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Exploring the Potential of Virtual Reality for Model-Based Systems Architecting

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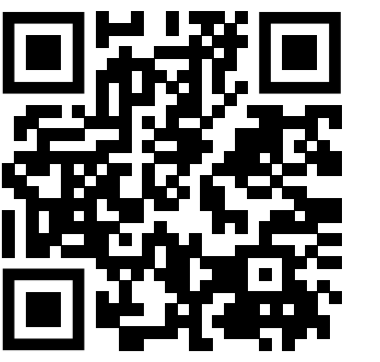
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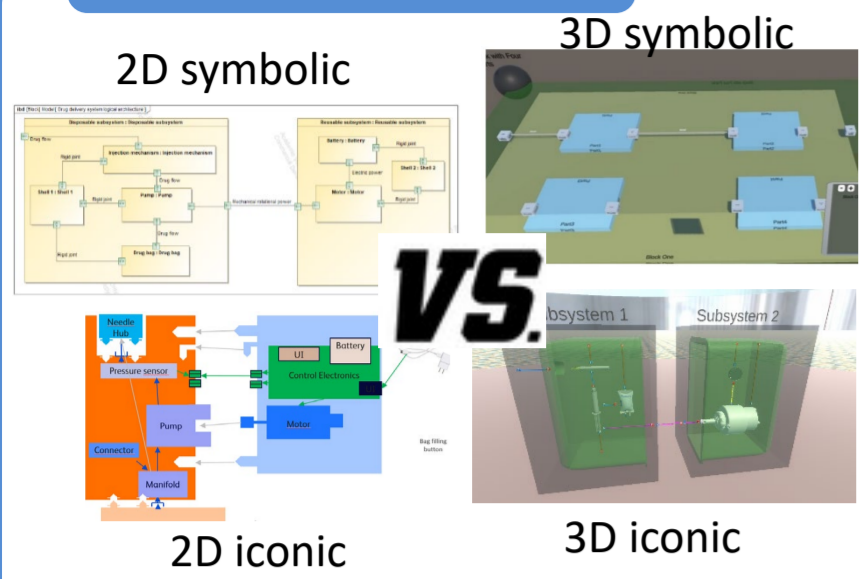


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1. Context



Virtual Reality is a SE Megatrend:

INCOSE The future of systems engineering is predominantly MBSE, with virtual reality-based models, immersive design and exploration space.

NASA The NASA systems engineer, in this future vision, works with a global project team in a virtual and collaborative environment, engineers the system, and uses digital approaches as the routine and default way of working.

Model-Based Systems Architecting is mainly based on box-and-arrow diagrams, where many elements are essentially the same, thus making it difficult to extract anything of significance, which hampers communication in a multidisciplinary design team.

2. Problematic

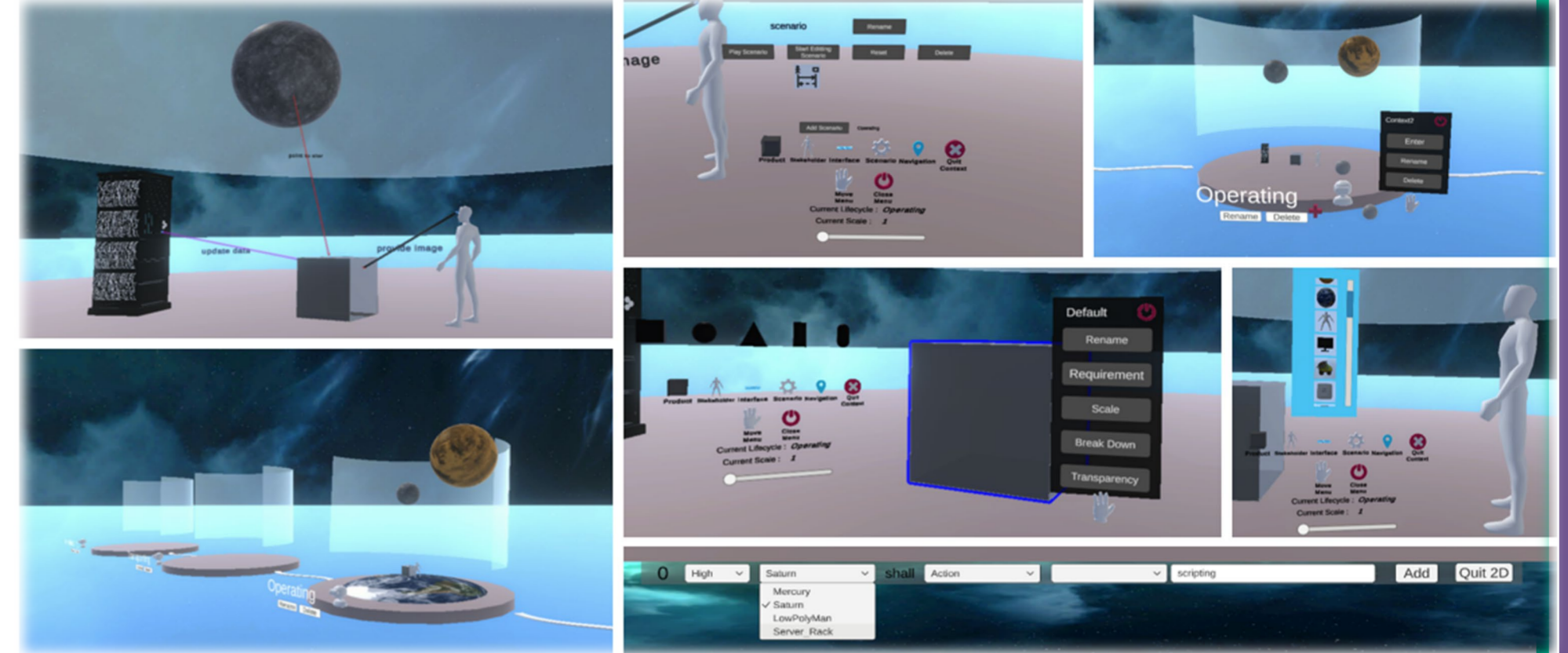
There is a lack of adoption of MBSE modelling interfaces, which hampers the general acceptability and acceptance of a MBSE approach.

