# Valuing our place in the world - Using Systems Engineering in Programme and Project Management

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**Abstract.** With a "coming of age" comes an increasing sense of awareness and of responsibilities outside one's immediate circle. For Systems Engineers, this is where the discipline is able to fulfil its potential to support, define and drive an organisation's activities to solve complex business problems. Programmes and projects need both technical and managerial leaders who understand and support each other's needs and challenges, and therefore work in an integrated way to achieve success.

The INCOSE UK/APM Joint Working Group (JWG) on Systems Engineering (SE) and Project/Programme Management (PM) Integration has been building a shared understanding of mutual dependencies. It is seeking to promote both the benefits of systems thinking across the wider decision making community and how to deliver these benefits.

One particular area of the JWG's work has been the analysis and integration of life cycle and process definitions. In this area the JWG has continued to develop the narratives of past ASEC events to arrive at a comparison and categorisation of different SE and PM life cycle representations, and an analysis of where SE and PM processes touch, overlap and support each other.

Categorising the range of different life cycle representations into Scenarios, Approaches and Models helps communicate the importance of understanding and selecting the correct life cycle. Introducing a conceptual representation of an integrated life cycle model makes it possible to explore and articulate touch points, tensions and fusions between the two disciplines as indicators of the wider synergies that can be achieved.

Our work demonstrates the benefits of embracing different perspectives and the application of Systems Thinking to the wider delivery system.

On INCOSE UK's 21st anniversary, can we give the SE community the keys to help unlock the barriers between SE and PM?

## Introduction

**A coming of age?** A 21st birthday is a time typically associated with 'coming of age'. This includes an increasing sense of awareness, of responsibilities outside one's own immediate sphere of influence, and of finding a place in the world where one can feel valued. On the occasion of INCOSE UK's 21st birthday it is appropriate to reflect on how SE can be valued outside of its immediate environment and especially in its relationship with project and programme management practitioners.

This paper explores and describes some of the findings of a working group established to consider how best to increase the level of mutual understanding between SE and PM practitioners, obtain greater value through the application of SE principles and techniques to PM activities, and achieve increased recognition of the benefits of SE.

**The Joint Working Group**. The INCOSE UK/APM Systems Engineering and Project Management[1] Joint Working Group (SEPM JWG) was formed in July 2013 as a result of a recognition by both organisations that closer integration of the two disciplines should increase the probability of project success. Its aim is …

> *To develop and promote good practice and guidance dovetailing SE and PM and promote systems thinking across the wider decision making community in the UK […] in order to support the improved delivery of complex projects and avoid common pitfalls. (SEPM JWG 2013)*

The SEPM JWG is composed of eight work streams (WS), shown in Table 1, which were established in order to define the benefits and value of increased SE and PM integration; to provide a focus in how to deliver these benefits, and how to communicate the benefits to a wide range of audiences.

**Table 1: SEPM JWG Workstreams**

| What are the benefits? | |
|---|---|
| WS 1 | Compelling value proposition |
| **How to deliver the benefits?** | |
| WS 8 | Life cycles and processes |
| WS 4 | Roles and responsibilities |
| WS 6 | Competency framework |
| WS 7 | Education and training |
| **How to promote the benefits?** | |
| WS 2 | Communication & exploitation |
| WS 3 | Guidance material |
| WS 5 | Case studies |

The work of the SEPM JWG is not yet complete, but some of the outputs have already been disseminated – an INCOSE UK Z-guide (Z11) was presented at ASEC 2013 (Cowper & McGlynn 2013); a one-page value proposition and a poster describing outputs were provided at ASEC 2014 (SEPM JWG 2014), and a presentation based on the work of the JWG was made at the APM Conference in 2015 (Cooke & Rooke 2015).

