The use of Patterns and Anti-patterns in Complex Systems Engineering

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Traditional systems engineering provides a basis for the design of well-bounded, deterministic systems, where the needs can be established and constant and the components of the system are well understood and deterministic. However, the complex operating environments that systems find themselves in and the number and non-determinism of their components, show the inadequacy of traditional systems engineering. One technique that has been proposed to support the design and deployment of these complex systems is the use of patterns and anti-patterns.

The project aims to understand how patterns and anti-patterns could be designed, specified and employed both in the design and operational spaces. Patterns and anti-patterns could be used to understand how new components could be designed to fit into the 'system of systems' and how components could be put together effectively in operational space – how they should not be put together.

The project would involve the following:

- Review of the literature on Complex Systems Engineering and the short-falls of traditional systems engineering.
- Research and specify what constitutes a Pattern and Anti-patterns.
- Work with stakeholders to identify how Patterns and Anti-patterns could be used.
- Work with research staff to establish a candidate set of design and deployment Patterns and Anti-patterns for a specific use case.

This work will build on existing work detailing the short-falls of traditional systems engineering techniques [1], [2] and the descriptions of architectural patterns by Christopher Alexander [3], [4].

[1] Norman and Kuras, *Engineering Complex Systems*, The Mitre Corporation, January 2004.

[2] Warwick, Norris, *Designs for Success*, Aviation Week and Space Technology, November 1/8, 2010.

[3] Alexander, *A Pattern Language: Towns, Buildings, Construction*, Oxford University Press, 1977.