International Council on Systems Engineering
A better world through a systems approach

Successfully Integrating Early Validation and Verification in Industrial MBSE

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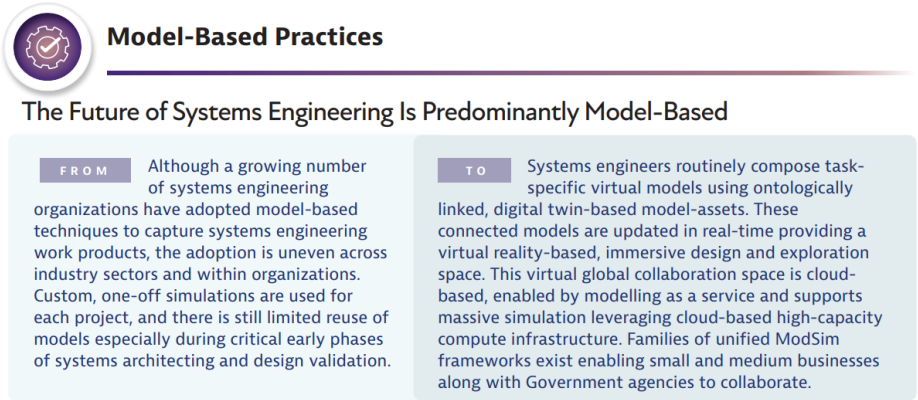
INCOSE SE Vision 2035

INCOSE 2035 vision and Model-Based Systems Engineering (MBSE).

MBSE promotes several quality attributes, such as traceability and consistency management.

MBSE is often discussed through languages, methods, and tools.

MBSE enables, among other things, increase capabilities for early V&V.



Model-Based Systems Engineering adoption

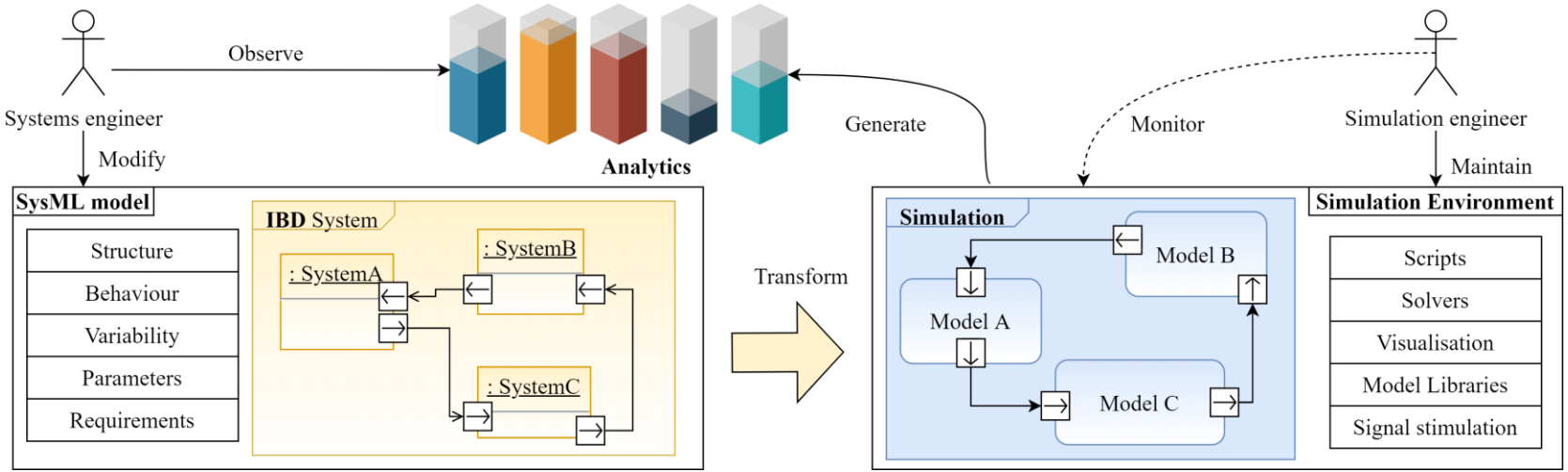
While MBSE is seeing significant attention, many studies and experiences point to challenges during adoption.

To some extent, there is also a mismatch between what might be considered the best practice in industry, contra what is the state-of-the-art research.

Model-based methods are also relying more on software approaches and tools, which might cause some friction with the SE community.

In this paper, we investigate the use of MBSE for early V&V.