**Life cycles and processes.** This paper explores ways of exploiting the value of greater SE and PM integration through the SEPM JWG work looking at *Life Cycles and Processes* ("WS 8" in Table 1). This workstream is identifying where SE and PM models, approaches and ways of working overlap; it is developing a unified conceptual model to illustrate the touch points between the disciplines, and it is communicating the exploitation of such synergies amongst the SE and PM communities.

This work has not been undertaken in isolation but in conjunction with the efforts of the JWG across all work streams. Analysing life cycle representations and processes helps to identify and explore the differences in perspective between the two disciplines and where they touch, overlap and support each other - or where they create tension.

## Approach to identifying the range of life cycle and process definitions

**Continuing ASEC narratives.** The work of the JWG on life cycles and processes is a continuation of existing narratives within the SE and PM communities, of which ASEC (and its predecessors) forms an important part. These narratives have informed an important element of the research approach taken by the JWG in comparing, contrasting and consolidating information gathered from many sources, and interpreting this information in ways that could provide benefit to both SE and PM practitioners.

[1] Within the context of this paper the term 'project management' (and abbreviation PM) also represents the disciplines of programme and portfolio management unless indicated otherwise

Firstly, at the 2009 Autumn Assembly, Rick Adcock & Andrew Farncombe re-examined various SE life cycle models and approaches (Adcock & Farncombe 2009), looking to review their applicability and identify areas for future work. This theme was subsequently picked up and discussed by a Bristol Local Group workshop (Brain & Gibson 2011).

Secondly, at ASEC 2011, Mark Fielding-Smith presented the results of a Selex SI/UCL survey into the behaviours of PM and SE practitioners and the integration of programme management and SE approaches (Fielding-Smith 2011), which included recommendations to review and consider the integration between SE and PM processes.

Both of these narratives have been used as a springboard by the JWG to bring elements together from a variety of other sources, and an interim set of findings was provided at ASEC 2014 (SEPM JWG 2014).

**Life cycle representations.** Key sources of information for identifying the wide range of life cycle representations included the INCOSE SE Handbook, the APM Body of Knowledge, the PMI Body of Knowledge and various sector-specific examples from the fields of defence, construction, aerospace, software generation, transportation and health care. Information was also drawn from the Axelos Best Management Practice suite (including MoP®, MSP®, PRINCE2®).

**Process comparisons.** Information on SE and PM processes was drawn from the same key sources as for life cycles. In addition, the ISO standards for SE (ISO15288:2008) and Project Management (ISO21500:2012) allowed a direct comparison of processes on a consistent basis, as shown in Figure 1.

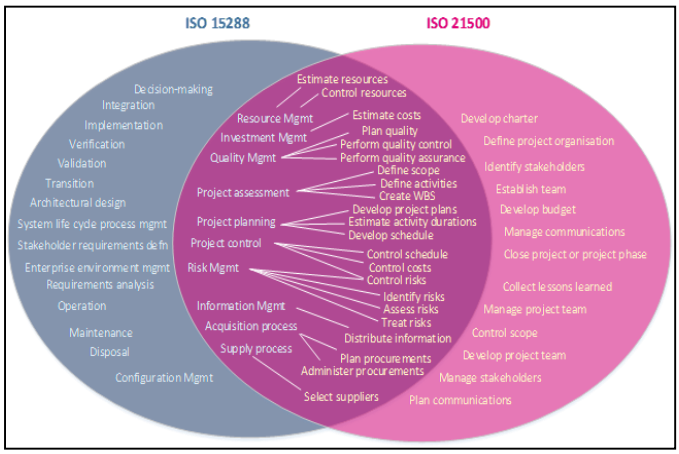


**Figure 1: Example comparison of processes for SE and PM (using ISO definitions)**

## Results from analysing the range of representations

**SE vs PM terminology.** It is important for mutual understanding that common terminology is used, or at least the differences in terminology are recognised and understood. For example, there is a key difference in the principal use of the term 'life cycle' by the two communities. A project or programme life cycle is typically focused on the *implementation* of a system (or product) rather than the life cycle of the system (or product) itself, as shown in Figure 2. Other terms such as 'Stage' or 'Phase' are used interchangeably in some cases, but have specific meanings in other situations (for example the term 'Stage' within the PRINCE2® framework).

