interactions within a system and between the system and its environment, including patterns and trends in how the system changes over time, the impact of time delays in the system's operation, the circular nature of complex cause-and-effect relationships, the problem of where unintended consequences are going to emerge, and the ability of a system to address customer requirements.

Because of the black-box, hierarchical nature of an SE model and SE techniques more broadly, the techniques used for definition and development in the top half of the V model need not necessarily be the same as those used in the bottom half. The cutoff comes after the interfaces for individual components and subsystems have been defined; how those different parts are going to work together.

SE techniques are used to develop a product architecture with strict and clear standards for how the individual components will connect together along with the overall design constraints and objectives. Additionally the capacity to swap those components out as requirements evolve is achieved with only a minimal or well-understood effect on the behaviour of the rest of the system. From there, Agile project management can be used to drive innovation, value, speed and adaptability at the subsystem level.



Driven by the open system architecture that enables both of these methodologies to work together, hybrid ASE techniques have unlocked some impressive capabilities, demonstrated well by a paradigm and extensively studied ASE project: the Johns Hopkins Applied Physics Laboratory's Multi-Mission Bus Demonstration project[3]. This project was a successful attempt to produce a military space satellite to the size- and weight-restricted 'CubeSat' specification, which would allow the satellite to be launched more cheaply through 'ridesharing' with other payloads.

The team had very strict time and budget constraints, and the project required extensive development of new technologies and system components. It was clear that traditional project management wasn't going to be fit for the challenge.

A pure Agile methodology wasn't going to work either, because of the extreme constraints on how the individual components of the satellite had to fit and work together. As such, the project did some initial SE-like activity at the outset to define the plug compatibility standards, the interface with the spacecraft bus itself, and the external form, fit and function of the individual subsystems[4].

[3] INCOSE. 2015. Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities, version 4.0. Hoboken, NJ, USA: John Wiley and Sons, Inc, ISBN: 978-1-118-99940-0

[4] Philip Huang, et al. Agile hardware and software systems engineering for critical military space applications, 2012. Proc. of SPIE Vol. 8385. https://www.spiedigitallibrary.org/conference-proceedings-of-spie

From there, scrum-like teams were assigned to work on the individual component subsystems, and were empowered to make incremental improvements to the design within the constraints assigned by the overall system architecture. These constraints could be modified if necessary, but only through a more SE-like top-down committee involving all of the subsystem scrum masters and the program manager.

The project was a success, and the satellites, in addition to a number of successor projects, are working in orbit.

CHASE Process and Tools

Hybrid Agile Systems Engineering needs to be collaborative. Both domains need to learn from one another, work together well and to an extent, learn from one another's techniques; SE teams managing interfaces will also likely need to understand and promulgate project plans that use Agile methods of dependency tracking, prioritisation and workflow management, and Agile teams developing components will have to learn to conform to SE interface standards and likely adapt to requirements specified in ways that more closely resemble SE good practice. Nonetheless, SE absolutely has to own the programme governance, the high-level requirements and the interface standards to which individual projects and components must conform.

Collaborative Hybrid Agile Systems Engineering (CHASE) is our approach to bringing these two engineering management philosophies together, and delivering the value benefits of both. Doing CHASE well requires excellence in both Agile and SE processes, a unique tool configuration, and skills among team members to allow these techniques to work together effectively. And done right, we believe it could be a major step forward.

The Complexity Gap

Managing Complexity in Rail Supply Using Proven Systems Engineering Methods

Even before the COVID-19 crisis, the next few years looked like a period of significant change for the rail industry. The network is being transformed by massive investment in the digital railway, and technologies like cab signalling and condition-based maintenance require IT integration between systems that never used to directly interact.

In the longer run, greater central control of the network and a set of common strategic priorities set by an independent guiding mind, will create pressure for the different components of the network, and suppliers to it, to work together better. Opportunities from decarbonisation, accessibility, Augmented Reality, automation and Internet of Things technologies only make the technical complexity of supplying to the rail industry seem more formidable on longer time horizons. Rail systems, in short, from the remotest level-crossing to the network as a whole, are getting much more complicated. Every little piece of infrastructure, every part of a train, increasingly needs to be looked upon as a detail in a big picture rather than as something more discrete, with its own maintenance schedule and separately identifiable requirements.

