Authoring Tool for Industrial Augmented Reality

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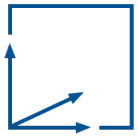

Final: Master Informatics: Games Engineering

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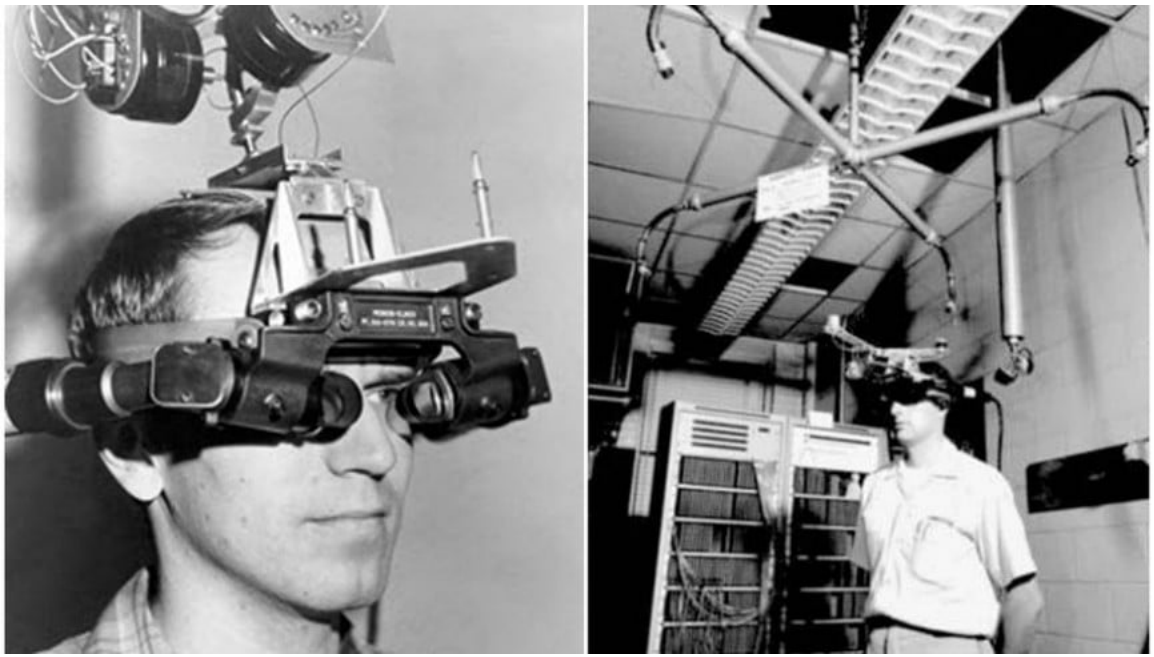
Advisors: Jan Heitger (RE'FLEKT), Sandro Weber

Introduction / Motivation

- Augmented Reality, a key technology for 21st century
- Investment of over 4.1 billion dollars in 2019
- Industrial Augmented Reality
- Microsoft, Google, Apple and many more invested

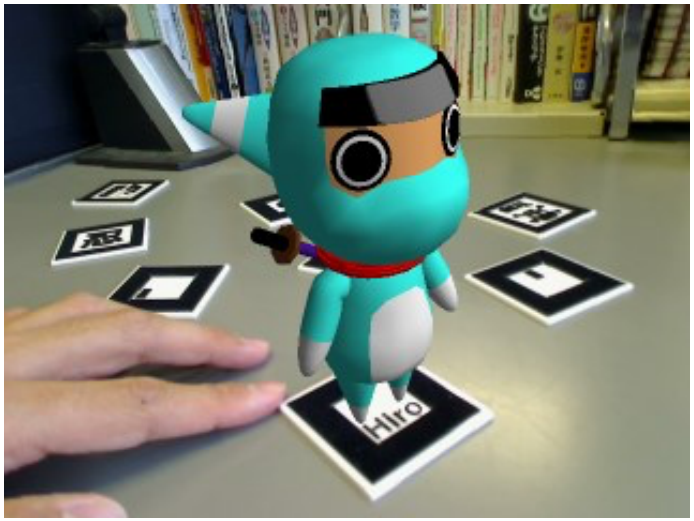
Introduction / Motivation

- Ivan Sutherland, Sword of Democles (1968)
- Limited military and industrial research until 2000s



