

System Engineering (SE)

Point of View

Most companies in the Aerospace & Defence (A&D), transport and automotive sectors which are developing complex systems, under strong technical and normative constraints, have benefited from SE for more than 20 years to:

- Reduce their development cycle time,
- Increase their responsiveness to rapidly changing customer needs
- Easily absorb regulatory constraints

All these actors have, in addition, implemented strong policies in terms of:

- Standardization and reuse (requirements, technical building blocks, verification and validation elements...),
- Extended business operation with multiple stakeholders: customers, suppliers, regulatory organizations
- Digitization of engineering data: requirements, technical data-models, 2D, 3D, IVVQ by HIL (Hardware in the loop), MIL (Model in the Loop)... - and programmatic: engineering sequences, workflows, design reviews...

Cycle time reduction



5 to 10%

System cost reduction



15 to 25%

Development effort minimization



10 to 15%

Attractiveness improvement



Engineering career and expertise

Development cost reduction



8 to 12%

Alignment to stakeholder's needs optimization



Solution optimization

*Source : return of experience from best practices industries, PwC analysis.

System Engineering addresses the challenges of engineering intensive' industries

SE allows to master the increasing complexity of systems and their environment through a rigorous approach to better manage the needs of key stakeholders: customers, certification authorities, regulators, etc. and their evolutions. Systems Engineering helps structure the needs and requirements coming from all stakeholders (volumetric, quality, relevance ...), so as to:

- Define the essential needs in a manageable volume of requirements
- Design systems finding both technical and economic optimization
- Rigorously control (allocate, trace) requirements over the entire life cycle of the system and over the entire industrial chain
- Master the configurations and evolutions of systems or system of systems

SE increases the efficiency of engineering activities, in particular by creating resilience to changes in needs while controlling expenditure.

This includes:

- Integrated management of the project and business portfolio in order to pool resources to control costs and ensure developments quality
- Shared and optimized multidisciplinary engineering sequences that respect the principles of concurrent engineering (parallelization of activities and reasoning with references) and simultaneous engineering (working on both the system of interest and all its contributor systems – such as test benches, industrial means, integrated logistic support...)
- Holistic engineering data management rather than document centric to enable simultaneous use by all stakeholders (especially from the industrial chain) at each development phases
- A rigorously applied capitalization mechanism embedded in the engineering framework
- A strong reuse and platforming approach allowing to:
 - Leverage standard frames and building blocks which can be carried over from one generation of system to the other or carried across product lines
 - Maximize the use of on-shelf components

SE serves as a reference within industrial ecosystem by implementing an approach that relies on:

- A common language that brings together internal and external stakeholders around a shared repository
- A standard development cycle that accelerates the development activities (specification, design, purchasing, integration, verification, validation, quality, etc.) and ensures the robustness of the design through a mechanism of maturity milestones

- Fundamental systems structures: Product Breakdown Structure, Work Breakdown Structure, Organizational Breakdown Structure ...
- Development methods based on dedicated digital tools:
 - A multidisciplinary and multi-stakeholder collaborative digital engineering environment based on PLM (Product Lifecycle Management) or ALM (Application Lifecycle Management) solutions
 - A Model Based System Engineering (MBSE) approach that allows architecting optimized systems by crossing system views: functional, organic, operational, organizational, technical ...
 - Multi-criteria analysis algorithms (trade-off) for different design choices, design reviews, securing the “need and solution adequacy”...
 - Integration of all dysfunctional methods (RAMDS - Reliability, Availability, Maintainability, Dependability, Safety) to ensure design robustness
 - An intensive use of numerical computations, augmented reality visualization and virtual reality, Hardware in the Loop test systems, Software in the Loop, Model in the Loop, User in the Loop ... to anticipate integration, verification and validation phases while drastically decreasing investments in physical prototypes
- Clarified roles and responsibilities allowing integrated teams operations, around a strong System Architect function.

However, adopting system engineering requires a progressive and controlled transformation path:

The return on experience from major A&D, Energy and Automotive Industrials shows that following a massive and undifferentiated implementation path whatever projects complexity and focused mainly on the tools leads to a rejection by the teams and a loss of efficiency in system or product developments.

The current leaders in system engineering have, for the most part, been confronted with these typical pitfalls, in particular by following an approach which was too much “tool centric”.

To remedy this, they put in place:

- A differentiated approach by activities according to the stakes and the complexity adapting methods, tools and their depth of application
- A digital engineering environment that:
 - Allows direct work on data and engineering productions rather than documents
 - Eases the engineering sequences
- A field operational support
- Practical and operational guides by activities consistent with business processes.

- The implementation of system engineering must follow a gradual implementation, focusing first on working on the methods before developing the other components (tools, support ...), consistent with business challenges. In other words, there is no «monolithic» approach to tackle the SE transformation challenge.

It is important for each organization to find the right balance between the execution phases of the Systems Engineering work on development projects and the methodological deepening of activities that could prove to be less mature.