Early V&V example

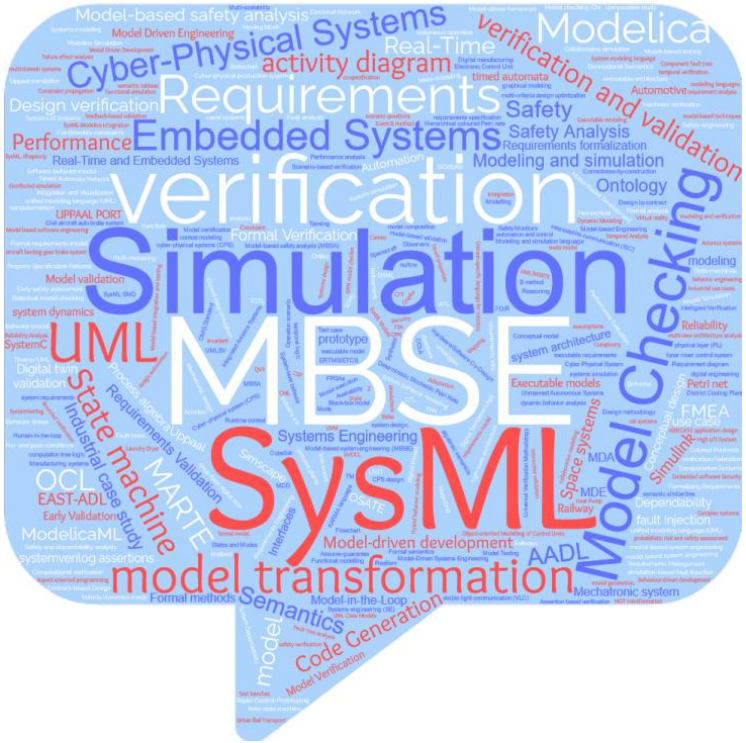


A systematic study

Previously we have performed a systematic study on early V&V in MBSE.

One of the key weaknesses identified is the lack of industrial viability of solutions.

Particularly, we saw very little real-world application or validation among solutions.



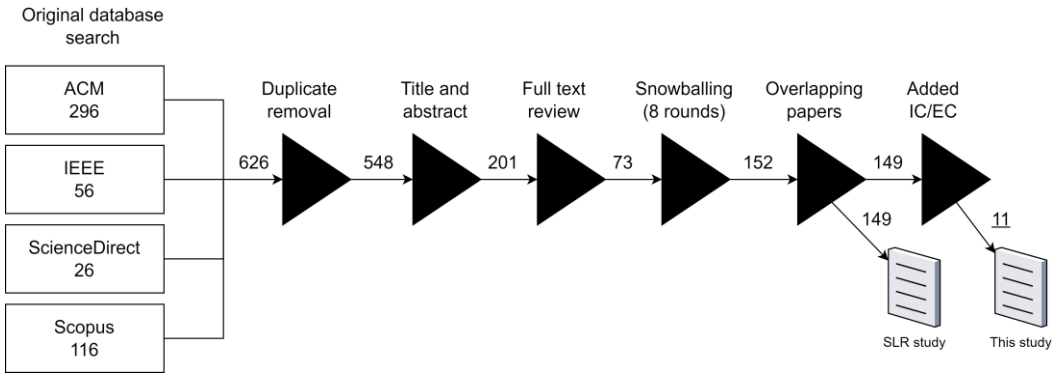
Cederbladh, J., Cicchetti, A., & Suryadevara, J. (2024). Early validation and verification of system behaviour in model-based systems engineering: A systematic literature review. *ACM Transactions on Software Engineering and Methodology*, *33*(3), 1-67.

A systematic study follow-up

In this paper we follow-up the systematic study, using additional criteria for study inclusion or exclusion.

Additional criteria: The paper is validated in an industrial setting.

Additional criteria: The paper provides tangible metrics and/or evaluation of the solution.



Analysis of papers

The selected 11 papers were thematically analyzed for success factors during industrial adoption, and we saw the following:

1. Realistic problems.
2. Standardized use cases.
3. Integration with existing tools.
4. Low added efforts from users.
5. Flexible application in of modeling.
6. Industrial standard alignment.
7. Modeling supports several needs.

Given these points, what's stopping us?

1. Large and complex problems, which can be hard to fit into papers. Problems are usually not the same.
2. Many domains, different ways of working.
3. Semi formality in standards, interoperability with tools.
4. New technology, model-based not always part of current practice.
5. Consistency among models, collaboration among users, integration of languages and meta-models.
6. Creating accepted standards, balance between general-purpose and domain-specific, mapping of concepts.
7. Modeling not matching with existing processes, modeling not seen as useful by all stakeholders.

Community recommendations

From our analysis, we provide 5 recommendations towards publication strategies.

Emphasize artifact submissions.
Allow models or other artifacts to be submissions to conferences and venues.

Support artifact evaluation.
Offer some form of review of artifacts attached to papers, perhaps giving “stamps” on published papers as is done for some software conferences.

Offer modelling challenges to support comparison.
Requirements for system models in conferences/journals, enabling comparison across solutions.

Separate MBSE into components.
Limiting the MBSE scope of submissions more explicitly can offer more tangible contributions.

Standardize evaluation sheets.
A set of standard variables or characteristics to evaluate for submissions can assist in scoping.

Discussion

- A systematic study is a bottom-up approach, in that it analyses the work that is already existing.
- Many of the concepts such as MBSE are not strictly defined or contains several definitions/interpretations.
- The domain-specific vs domain-agnostic balance is tricky but central to many pain-points in modeling.
- In this paper we care about early V&V specifically.

Conclusion

- We extend a systematic study on early V&V in MBSE in relation to industrial integration.
- We identify a number of success factors, and discuss what might inhibit them in practice.
- We provide a number of recommendations for the community on how we might support moving in the right direction from an academic submission stand-point.

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