- **Visual notation ignored:** the highly codified diagrammatic modelling notations inherited from software engineering for MBSA activities are too esoteric for notational nonexperts.
- **Dispersed information in models:** the need to perceptually integrate information from various diagrams impacts our reasoning capabilities.

3. Research gap

What is the potential of using **virtual reality (VR)** technology to model a system architecture, compared with conventional model-based systems architecting notations, software, and devices?

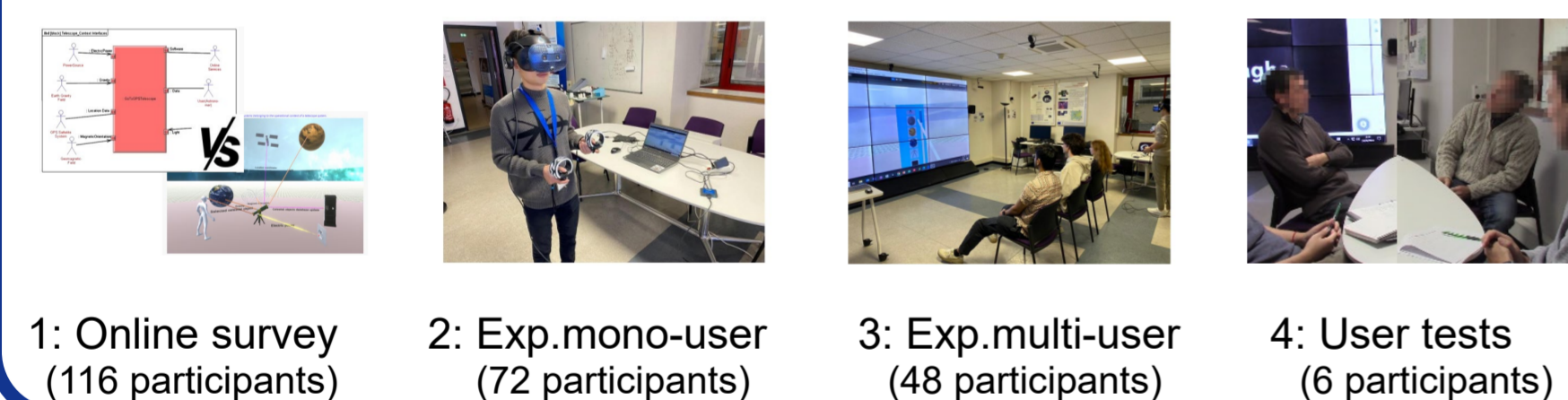
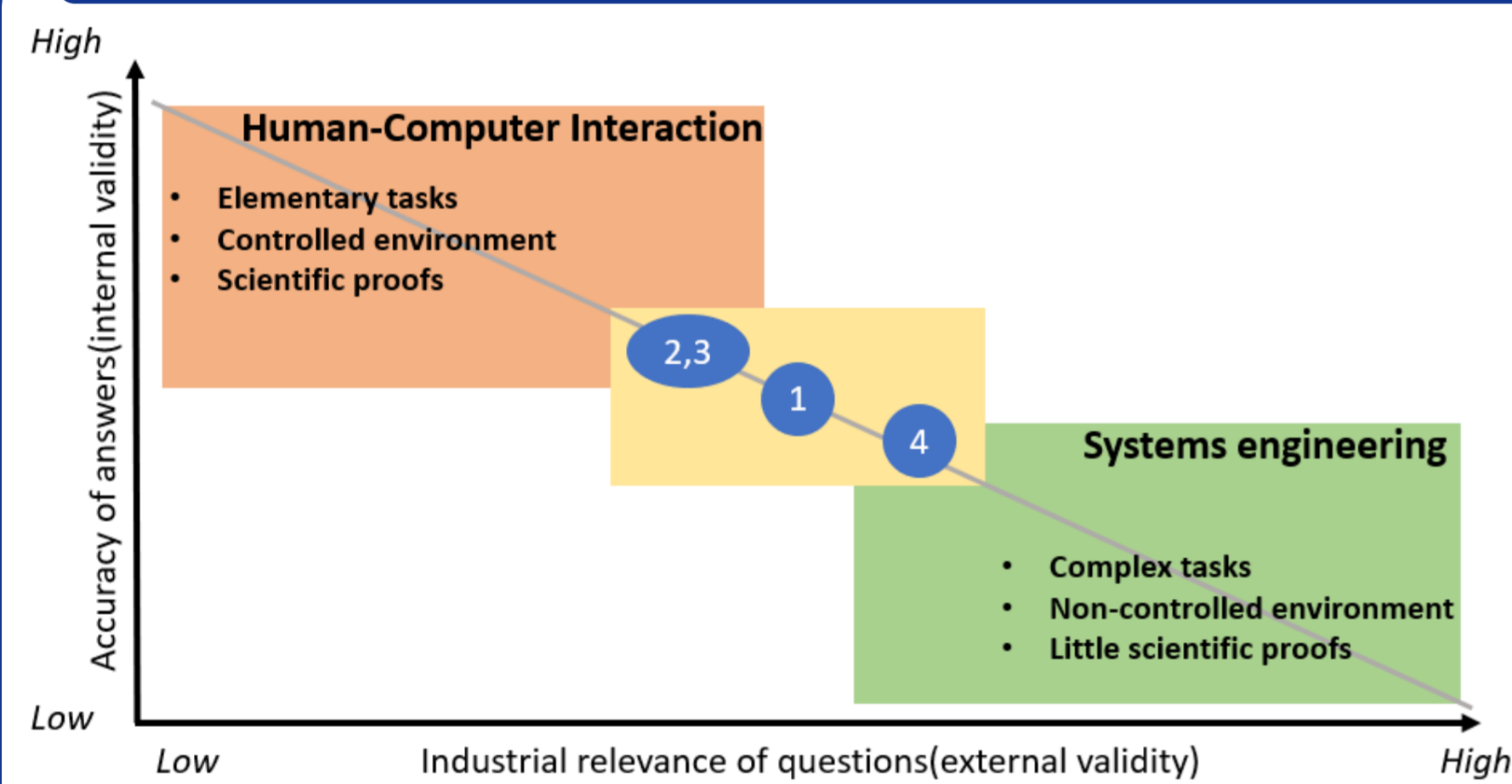
4. Practical Contribution