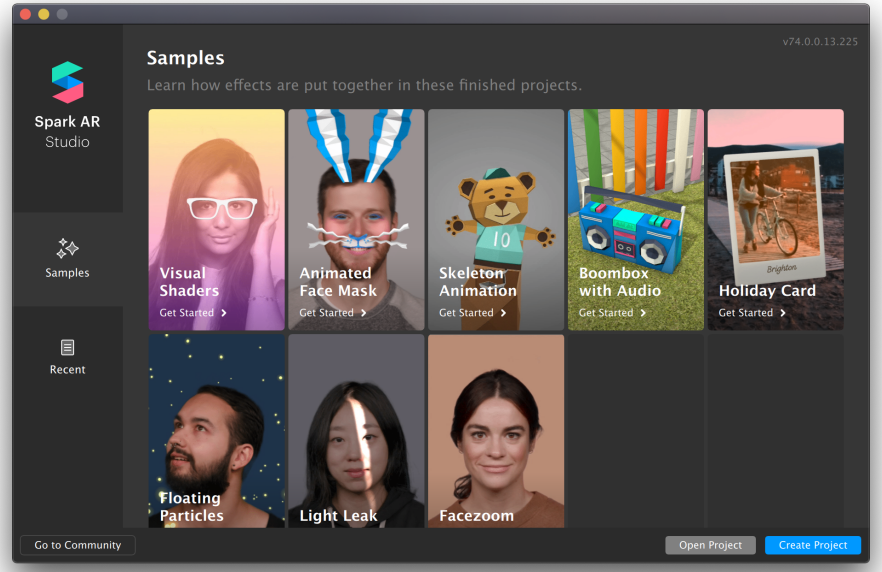
Introduction / Motivation

- 2000s:
- Creation of ARToolkit, wide usage of marker tracking
- Adoption in media and entertainment fields



Introduction / Motivation

- 2010s:
- Mobile AR with smartphones
- Wearable AR: Google Glass, HoloLens, Magic Leap
- ARKit, ARCore: successors to ARToolKit



Problem Description: Issues

- Many technical challenges are solved today
- Good processes and supporting tools are still needed for effective and efficient solutions
- Content creation, authoring is lacking
- Used authoring software do not utilize augmented reality features well enough
- Limited research regarding authoring tools for AR and best practices

Goals of this Thesis

- Conduct a research about the essential concepts of industrial augmented reality authoring
- Use this research to create an authoring tool which enables content creators to effectively author anything using augmented reality interaction techniques and ideas.
- Develop the authoring tool so that it fits RE‘FLEKT‘s needs, combined with the previous research

Critical Research Issues

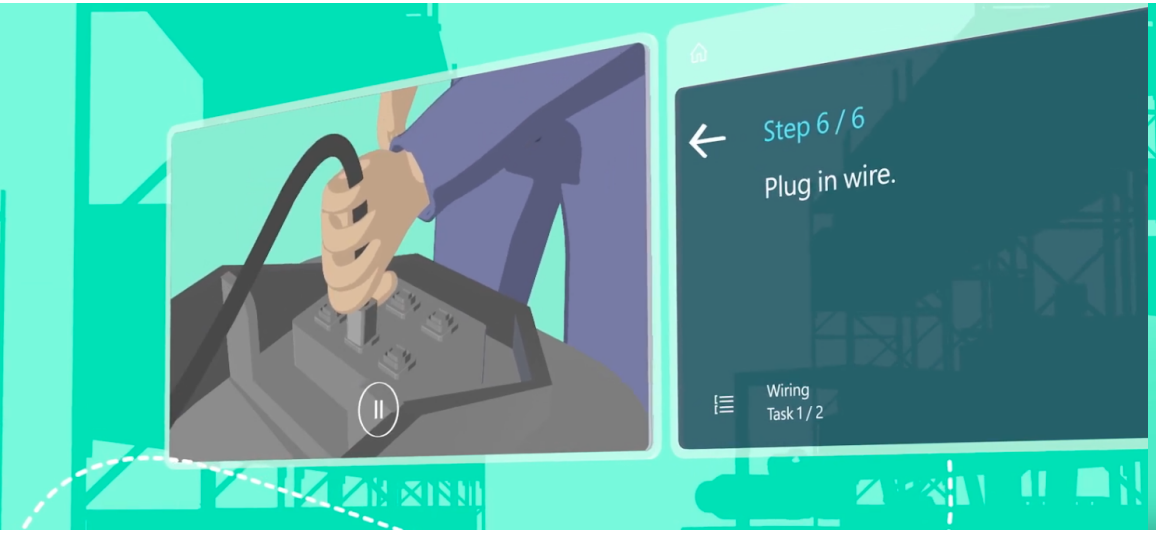
- What are the best practices for authoring in industrial augmented reality?
- Do these practices align well with RE‘FLEKT ONE?
- What are the problem areas for authors when creating content?
- Which tools are needed in the authoring tool
- How can we realize the multi-device usage in authoring?
- Which AR interactions are best suited for authoring?

