UK Architecture Working Group: “What it does and What it’s Delivered”

Brian Hepworth
INCOSE UK South Coast Group, 24th April 2012
The Prologue – from Z8

Architecture is a popular and evidently useful concept, with many uses and benefits – unfortunately for the novice and the unwary there are many different interpretations in widespread use.

Drawing on a variety of such interpretations, the following is our summary definition that captures the majority of the common ground:

“The architecture of a system is its fundamental structure – which may include principles applying to the structure as well as specific structures.”

Some authors broaden the definition of architecture to include, for example, principles associated with the realisation of the system (how it is implemented) or governing its evolution over time.

What fundamental means in practice is found to be context dependent. The identification of types of structure considered fundamental usually depends on the nature of the system as well as on the purpose of the architecture. Structure that is judged not to be fundamental should be excluded from the architecture.
Example - Postal Service Fundamentals

**Purpose of Architecture:** Provide an overview to a new managing director of the Fundamentals of a Postal Service

**Purpose of Service:** Provide node-to-point collection and delivery service for letters and parcels. Hence architecture (for MD) would have to show the mechanisms as to how this is achieved.

**Current Mechanisms:**

1. Distributed set of Collection Points (Nodes) e.g. Post Boxes / Post Office Counters.
2. Collection Services / Facilities (node-to-hub)
3. Sorting Mechanisms / Facilities (hub)
4. Transportation Mechanisms (hub-to-hub / hub-to-node)
5. Delivery Services / Facilities (node-to-point)
6. Revenue Collection Mechanisms

**Service Level Performance:** Measures of end-to-end performance based on a range of charges for the range of artefacts (letters and parcels) which can be collected, transported and delivered via the service.

INCOSE UK South Coast, 24th April 2012
Some Things to Understand

System-of-Interest
Architecture
Architecture Description
Stakeholder
System Concern
Architecture Viewpoint
Architecture View
Model Kind
Architecture Model
Architecture Rationale
Correspondence Rule
1. AWG Context and Remit
2. Scoping the AWG’s Work
3. What the AWG has Delivered
4. What the AWG has Achieved
5. Future Work
1. Context and Remit
INCOSE Working Groups

**International**

**Knowledge**
- Architecture
- Competency
- Complex Systems
- Decision Analysis
- Intelligent Enterprises
- Knowledge Management
- Process Improvement
- Resilient Systems
- Systems Engineering Effectiveness
- Systems Science
- Training

**Processes**
- Affordability
- Cost Engineering
- Human Systems Integration
- In-Service Systems
- Lean Systems Engineering
- Life Cycle Management
- Measurement
- Object-Oriented SE Method
- Requirements
- Reliability Engineering
- Risk Management
- System Safety Integration
- Systems Security Engineering

**Industry**
- Biomedical
- Infrastructure
- Net-Centric Operations
- SE in VSME

**Government**
- Anti-Terrorism International
- Defence Systems
- Global Earth Observation SoS
- Power & Energy Systems
- Space Systems
- Transportation

**Technology**
- Autonomous System Test & Evaluation
- Tools Database
- Tools Integration & Interoperability

**UK**

**Architecture**

**Capability**

**Competencies**

**In-Service Systems**

**Technology Lifecycle**

**Railway Interest**

INCOSE UK South Coast, 24th April 2012
Circa. 2006

Evidence of Change from Traditional Systems Engineering


In Traditional SE – System Architecture sat between System Requirements Definition and System Design (ISO 15288)

Development of MODAF in UK appeared to put Architecture / Architecture Frameworks on a higher plane than Traditional Systems Engineering Processes

UK Board asked UKAB to examine need for Architecture Working Group to look into the subject and provide guidance for the UK Membership.
UK AWG - Established 2007

To Provide Guidance and Advice on UK Architecture Practice and how it might be different from that in other countries - Develop a UK Frame of Reference

To Exert Influence on INCOSE Policy and Standards Bodies in respect of UK Architecture Practice

To Liaise / Coordinate with other Architecture Groups e.g. International AWG and French AFIS AWG