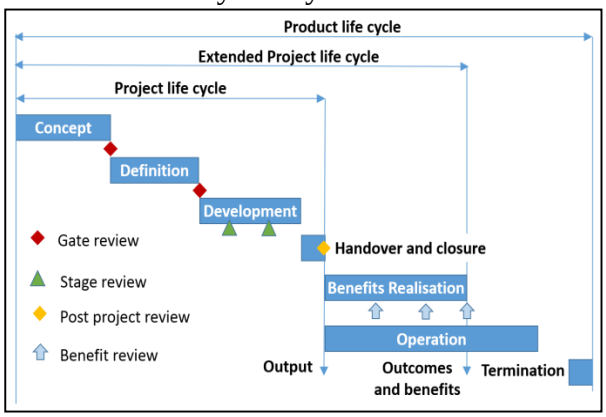


**Figure 2: Comparison of project vs product life cycle (from APMBoK 2012)**

**Addressing a multitude of life cycle representations**. There are many different representations by which life cycles are understood, deployed or navigated, and these can be influenced by objectives, environments, organisations and other incentives or constraints. In order to aid the aggregation and communication of information across SE and PM practitioners, a common

terminology has been adopted by dividing these different representations into *Scenarios, Approaches* and *Models* as shown in Table 2.

The term ***Scenario*** is used to depict high-level strategies or plans to achieve specific goals. These scenarios will be shaped by factors that influence the business environment such as challenges, conditions, organisations and market requirements. *Business Change Life Cycles* as understood within Portfolio Management (Jenner & Kilford 2011) are included within this category.

***Approaches*** are representations of flows and interactions between discrete life cycle models. Different approaches may be used for different scenarios and/or combine different models, and typically can be associated with programme delivery and transition planning.

***Models*** are a specific representation of a framework of processes and activities within each life cycle phase that depict the elements that are undertaken and how they relate together. A model comprises phases / stages, constituent processes, the products generated as outputs of those processes, and definitions of the roles and responsibilities in contributing to each process and the generation of each product.

**Table 2: Categorisation of life cycle scenarios, approaches and models**

| Life Cycle Scenarios |
|---|
| New product/facility/software design, development and introduction |
| Transformational change |
| Capability or service acquisition |
| **Life Cycle Approaches** |
| Base |
| Experimental |
| Incremental |
| Evolutionary |
| **Life Cycle Models** |
| Management |
| Development |

PM practitioners need to understand these different representations when deciding upon the strategy that best addresses the portfolio, programme and/or project objectives. SE practitioners need to support PM practitioners in this by explaining the development needs, and the implications of the choice of life cycle on the overall project or programme strategy.

**A combined conceptual life cycle model.** To demonstrate how PM and SE interact, and the benefits of joined-up thinking, the JWG has extended a conceptual SE development model (Vee-model) to incorporate a management perspective based on an earlier PM representation (Chapman & Gray 2014). Figure 3 shows the resulting combined Vee-model which highlights areas of overlap and where the two views complement or enhance each other ('touch points').