Our benchmark shows that the most advanced industry players have engrained Systems Engineering in their business processes and that the success of their transformation path was based on:

- An ambition whose realism must be constantly controlled
- An immediate application on ongoing projects
- A simultaneous action on processes, methods, tools and individuals
- A constant sponsorship at the highest level of the organization
- A systematic involvement of engineers in defining their SE methods and tools
- A central / local articulation of methodological support

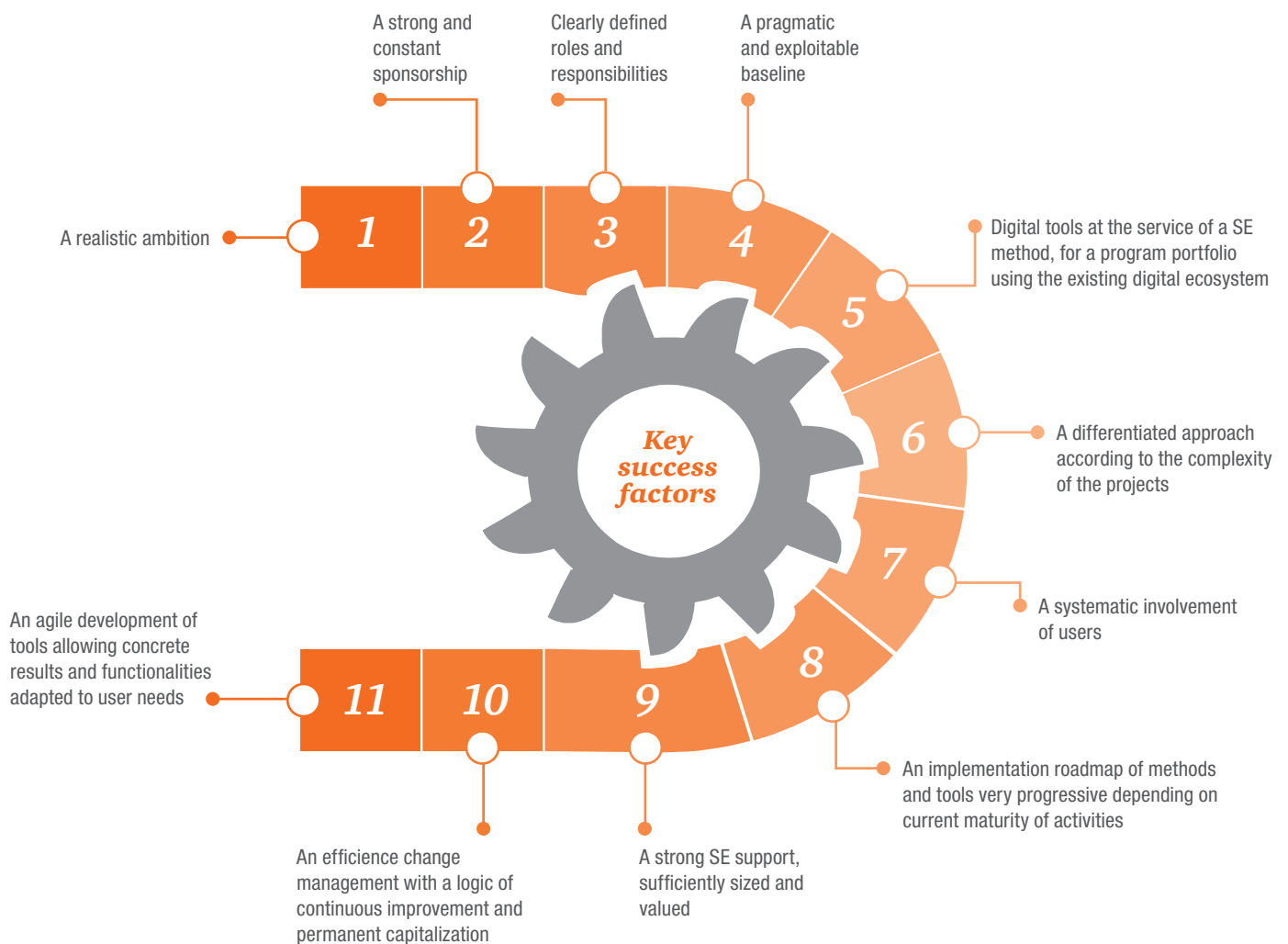


Illustration of recent credentials

NATO

PwC has provided its expertise and support to the BMD/ AMDC2 Defense program, the NATO Ballistic Missiles Defense program for the development of a capability based on a complex system of systems (space, naval, air and land capabilities).

French MOD DGA

PwC supports the French MOD on the development and implementation of Systems Engineering for the benefit of efficient defense systems acquisition programs. PwC accompanies the SE transformation roadmap for processes, development methods, roles and responsibilities as well as digital engineering tool set.

ENGINEERING ORGANIZATION OF A MAJOR FRENCH ENERGY PROVIDER

PwC helps the engineering organization assessing its global Systems Engineering maturity and supports the team for the adoption and tailoring of SE processes and best practices for their business

AUTOMOTIVE OEM

PwC supports a major OEM in optimizing its R&D effort for its platform development

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