NOT to be a Lobby Group
Not act as a lobby group for the use of Architectures and Architectural Frameworks, taking cognisance of both positive and negative experience.
A UK Frame of Reference

1. **Develop Methodology** to Understand conflicting Architecture Beliefs / Perspectives

2. **Application of Methodology** to drive out Beliefs / Perspectives in:
   (i) Architecture Standards / Publications
   (ii) Architecture Practice in UK Industry / Government

3. **Understand SE to SA Relationship Perspectives**
Who - Member Organisations and Leads

AWG Member Organisations

Industry: BAE Systems, MBDA, Rolls-Royce, Thales, London Underground
Consulting: Atkins, Detica, Logica, JBA, PA Consulting Group
Academia: UCL, Loughborough University, University of Hertfordshire, Cranfield University

AWG Leadership and Governance

Co-Chairs: Mike Wilkinson, Dave Mawby, Peter Bryant
Secretary: Brian Hepworth

Standards Liaison: Peter Bryant, Stuart Arnold, Paul King
Research: Mike Wilkinson, Michael Emes, Ady James
SE–SA Relationship: Stuart Arnold
Architecture Practice: Peter Bryant
Enterprise Architecture: Peter Brook
Service Architecture: Nick Frall
2. Scoping the AWG’s Work
Scoping the AWG’s Work

Initially as a UKAB Working Group on Architecture
Identified areas for possible work / guidance and established priority topics as recommendation to UK INCOSE Board. Research and Representation on ISO Architecture Standard body funded by INCOSE UK.

Now more driven by the AWG Itself
Considers Architecture PESTLE factors / Interests of Group and establishes Workstreams to develop guidance; non-funded activity.

Some co-ordinated activities with International AWG
Where appropriate to reflect UK position – CSEP / BKCASE (SEBoK + GRCSE); non-funded activity.
Initial Prioritised Topics - 2007

**Terminology** – develop and use soft systems approach to consider multiple perspectives / viewpoints on architecture allowing equally valid interpretations. Migrated to Standards Liaison (ISO 42010) and Research Workstreams

**Uses & Types of Architecture** – develop an understanding of the different uses and types of architecture: AA’07 Workshop and write-up on Wiki.

**Relationship between Architecture and SE** – consider how architecture should be separated from or distinguished within systems engineering.
Things we saved for later – i.e. Now!

**Enterprise Architecture** - exactly what differences there were in the derivation and representation of enterprise architectures compared with system architectures.

**Architecture Evaluation** - what processes, methods and tools should be used. Migrated to [Standards Liaison (ISO 42030)](https://www.iso.org/standard/42030.html)

**Architecture Practice** – A picture of how architecture is being applied within the SE Community – Supported with Case Studies

**Service Architectures** – A look at the Services concepts and their application
Things we saved for later – not yet!

ISO 15288 and Other Systems Engineering Standards - 15288 identifies an Architectural Design Processes. More clarity is required concerning how these processes relate to the notions of systems architecting and systems design, and to architecting in other domains.

Architectures as Models – many people who produce models within an architecture framework believe that they are “developing architecture”. This raised the question as to the relationship between architecting and modelling: eg, whether the development of model-based specifications could be regarded as a strand of architecting or just a facet of system modeling?

Role of the Architect – in some quarters of the USA there is a limited view of what a systems engineer does; they tend to refer to system architects as we in the UK would refer to systems engineers – another opportunity for a soft systems approach
3. What the AWG has Delivered
Papers / Deliverables

General

Terminology / Belief Systems in Architecture

Uses and Types of Architecture

Relationship of Architecture to Systems Engineering
Where to Find “Deliverables”

INCOSE UK Chapter Website

1. What is System Architecture?

2. What is Architectural Structure?

3. What is System Architecting?

4. What are the different Types of Architecture?

5. What is the Role of Architecture?

6. How is Architecture related to Systems Engineering?

7. Architecture Frameworks

8. Further Information
[3]: Belief Systems Methodology

Graphical CATWOE Schema

Customers - The beneficiaries of the transformation
Actors - Those agents responsible for effecting the transformation
Transformation - The proposed or observed change that is the focus of the soft systems analysis
Worldview - The beliefs directly relevant to the transformation that explain its purpose
Owners - Those responsible for the outcomes of the process and with the power to stop it.
Environment - The constraints or influences imposed by the outside world on the transformation