When industries turn 'smart', when that threshold of technical complexity is passed, it usually requires of engineering to radically rethink its workflow and practices. When it happened to software engineering in the 1990s, Agile was the result. Rail is getting to a similar position now, and the time has come for it to explore options for how it can adapt to this changing environment. Agile, for all the buzz, is unlikely to translate well to rail systems in most cases. Agile was designed for products with frequent update potential, low integration costs, little dependence on specialised hardware, and with minimal regulatory constraints. In other words, there is little risk associated with getting it wrong the first time.

In rail, the whole thing had better work together first time, not just as an independent system, but in the context of the complex system-of-systems that is the network around it. If there is a defect in the product arising from an unexpected feedback interaction between apparently independent components, it could at best require you to go all the way back to the drawing board, and at worst result in a deadly disaster.

Software engineering wasn't the first industry to reach a complexity threshold which required them to throw out the engineering management playbook; that honour goes to aerospace and defence, which began overhauling its methods during World War II, and has continued to develop these engineering management techniques – which came to be known as Systems Engineering (SE) – through the space programme and into the most complex military systems of today.

Rail supply needs an Agile-like revolution in the way it manages engineering complexity, but Agile itself will only work in very specific and limited contexts. SE has already made considerable headway in the rail industry as an alternative way forward, starting with major infrastructure owners and projects like Network Rail, TfL, Crossrail and HS2. But it is yet to reach all parts of the industry, and as growing rail network complexity reaches further down the supply chain, the argument to adopt SE techniques more broadly, only grows stronger.

Processes & Tools

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, organisations can have assurance from the start that the right thing is being built in the right way, and that their product 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.

SE 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. Of particular interest is how SE thinking has produced a robust and scientific approach to requirements management and verification, a greater focus on the full life cycle of a product, and novel modelling techniques for complex emergent behaviour.

An SE approach to requirements is designed to cleanly and specifically identify ambiguities and gaps in stakeholder

needs. SE treats the requirements engineering process like formulating a scientific hypothesis. If an SE process for generating requirements is followed, it is immediately and specifically visible when individual requirements are not clear, verifiable, functional or minimal, as well as when they are together incomplete or inconsistent. As a result, the question that needs to be answered either by stakeholders or by engineering is specified precisely and robustly.

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 an SE 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.

The most fundamental insight of SE models is that by analysing the structure of a system, you can understand aspects of its behaviour that would be missed by focusing only on the individual system elements.

These elements are organised into systems, and then even into a 'system-of-systems', which is a model for systems with very independent components and a function that firmly rests on emergent behaviour, like a railway network or a supply chain.

Using a model like this enables a systems engineer to focus on complex interactions within a system, and between the system and its environment, including: patterns and trends in how the system changes over time; the impact of time delays in the system's operation; the circular nature of complex cause-and-effect relationships; the problem of where unintended consequences are going to emerge, and the ability of a system to address stakeholder needs.

SE also provides a much more robust process for integration, verification and validation. By using a scientific approach to requirements management with specifically enumerated constraints on what requirements can look like both individually and as a set, the SE process ensures that verification and validation are conducted in relation to specific, measurable and consistent goals.

Finally, by taking a whole life cycle approach, SE can help to ensure the success of midlife upgrades, prevent the loss of system capabilities during operation and avoid costly compliance failures and other losses during end-of-life disposal.

SE, in the rail industry and elsewhere, has a proven track record of delivering increased efficiency, capability and adaptability in the development of complex systems. Now could be the moment for far more of the rail industry to adopt the technique.

Meet the Team

Matt Muller

Principal Consultant

A professional consultant who excels at application development and implementation for engineering life cycle solutions.

Matt has worked with prestigious customers in automotive, defence, banking and transport sectors, to deliver and support systems and software solutions. We were delighted to welcome Matt to the SyntheSys Technologies technical team in September 2020.

Here, Matt tells us more about his background, experience and what makes him tick!

"Happiness is mostly a by-product of doing what makes us feel fulfilled" *- Dr Benjamin Spoke, 1903-1998.*

My career started in engineering at Rugby General Electric Company. I worked with key customers on very interesting and dynamic projects in the Power Conversion team which formed the basis of my background in electrical engineering and project management. All forms of engineering and technology interest me. At 17, I purchased my first car, an MG Metro, and have been fascinated by cars, motor sports and watching car restoration programmes ever since. It was my goal to work in the fast-paced automotive environment, so I was thrilled to join Jaguar Land Rover (JLR) as the administrator for their Ford Design Verification System (FDVS) under Premier Automotive Group (Ford, Volvo, JLR and Aston Martin) for Requirements Management and Design, Verification and Validation. It was a great decision and a very enjoyable 12 years of my working life.

