



THE BIRTH AND DEVELOPMENT OF SI:D³ AND LESSONS LEARNED

This article explores the evolution of WSP's systems integration approach.

In the beginning, chaos prevailed... Everything changed when WSP's UK Systems Engineering & Integration team codified the systems integration (SI) processes and techniques we were applying in major railway programs. Each new megaproject could then benefit from WSP's proven SI approach that provided an enlightened perspective and a clear path to deliver targeted client outcomes. Today, SI:D³ reflects years of learning by doing. A brief tour through history offers insight into why SI:D³ is a timely approach for current complex programs.

In the Beginning

WSP's SI capability has developed from experience with several major railway programs such as the East London Line and Victoria Line Upgrade (where through acquisition WSP inherited legacy knowledge and capability) between 2005 and 2009. At that time, the application of a systems approach was in its infancy in the railway sector, and concepts such as a migration plan were developed to manage the staged delivery of program benefits. Many of the concepts were consolidated and advanced into breakthrough thinking on the Thameslink Programme to manage the delivery of Key Output 2 (KO2), bringing clarity to the complexity of that program. But that wasn't all. As part of working with the Thameslink SI team, we brought together several systems thinking processes to provide a holistic approach—for example, a suite of system architecture views that described the changes applied to the railway at each of the defined configuration (migration) states.



Thameslink train at London Bridge Station, United Kingdom

The benefits of SI soon became evident, and the approach was highlighted as best practice in a major United Kingdom (UK) government review (the McNulty report of 2011). As the investment in rail in the UK grew and several complex programs were initiated, it became apparent that program-level SI would now be demanded by the UK Department for Transport and the UK Rail Infrastructure Managers, especially Network Rail in their major projects going forward.

This moment in railway evolution clearly presented an opportunity to cultivate our SI approach for widespread application.

The Birth of SI:D³

In view of the growth in complexity and the need for a systems approach to be applied at the top level of major programs, WSP determined that the techniques our team had been using should be codified to form the foundation of a service. Based on how SI had been managed on Thameslink, and with the aid of internal innovation funding, we set about developing our method for managing—and organizing—complexity. After a few false starts, we agreed upon “Systems Integration: Develop the strategy, Define the system, Deliver integration”—or SI:D³, a flexible framework of processes, tools and techniques.

A handbook (Figure 1) was produced along with the “wheel” (Figure 2) showing the processes involved.



Figure 1 - SI:D³ Original Brochure



Figure 2 - SI:D³ Original Process "Wheel"

Since then, our focus has been on developing the techniques and tools that underpin the delivery of the processes included in the framework (Figure 3).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Victoria Line Upgrade													<ul style="list-style-type: none"> • Concept of Systems Integration Management proven • Systems Migration Plan • Alignment to common goals • Some tools & techniques developed 		
Thameslink													<ul style="list-style-type: none"> • Enhanced approach • System architecture views • Operational Integration • Formal process captured 		
Northern Hub													<ul style="list-style-type: none"> • Process led application • Continuous improvement of tools & techniques • Repeatable approach 		
HS2 Phase 1 & Phase 2													<ul style="list-style-type: none"> • Adoption of data driven tools • Additional architecture views develop 		
The Greater West Programme													<ul style="list-style-type: none"> • Expansion data driven toolset • Development of interface mapping 		
Deep Tube Upgrade Programme													<ul style="list-style-type: none"> • Further development of architecture toolset • Common dataset developed 		

Figure 2 - SI:D³ Over 10 Years in Development

Systems Engineering for All

One of our principal differentiators—which has made the application of SI:D³ successful in so many projects—has been easy-to-understand graphical SI outputs, ranging from relatively simple depictions of a scheme as a context diagram to complex systems architecture diagrams (Figure 4).

