List of Top Challenges

Challenge 1

Challenge Statement: **Develop platforms to support manufacturing industry and relationships to consumers/ business clients.** **Protocols for the communication and data representation to make the retrieval (of information) easier (and) to make the decision making (process) quicker.**	**Score** 10 stars
Context: To underpin CPS, SoS and provide security money transfers, etc. Due to the increased volume and complexity of data sets (involvement of heterogeneous data sets) from machines and humans Standardised protocols across different systems Standardised representation from the different datasets.	
Potential Impact: Help UK/EPSRC develop the digital economy and make it convenient to consumers. Improve the data retrieval and analytical process to support informed decision making. Avoid information conflict and different (interpretation of) systems views.	
Perceived Difficulty: Very complex will need collaboration beyond engineering; regulations trust, etc. Development of communication protocols and standard data structures will require understanding of requirement specifications from whole supply chain level.	

Challenge 2

Challenge Statement: **Changing educational establishment to produce a workforce for the digital economy.** **CPS and SoS and consumers need new classes of skills.**	**Score** 8 stars
Context: Complex CPS, SoS will be in fast evolution and will have many problems due to latent software faults, insufficient V & V, and incorporation of legacy systems.	
Potential Impact: Huge. CPS and SoS need these to operate efficiently.	
Perceived Difficulty: Complex, requiring change to institutions and cultures. Sociotechnical challenge.	

Challenge 3

Challenge Statement:	Score
Future Systems Engineering environments that support • **Evolutionary development** • **Merging of developments and operations** • **Handling of complexity to support engineers** • **Analysis and predictability of system's properties**	7 stars
Context: • Large scale customisation • Systems of Systems • Development and extension of existing operational systems • Increasing complexity	

Challenge 4

Challenge Statement:	Score
Real time model update of designed product during development/manufacturing. **A verification and control management system that can check the product conformity to designed virtual model even through operational life; the model will be (able to be) updated for maintenance or servicing purposes.**	6 stars
Context: High value manufacturing carries a potential risk of mismatch between specifications and product manufacturing. Even in the operational life the product may need servicing or update which (can be) monitored by relating and comparing the product (model) to developed product.	
Potential Impact: Preventing maintenance Project goes well planned	
Perceived Difficulty: Amount of sensors or monitoring resources (needed) during manufacturing & operation Modelling system for model update Control system to detect potential misalignment (problems) and advising a solution.	

Challenge 5

Challenge Statement:	Score
How to integrate different models/ views of different parts of a system /different stake holders into an overall system which is consistent and has the ability to reflect changes of one view in other views.	5 stars
Context: Assembly lines are built from (component) machines from different providers and consume materials and products from a range of different sources to produce a range of products. All these constituents are produced specified (modelled) and configured independently and using different terminology, but need to be integrated.	
Potential Impact:	

Addressing this challenge is fundamental to MBSE and Industry 4.0 as it is fundamental to achieving control of the inherent complexity.	
Perceived Difficulty: High. The challenge is twofold: 1. Developing a system for managing viewpoints and their interactions - medium difficulty: this is being worked on in Model-Driven Software Engineering 2. Identifying the most suitable views and their specific interactions	

Challenge 6

Challenge Statement: **Achieving fidelity between models of anything in the real world and the real world.** **Data analysis** **Model fidelity** **Over engineered systems** **Real-time systems**	**Score** 4 star
Context: 1. Accuracy of measurement 2. Timing issues plus delays	
Potential Impact: Wrong decisions due to discrepancy of model V.S. reality.	

Challenge 7

Challenge Statement: **Building up standard framework for eliciting requirements, extracting information under the regulatory constraints.** **Building standard interfaces to liase requirements between diverse stakeholders.**	Score 3 stars
Context: Eliciting requirements is most vital part of product development. In automatic development environment where a central artificial system uses initial input to arrange for process building and resource management, human users will require to follow a common framework which needs to be adaptable to user preferences and therefore provide room for potential changes/specifications.	
Potential Impact: - Disambiguation in communication - Concise requirements specification derivation - Clear relationships between requirements - No down the line hold ups due to potential risks - Effective change management	
Perceived Difficulty: • Ambiguity in natural languages (multiple interpretations) • Flexibility in framework • Integration of present external constraints (safety standards etc.)	

Challenge 8

Challenge Statement: **Establishing sound large-scale models of the interaction between properties of machines and assembly lines and properties of the resulting products.**	**Score** 1 star
Context: In order to make adaptation (or design) decisions about assembly lines, we need a predictive (model) capable of predicting the effect of different alternatives on product quality. Presently, the only way of testing new designs is through models for dedicated, small-scale experimentation. It is unclear if these will scale to real production environments.	
Potential Impact: Having these predictive models will enable quality-led design and adaptation decisions.	
Perceived Difficulty: High	

Challenge 9

Challenge Statement: **Flexibility in automation**	
Context: Humans have cognitive abilities – automation does not.	
-Potential Impact No flexibility for part variation- failed processes/parts	
Perceived Difficulty: Sensing Communication Stakeholder mapping/ cross boundary/ skill set working/ learning	