A **3D modelling interface in Virtual Reality** to support Model-Based Systems Architecting tasks is proposed with:

- **3D visual notation:** 3D iconic graphic visuals which are semantically more transparent and appealing.
- **Holistic view:** a 3D virtual world improves the perceptual integration process by exploring all model elements gathered in one environment without interrupting the cognitive process while switching between views.

4. Methods and theoretical contribution



	User satisfaction							Visual notation quality						
	Usability	Perceived efficiency	Perceived effectiveness	Perceived retention rate	Intention to use in the future	Usage fun	User motivation	Perceptual discriminability	Semantic transparency	Complexity management	Visual expressiveness	Graphic economy	Presence IPQ	Cognitive load NASA-TLX
1: Online survey^a	N/A	N/A	N/A	N/A	N/A	N/A	N/A	+	+	0	0	0	N/A	N/A
2: Exp. mono-user^a	+	0	-	0	-	+	+	+	+	+	+	0	--	+
3: Exp. multi-user^a	0	0	0	0	0	+	+	+	+	+	+	+	N/A	0
4: User tests^b	↘	→	↘	↘	↘	↗	↗	↗	↗	↗	↗	↗	↗	→
Meta analysis	0	0	0	0	0	+	+	+	+	+	+	+	+	0

5. Future work

PhD results contributed to the creation of the ANR joint research lab MIMESIS with the VR software editor SKYREAL. As part of this 5-year project, future work will concentrate on:

- Extending the 3D MBSA modelling interface to **co-architecting** complex industrial **product-process systems**.
- The **2D-3D continuum by mixing heterogeneous representations** (images, sketches, diagrams, icons, 3D, text, voice recording, simulation, etc.) in enriched, flexible hybrid digital objects.
- Including **cross-device** (CAVE, HMD, large screen, desktop PC) **collaboration** capabilities.
- Develop **more natural and efficient human-model interactions** using **context-aware conversational generative AI**.



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Collaboration industrielle : Usability tests with Becton Dickinson, Schneider Electric, and AXONE Group