Lean Systems Engineering

Model-Based Systems Engineering Needs

A central issue is Lean Systems Engineering is driving use of models for target setting, verification, performance prediction and for training new engineers

1. **Finding the most efficient & effective methods to build parametric transfer function models that involve qualitative (subjective) success criteria – recognizing there are diverse model needs which may require unique solutions**
   - For example: Modelling functions that encompass human-facing qualitative attributes such as comfort, appearance, or quality perception.
   - Are there quick DoE-type methods that could be used as a standard practice we could advocate to characterize basic relationships upon which to base deeper studies?
2. **How most productively to engage engineers & Enterprise leadership to advocate & fund the development & use of models knowing there is inherent error that probably can only be reduced through continuous improvement and further study**
   - For example: Modelling complex functions where only a portion of the transfer function is understood such as customer satisfaction models or models where quantitative elements interact with qualitative elements to create emergent behaviors
   - Is there any research on the risk tolerance of Engineers and of Corporate leaders that we could cite to make the investment of time, energy and resources into model creation/validation more positively viewed?

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Model-Based Systems Engineering Needs (continued)

3. **For very complex Systems, it is difficult to predict total System performance characteristics due to complex internal interactions which can be confounded in some usage scenarios and/or can result in emergent responses in other usage scenarios. We have observed two fundamental approaches to modelling complex systems performance: "Top-Down System" model or a "Bottom-Up Subsystem" modelling approach.**
   - For example: Engineering leaders in my past experience developing complex products (Automotive Industry) tend to favor develop of "top-down total system" models to predict performance of the overall System of Intent. These "top-down total system models" many times have inherent error due to the complexity of the internal interactions. The lean role-model Companies we have studied approach the comparable System performance prediction problem through the development of a large number of higher confidence "Bottom-up subsystem and element models" which then assembled to predict system performance. This "Bottom-Up" strategy usually tries to isolate specific problematic prediction issues which are explicitly subjected to Robustness Failure Mode Avoidance analyses during the program development. A specific example, is Ford has been working on a single "vehicle" model for road noise prediction for many years, but Mazda who can develop a vehicle far more efficiently uses over 400 lower level models to predict road noise response.
   - We recognize there is no single correct approach to solve every System MBSE modelling challenge, but we do not hear much discussion of the relative efficiency and effectiveness of these two model development strategies. Does the MBSE Initiative Leadership team or other INCOSE groups have an opinion on the relative value comparison of these two methods? Like situations when we should advocate using "Top-Down System" models and situations where we should advocate "Bottom-up Subsystem" models?