

Workshop Discussion Report - A Future Vision of Flexible Configurable Manufacturing in a Digitised World

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This workshop, involving 23 participants from industry and academia, focused on clarifying the key topics of concern towards fully exploiting digitisation solutions in a flexible and configurable way. It discussed the potential solution paths that must be explored to achieve an effective future vision of flexible configurable manufacture. The workshop was conducted in two parts: (i) discussions around four presentations offering different perspectives on the problems and then (ii) detailed discussions around two general themes of interest (a) towards effective digital twins and (b) advanced multi-stakeholder decision support systems.

In the first part of the workshop presentations were provided from the perspectives of enterprise modelling, systems integration, embedded intelligence, and business ecosystems. The key issues arising from these were:

- Integrated enterprise modelling should be a support to overcome interoperability challenges across and between enterprises, but (a) what benefits and risks follow from combining AI with such solutions, (b) how should company infrastructures change to take account of necessary standardised approaches and (c) what requirements arise in supply network infrastructures.
- Unpredictable events in AI enhanced human/robot interactions must somehow be managed, but (a) how should we change programming architectures to new AI knowledge streams, (b) how can we ensure all eventualities are covered and (c) how to re-commission a knowledge system that has learned ‘bad habits’.
- Embedded Intelligence has huge potential to provide high quality information where and when needed for both systems automation and for decision support, but (a) in configuring such systems how can we capture, classify and reuse the necessary underpinning technical knowledge, (b) how can we evolve the understanding of how to capture and share the knowledge needed against differing business requirements and (c) how can we generate new methods to structure, share and interrogate knowledge interoperably given that present day ontological approaches are inadequate.
- Business ecosystems in a digitised world suggests the need for de-centralised, but co-ordinated autonomous units, but (a) how should the necessary digital production units be provided, (b) how can the required knowledge be provided and (c) how can the necessary collaboration platform for decision making be developed.

In part two of the workshop the discussion around effective digital twins highlighted the following key points:

- Current limitations: digital twins are currently mainly being developed as research projects with some limited working examples in OEMs. The slow uptake in digital twins was attributed to cost, lack of data availability and connectivity as well as the need to agree on standards on how to apply digital technology. The problem is complex with a lack of technical knowledge making it difficult for businesses to develop a clear digital strategy.
- Design and development: the development of a digital twin should be based on a set of requirements which clearly defines the need for specific parameters. An incremental development process is sensible due to the time and cost involved. The evaluation of a digital twin would benefit from some clear measurement methods, not just on cost benefit



but also on whether the system has taken account of all relevant aspects of the physical system.

In the parallel session on advanced multi-stakeholder decision support systems (DSS) the discussion highlighted the following key points:

- Challenges of Multi-stakeholder support: Stakeholders need to be identified possibly through a formal analysis not only in terms of their inputs but also on the effect on them of any resulting decisions. How to manage potential detriment effects on stakeholders is an issue.
- Data requirements: It is important to only collect enough data for the specific decisions to be made effectively so specifying the frequency of data collection is critical. Defining how much is enough is not necessarily easy but is influenced by evaluating the statistical relevance of the data, the spread of the data and whether there may be any rare events that need to be monitored.
- Trust in decision support systems: The following factors that influence trust in a decision support system were identified as (a) the trustworthiness of the DSS owner, (b) the consistency of the results from multiple runs of the system (c) whether the system is being used in a setting that is well understood and (d) whether the systems could explain their results e.g. through explainable AI. Further key factors were (e) whether effective cybersecurity measures were in place to ensure no data tampering could take place and (f) how safety critical the resulting decisions are; in high safety critical situations the trust level must be very high.