ICARUS VR Tool Derisk Executive Summary

Document reference	ATG-NL-RP-AE-22-04276
ATG internal reference	N.A.
Additional reference (optional)	
Deliverable number	ESR
Document type	RPT - Report
Classification	N.A.
Issue	1
Date	16 December 2022
Number of pages	4
Status	FINAL

Project	ICARUS VR Tool Derisk
Client	ESA
Client order reference	ESA AO/1-10537/20/NL/BJ
ATG offer reference	ATG-NL-PRP-VL-21-00512

Action	Name	Function	Date / signature
Prepared	Daniel Twigt	Project Manager	Daniel Twigt 2022.12.19 08:24:26 +01'00'
Checked	Emiel den Exter	Human Factors Engineer	Digitally signed by Emiel den Exter Date: 2022.12.17 08:47:30 +01'00'
Approved	Michiel Vullings	Business Unit Manager	michiel vullings 2022.12.19 09:38:11 +01'00'

CHANGE LOG

Issue	Date	Affected	Changes
1	16 12 2022		Copy from final report

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Company	Name	Comment
ESA	Peter van der Plas	
ATG-Europe	ICARUS team	
ISISpace	Eric Bertels	

Executive summary

Assembly and integration of complex systems is far from trivial in any industrial setting. In the space domain which is an industry where projects are characterized by high cost of development, due to quality requirements and low risk tolerance, this is even more so the case. At the same time, space projects are often performed by relatively large consortia of industrial parties, scattered over Europe. This introduces additional challenges in communication, alignment of stakeholders and simple on-schedule delivery of parts, components, and subsystems. This inevitably increases risk on the projects, the mitigation of which increases cost even further.

The **ICARUS** application aims to tackle several issues related to the risk apparent in the process of Assembly and Integration, as described above. Specifically, the tool provides an immersive environment that allows for training of procedures, assessments of interfaces and communication-over-distances between project stakeholders. By virtualizing the hardware system and subsystems that need to be integrated or assembled, risks are significantly decreased while insights into the assembly and the procedures are greatly increased. Furthermore, the use of models over physical hardware significantly reduces project cost-levels, which is essential for any commercial market. In this way ICARUS aims to provide a competitive advantage to its users in the space industry, but ultimately also to users in any high-tech industry prone to complex assembly and cooperation challenges.

An ICARUS **Minimum Viable Product (MVP)** is foreseen which focuses on the following key use-cases:

1. Virtual training for mechanical assembly and integration in an environment with recurring operations, either guided (instructions) or non-guided (trying-out what is possible)
2. Knowledge retention of the recurring operations through a virtual representation of the customers guidelines and best practices

In relation to this MVP development several risks were identified, the most significant of which dealt with the representation of tooling and of cables and their routing. Here, the question was whether these features could be represented sufficiently realistic for the intended purposes in ICARUS. In view of this, a Derisk project was initiated, focusing on these risks and features. During this Derisk project, an ICARUS **Proof of Concept (PoC)** was developed, in which the tooling and cables were further developed based on requirements provided by potential future users of ICARUS.

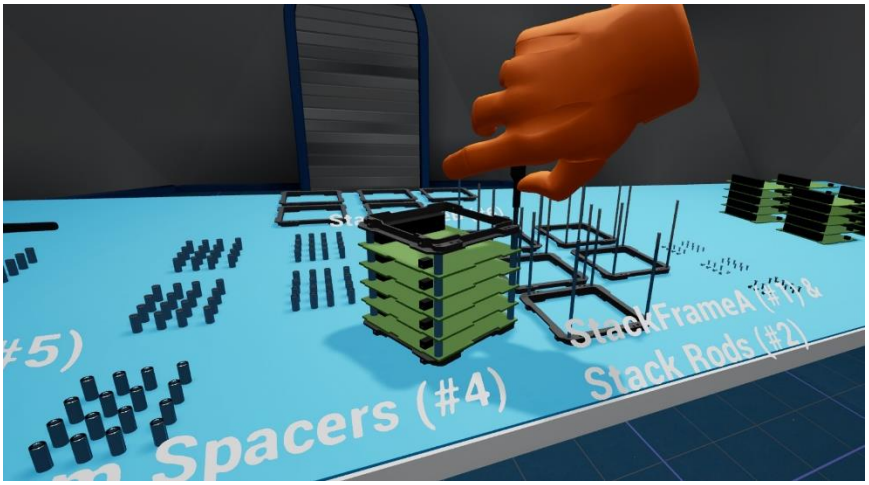

Figure: Assembling a cubesat PCB stack in ICARUS PoC

To validate the Derisk results, a validation scenario was implemented in the PoC, which was used as the basis for validation testing by these future users. The following is concluded based on this testing:

1. In general, tools and cables can be represented in ICARUS with sufficient realism for the intended purposes.
2. During validation, the current implementation of cables and tools in ICARUS shows no fundamental shortcomings which would jeopardize the successful finalization and utilization in the ICARUS MVP. Several improvements have been identified to further mature the implementation, including snap-positioning of tools in the hand, different sized screwdrivers, surface mounted anchor points for cables, etc. These improvements will be further incorporated during the ICARUS MVP development. However, none form a significant challenge to implement within the current system design.
3. To further mature these features, the feedback collected during the validation process provides clear ideas on how to proceed. Both the effort and the risk associated with these improvements are limited.

Hence, it is concluded that the likelihood of the risks considered has been substantially reduced by the Derisk project, to the point these risks are well manageable within the further MVP development. Furthermore, in addition to providing feedback on the implementation of the tools and cables in ICARUS, the testers also provided extensive feedback and ideas on the potential utilization of ICARUS, in both the AIT training and in the design process. It was noted, among others that ICARUS can be a very useful tool to “bridge the gap between design and assembly”. The ICARUS PoC as developed within this Derisk project will serve as a starting point for the further development of the ICARUS MVP.