Under the management of O within the environment E, A does X by Y to effect transformation T to achieve Z for the benefit of C
[4]: Belief Systems in Architecture “Standards”

## Purpose of Architecting

<table>
<thead>
<tr>
<th>ISO 42010</th>
<th>MODAF</th>
<th>Maier &amp; Rechtin</th>
</tr>
</thead>
<tbody>
<tr>
<td>To identify and to describe a fundamental system conception. This facilitates analysis and evaluation of alternative architectures, and communication and co-operation between parties that create, utilize and manage modern systems</td>
<td>To enable a coherent portfolio of military capability and better integrated systems, whilst avoiding unnecessary costs in the overall investment programme, by enabling standardised abstractions of complex real world situations that are amenable to detailed analysis</td>
<td>To ensure that the system delivers maximum value for its client</td>
</tr>
</tbody>
</table>
Customers / Beneficiaries

<table>
<thead>
<tr>
<th>ISO 42010</th>
<th>MODAF</th>
<th>Maier &amp; Rechtin</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Stakeholders</td>
<td>MOD and others in the Supply Chain through Viewpoints</td>
<td>The Client</td>
</tr>
</tbody>
</table>
“There are few direct contradictions between the standards as they focus on different aspects of the architecting process”
[6]: Belief Systems in UK Architecture Practice

### SA-1 (Rail Maybe?)

<table>
<thead>
<tr>
<th>Who</th>
<th>Why</th>
<th>What / How</th>
</tr>
</thead>
<tbody>
<tr>
<td>A team of engineers answerable to clients / project manages</td>
<td>To enable a shift from a silo-based approach to projects where most architectural decisions are taken by domain engineers to one which takes a systems approach</td>
<td>Provide a visual description using a common language / notation to facilitate cross-discipline communication and analysis</td>
</tr>
<tr>
<td></td>
<td>To provide a common approach across client and supply chain organisations</td>
<td></td>
</tr>
</tbody>
</table>
A Rail Perspective

Abstract Notation providing cross-discipline consideration of Assets and their interfaces.

Used in conjunction with specialist discipline notations
Different Industry Beliefs

“In contrast to the beliefs within the Standards, there was significant diversity of views and perspectives expressed by the limited number of Industry Communities examined”
[8]: SE-SA Relationship Perspectives


Perspectives on the Relationship between Systems Engineering and Systems Architecting

- Figure 1: Systems Architecting as a subset of Systems Engineering
- Figure 2: Systems Engineering as a subset of Systems Architecting
- Figure 3: Systems Engineering as a separate activity following Systems Architecting
- Figure 4: Systems Engineering as an activity that overlaps with Systems Architecting
- Figure 5: Systems Architecting and Systems Engineering as logically independent activities
- Figure 6: Systems Architecting and Systems Engineering as the same thing

INCOSE UK AWG “Consensus” Perspective
### AWG Views on SE-SA Relationship

<table>
<thead>
<tr>
<th>观点</th>
<th>百分比</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systems Architecting is a subset of Systems Engineering</td>
<td>93.8%</td>
</tr>
<tr>
<td>Systems Architecting <em>is</em> Systems Design</td>
<td>50.0%</td>
</tr>
<tr>
<td>Systems Architecting overlaps Systems Engineering</td>
<td>45.5%</td>
</tr>
<tr>
<td>Systems Architecting is improved Systems Engineering</td>
<td>33.3%</td>
</tr>
<tr>
<td>Systems Engineering follows Systems Architecting</td>
<td>31.3%</td>
</tr>
<tr>
<td>Systems Architecting <em>is</em> Systems Engineering</td>
<td>27.1%</td>
</tr>
<tr>
<td>Systems Engineering is improved Systems Architecting</td>
<td>22.7%</td>
</tr>
<tr>
<td>Systems Architecting has no logical relationship to SE</td>
<td>20.8%</td>
</tr>
<tr>
<td>Systems Engineering is a subset of Systems Architecting</td>
<td>8.3%</td>
</tr>
</tbody>
</table>
So What’s in the Crescent?

