

# Robust Flexibility: A Methodology for Agile Systems Engineering in Mining

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## ABSTRACT

Projects must be flexible to account for the rapid development of new technologies and changing stakeholder expectations. Developing and integrating solutions is becoming increasingly complex. The flexibility to 'pivot' to effective solutions is fundamental to the Agile methodology. Coupled with calls for bleeding-edge solutions, customers, shareholders, and regulators demand robust, safe products and systems-of-systems. These have traditionally been delivered with systems engineering applied through a waterfall methodology. Agile systems engineering combines both approaches and presents a means to achieve these goals without compromising flexibility, quality or safety. A robust methodology for the application of agile systems engineering is required to enhance practical outcomes and reduce risk for real-world mining projects.

Any agile systems engineering approach requires incremental implementation due to the significant cultural and mindset shift from a traditional waterfall approach. An agile systems engineering methodology for the mining industry is based on a select few critical improvement areas. The eight core aspects of agile systems engineering established by Dove et al provide a solid foundation for this work: Agile Operations Concept, Product Line Architectures, Shared-Knowledge Management, Continual Integration and Test, Common-Mission Teaming, Iterative Incremental Development, Attentive Decision Making, and Attentive Situational Awareness. From this foundation, this paper identifies three aspects as critical improvement areas that will enable interested parties within the mining industry to begin adopting agile systems engineering methods for their projects and products. These selected aspects are justified by real-world projects, practical lessons learned, and literature that addresses the challenges of adopting agile methodologies.

The generalised methodology for mining is built around the following aspects: Continual Integration and Test, Iterative Incremental Development, and Attentive Decision Making. These aspects represent the opportunities for greatest return-on-investment for the mining industry. The selected aspects are supported by the establishment and utilisation of integrated project teams, the implementation of contemporary Test & Evaluation methods, and the use of digital engineering capabilities to harness intelligent digital twins.

From the starting point outlined in this paper, the methodology is intended to spark discussion and reflection, and provide some initial guidance for those in the mining industry that are seeking to leverage the benefits of agile systems engineering but are unsure of where to start. The methodology will grow and evolve as agile systems engineering is implemented more broadly; active discussion is encouraged. It is hoped that the framework will also inspire industry leaders to approach agile systems engineering as a feasible undertaking, worthy of investment.