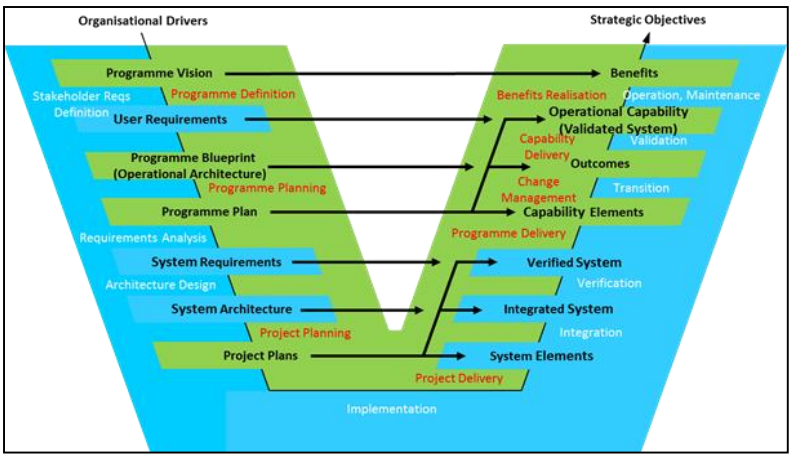


**Figure 3: The SEPM Vee-model (the outer Vee represents SE processes, the inner Vee PM processes)**

**Touch points.** The model identifies touch points where the two perspectives are looking to achieve the same objective but use different concepts or terminology. For example, both perspectives look to define current and future states but SE uses the concept of an Operational (or Enterprise) Architecture - the output of a modelling activity based upon an Architecture Framework - whereas PM uses the concept of a Programme Blueprint. Similarly, the two communities use different terms, Validated System (SE) and Operational Capability (PM) to

describe the delivered system after transition to the operational environment ("Business as Usual").

**Tensions**. Tensions can arise not only from *actual* SE/PM perspective differences but also from preconceptions and mis-communications. Terminology clashes, over-elaboration in both requirement setting and project planning, overlaps or gaps in responsibilities and a failure to articulate the value of SE or PM processes to leaders or teams all contribute to tensions, underpinned by a lack of mutual understanding and respect (Fielding-Smith 2011).

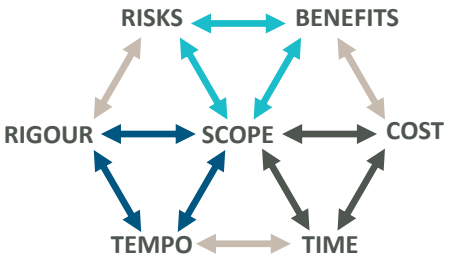


**Figure 4: Project tension fields**

In addition, any process issues are exacerbated by the 'tension fields' (see Figure 4) that operate within project environments due to the differing demands and objectives that are present. Both SE and PM practitioners must recognise and understand how their perspectives and actions both affect, and are affected by, these tensions.

**Fusions.** The review and analysis of processes within the SEPM Vee-model has identified a number of examples that illustrate the benefits of greater SE and PM integration. These fusions include:

- Employing SE techniques in project product-based planning
- Adopting a system of systems approach to programme definition and management
- Utilising architectural modelling in defining programmes and projects
- Extending verification and validation principles beyond test, evaluation and acceptance to plan and confirm the realisation of benefits
- Identifying and managing project to project interdependencies
- Applying soft systems methods to team design & management
- Using SE to improve the governance of complex projects

Details of these fusions will be the subject of future SEPM JWG publications.

## Conclusions

**Embracing different perspectives.** SE and PM are both ways of thinking about complex problems, ways of delivering enduring change, and ways of combining disparate disciplines. Even within the limited areas of life cycle representations and processes there are significant synergies, overlaps and tensions between the two perspectives, and these all offer opportunities for SE and PM practitioners to recognise and appreciate each other's perspective and contributions in order to collaborate for mutual benefit.

**The value of integrated working**. SE underpins the solution planning - development - delivery project lifecycle by providing the necessary discipline to the specification, design, implementation, testing and delivery of project outputs. PM helps to establish the 'business context' within which the SE activities are undertaken, and to understand the wider system of interest and its external influences. Addressing complexity, providing appropriate rigour, understanding the true system of interest, removing unproductive tensions and improving the recognition of risks will all result in tangible benefits to the organisation.

**The wider opportunities for greater mutual understanding**. The work of the SEPM JWG embraces many other aspects of SE/PM integration beyond the opportunities identified in the assessment of life cycles and processes. Further information and guidance material will be published in due course to provide practitioners with the awareness, understanding, tools and techniques to deliver greater value from the benefits of integrated working.

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