It was argued that IT/software engineering’s conventions for constructing **models that describe architecture**, with its emphasis on **viewpoints** and associated **stakeholder concerns** that separate regions of a system’s complexity, are acknowledged as **different to mainstream systems engineering**, despite contributions from MBSE.

In addition, the codification, management and navigation of **frameworks of models**, notably those already defined for the enterprise class of systems, bring an approach that **complements traditional systems engineering practice**.
How Big is the Crescent?

Since systems engineering and system architecture can apply across a range of system classes, the extent of the overlap may vary according to the class of system under consideration.

For example, particular advances in architecture principles and methods have arisen out of the design and evolution of IT infrastructure for businesses, so for the system class termed enterprise the crescent region for enterprise architecting could be larger.
A wake-up call for SE / INCOSE

“Changes lie ahead, and INCOSE, as the international organisation dedicated to the profession of systems engineering, needs to be prepared to act, otherwise the opportunity to influence events may be lost.”

“Mainstream systems engineering should lead the way by accommodating recent advances in system architecture within its existing, customary set of systems engineering practices”

“INCOSE, guided by the AWG, should therefore act to lead the way for adjustments to systems engineering principles, semantics, practices and associated standardisation that will eliminate the crescent of systems architecting distinction.”
4. What the AWG has Achieved
Influence on Architecture Standards

- ZACHMAN
- DODAF
- MODAF
- TRAK
- TOGAF
- ISO/IEC 42010
- IEEE 1471
- ISO / IEC 42030
Influence within INCOSE

INCOSE Working Group Awards

Awarded 2010 - Architecture WG

**Citation:** For exceptional work and international cooperation with the IEEE to advance academic research in Systems Engineering Architecture.

Awarded 2010 - TRAK (The Rail Architecture Framework)

**Citation:** For their outstanding effort in developing transportation architecting, the TRAK implementation team has developed a rigorous, customer focused open source architecture framework and the team has ensured that the framework is available as an open source product, developing a clear governance process, to ensure that the framework remains focused on transportation user needs.
“Re-discovery” of Soft Systems

Applied by Capability Working Group

INCOSE UK South Coast, 24th April 2012
5. Future Work
What Next - 2012

**Enterprise Architecture** - Understanding where SE should support the design of Enterprise Systems / Enterprise Architecture

**Service Architecture** - Understanding where Service Concepts and Service Architecture can be applied with Systems Engineering

**Architecture Evaluation** - Supporting the development of ISO/IEC 42030

**BKCASE = (SEBoK + GRCSE)** - Reviewing the V0.75 *Body of Knowledge and Curriculum to Advance Systems Engineering* and Ensuring that UK Architecture Frames of Reference are represented in the V1.0 to be issued in December 2012

**Exploitation** - Develop Seminar / Training Material for Specific INCOSE UK Audiences
EA and ESE – Developing its Ideas

Lead: Peter Brook (Dashwood Consulting / Cranfield University)
Services Architecture Proposal

Lead: Nick Frall (Niteworks - Chief Systems Engineer)

Niteworks have begun to formalise how we use Services and Service Architecture in a common way across our project portfolio. Similarly MOD, with its SOSA initiative has begin to try and formalise the use of Services across Defence Acquisition.

We propose that there is value in an exercise to provide guidance to the broader systems engineering community in the use of Services and Service Architecture in a variety of disciplines including Requirements Engineering and Systems design.
Where to Find “Work In Progress”

AWG Wiki

http://www.ukawg.org/architecture/doku.php?id=start

Need to request membership for “Logon Id + Password”

brian.hepworth@atkinsglobal.com
Visit the AWG Exhibition Stand

- Come and Chat
- Have a Look at our Deliverables
- Sign up to the Wiki
- Learn how to use the Wiki
- Offer Architecture Case Studies
- Discuss Workstreams
- Offer Support / Expertise