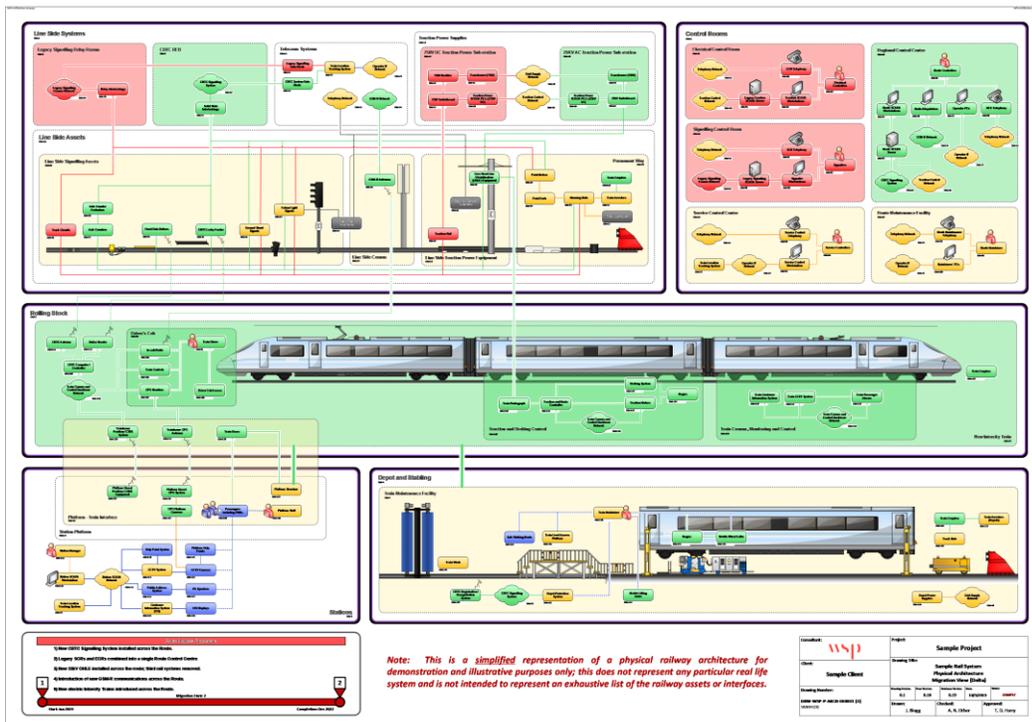


Figure 4 – SI:D³ Systems (Physical) Architecture Diagram

These original depictions appeal to a broad range of stakeholders as they are easily understandable, and thus provide a common understanding for everyone involved—from the sponsors and director of the program to the systems engineers who are implementing SI.

Model-Based Systems Engineering - Redefined

Over the years, we have found that there is limited understanding of the outputs from some of the commercially available model-based systems engineering (MBSE) tools that use structured languages such as Unified Modelling Language (UML) or Systems Modelling Language (SysML). These tools are excellent for systems engineers to use in the background to ensure that their analysis is valid, but the output diagrams are not easy for everyone to understand.

SI:D³ is a Soft Systems Methodology-based approach combining two “worlds”—the rigour of MBSE from the “systems engineering world” and the easy-to-use outputs from the “real world” (Figure 5).

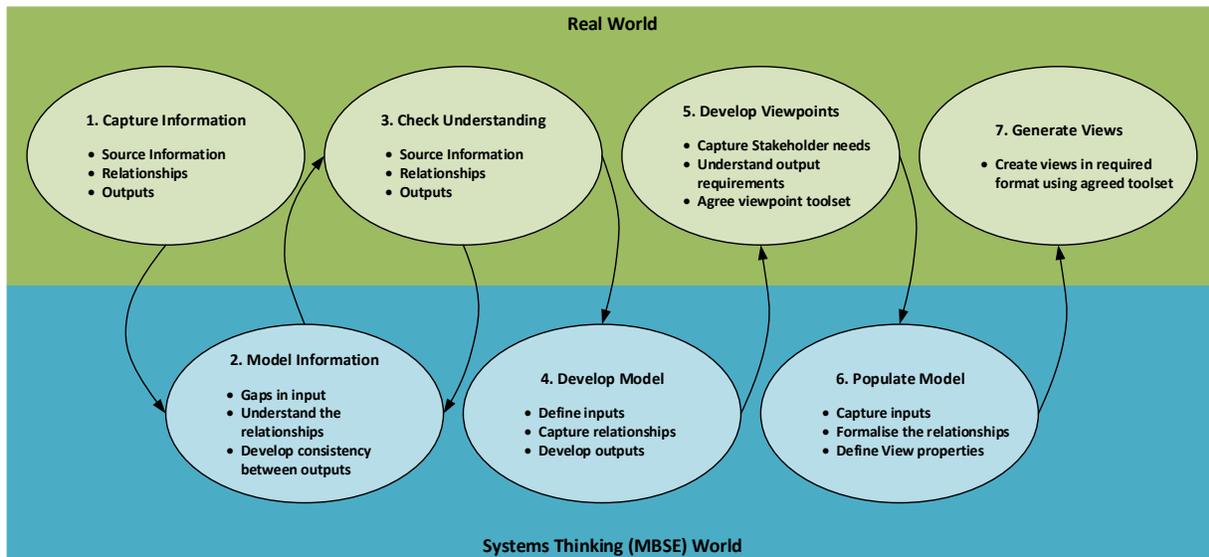


Figure 5 - SI:D³ uses Soft Systems Methodology.¹

Data Driven

Over the years, we have refined the WSP toolset not only to make the production of the SI outputs easier but also, more importantly, to produce the outputs based on data that is attributable to a configured source. We have achieved these goals in two ways: by using the data-linking available between MS Excel ® and MS Visio Professional ®, and by developing our own bespoke tools using MS Visio ®.

The Next Generation of SI:D³

We continue to improve and invest in the WSP global SI capability. With the increasing complexity of major railway (and other sector) schemes, the need for a holistic approach is stronger than ever. Our current focus is to enhance the proven SI:D³ framework. SI:D³ continues to evolve, becoming:

- **more usable:** By nurturing deep collaboration, we are reinforcing that people are at the centre of the approach.
- **more robust:** By continually improving SI:D³ with new lessons, tools and knowledge, we will maintain a fully-informed platform.

¹ WSP diagram based on the methodology developed by British management scientists Peter Checkland (1998) and Brian Wilson (2001)

- **more accessible:** By giving our practitioners in SI access to leading-edge practice, we will form a global community of knowledgeable SI:D³ users.
- **more flexible:** By recognizing that every client and every program is different, SI:D³ will provide an open platform to respond to a broad range of needs.

From Chaos to Cosmos

Using formal MBSE methods, we are modelling the SI:D³ processes to continuously validate them and help develop learning material for future SI practitioners so they are prepared to advance complex global railway schemes. Though the individual needs of the client and the goals of each megaproject distinguish each program, the ultimate success of all programs depends on creating clarity amid chaos from the start—to progress toward successful completion.

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