As my career progressed in the automotive domain, I found myself working with automotive architecture, standards, test procedures and automotive regulatory compliance; working with teams to define a common vehicle attribute architecture and the relationships between systems and sub-systems as part of vehicle strategic direction, for platform and shared systems across vehicle programs. This work was challenging and resulted in me learning about Systems Engineering themes such as Requirements Management, Configuration Management and Test Management.

This knowledge was useful and further flourished when my attention turned to application management and continuous improvement where the focus was on application development, deployment, configuration, user support, methods, guidance, training, workshops and support sessions. I quickly understood how to support projects, management, teams and users with varying needs.

During my JLR days, I was involved in the delivery of the web-based version of the FDVS, Clone and Go of the FDVS system, when JLR were sold to Tata in 2009. The biggest and most exciting project was the deployment of the replacement for FDVS - the new much improved Requirements Management and Design Verification and Validation (RMDV2) solution using IBM® Engineering Lifecycle Management; I consider this one of my biggest successes. Anybody working on this team will tell you how brilliant it was to work with such a great group of people to replace the legacy Ford system; a small team worked on the RMDV2 project and put my knowledge of the existing tool and strategy to good use. I had the pleasure of presenting the roadmap to the directors at JLR at the start of the project which helped shape the requirements part of the iPLM Product Lifecycle Management strategic direction. At that time, the IBM® tools were tactical solutions for the short term but grew to over 2000+ users and over 15 vehicle projects. The RMDV solution is still in operation now.

With 12 years+ at JLR I decided to take my knowledge and experience in deploying solutions to other markets and started offering consultancy services. I was ready to tackle new challenges but quickly found that different industries have very similar problem statements! Providing consultancy and experience from previous roles worked very well, enabling clients to progress project challenges through the application of transformational skill sets. This led me to working with software teams in the banking industry where new approaches interested me; this was my first exposure to Agile and Scaled Agile. I worked with many teams to define project solutions and Agile ways of working and provided the applications, tools and education to enable full agility across dispersed locations with common Sprint and project goals.

I was involved with consultancy contracts on various projects in the defence and rail sectors focusing on the migration and testing of IBM® applications on complex international deployment and also provided integrated solutions for Test Management and traceability for compliance and regulatory requirements. Then my consultancy journey came full circle, back to automotive when I started on the exciting Dyson Automotive project and then at Yasa Motors.

Developing, troubleshooting, and creating in an Engineering management environment brings many opportunities for a real sense of achievement but there are some more notable projects. Take for example, the work I did with NASA delivering a new Wind Tunnel into Langley Research. This was a fascinating project.

I consider the Requirements Management, Design and Verification work done for Yasa Motors, Tata Motors, JLR and Dyson Automotive some of my best and most rewarding work to date.

I take real satisfaction from the work I do with clients on migration, upgrading and testing; the client recommendations always have Continuous Improvement at the centre.

The key to understanding what success looks like for clients is to form strong and close relationships with them. I enjoy taking process and engineering challenges and look at how the team's knowledge and experience can be used to establish a roadmap for success. The most rewarding part of my job is to build on individuals' strength and empower teams to continuously improve. In every project that I've worked, my clients become friends and this is the most enjoyable part of my work.

In my home life, I'm a keen snowboarder and have visited many different resorts in Europe, Canada and America, enjoying time in the mountains with family and friends. As a family, we are enjoying spending time with our puppy (lockdown puppy) on family walks.

Finally, I am proud to have joined the SyntheSys Technologies family. I am already working with many exciting customer projects and I anticipate a bright career and future in this stimulating and challenging new role.

> ***"I'm about working smart, delivering best-in-class solutions and building strong client relationships."***

IBM® Engineering Lifecycle Management Health Check Service

During a thorough review and check-up, our consultants will review your technical and operational environment, the tools and applications you currently have implemented, and associated mechanisms. We will evaluate and identify any issues with performance, outstanding tickets, operational usage and technical constraints. We are experienced in reviewing the development processes and associated application configuration deployment, so as to promote continuous improvement of your implementation.

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- Experienced guidance from our best-in-class application consultant (remote or on site);
- Formal report containing recommendations and solutions for success.

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