Recent advancements in technology have led to the increased use of integrated "systems of systems (SoS)" which link together independently developed and usable capabilities into an integrated system that exhibits new, emergent capabilities. However, the resulting SoS is not well understood, where secondary and tertiary effects of tying systems together are often unpredictable and present severe consequences. The complexities of the composed system stem not only from system integration, but from a broad range of areas such as the competing objectives of different constituent system stakeholders, mismatched requirements from multiple process models, and architectures and interface approaches that are incompatible on multiple levels. While successful SoS development has proven to be a valuable tool for a wide range of applications, there are significant problems that remain with the development of such systems that need to be addressed during the early stages of engineering development within such environments. The purpose of this research is to define and demonstrate a methodology called Systems Geometry for analyzing SoS in the early stages of development to identify areas of potential unintended emergent behaviors as candidates for the employment of risk management strategies.

The literature review and the results of this study have identified key characteristics or dimensions that should be examined during SoS analysis and design. Although many methods exist for exploring system dimensions, there is a gap in techniques to explore cross dimensional interactions and their effect on emergent SoS behaviors. The study has resulted in a methodology for capturing dimensional information and recommended analytical methods for inter dimensional as well as cross dimensional analysis. A problem-based approach to the system analysis is recommended combined with the application of matrix methods, network analysis and modeling techniques to provide inter and cross dimensional insight.

The results of this research are applicable to a variety of socio-technical SoS analyses with applications in analysis, experimentation, test and evaluation and training.

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Approved for distribution by Dr. Jose Sepulveda, Committee Chair, on June 4, 2013.

The public is welcome to attend.