Existing Solutions / Related Work

- Dynamics365 Guides
- Vuforia Studio, Spatial Toolbox
- Reality Composer
- RapidManual, QuadriSpace
- Unity‘s MARS

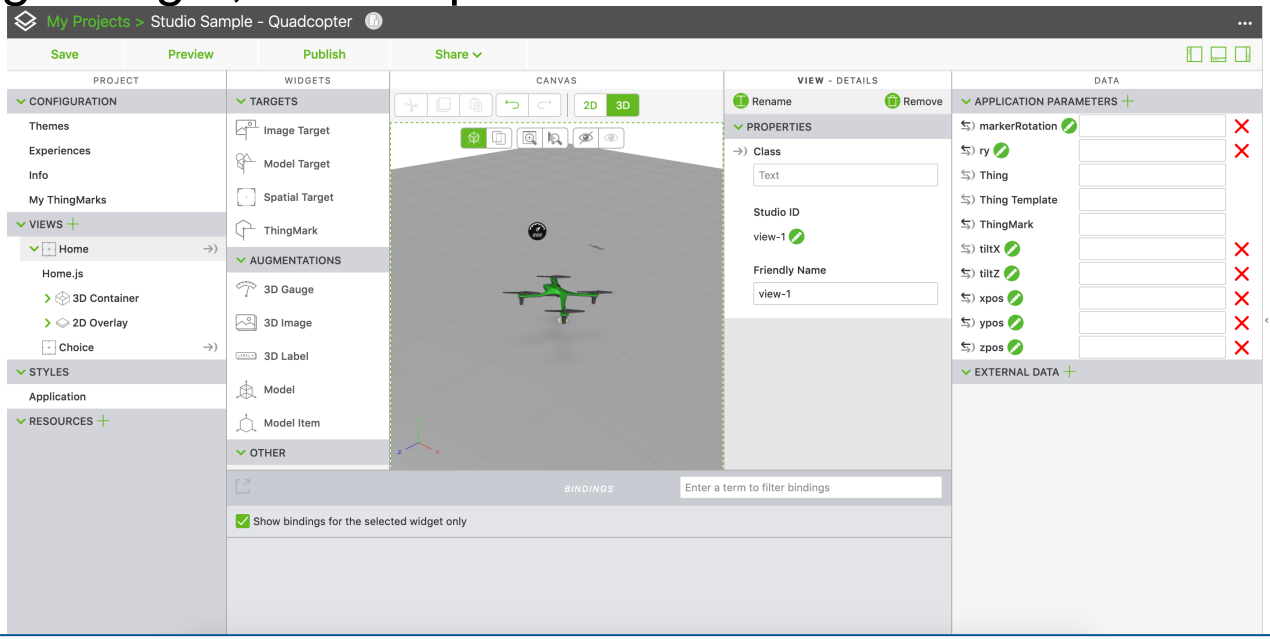
Existing Solutions / Related Work

- Dynamics365 Guides (Microsoft)
  - For HoloLens
  - Industrial Use Cases
  - Two step authoring process: First on desktop, then on HoloLens
  - High-level design



Existing Solutions / Related Work

- Vuforia Studio (PTC) and Spatial Toolbox
  - IoT (Internet of Things) focused authoring
  - Low level, suited mostly for industry
  - Web-based
  - Lightweight, but complicated

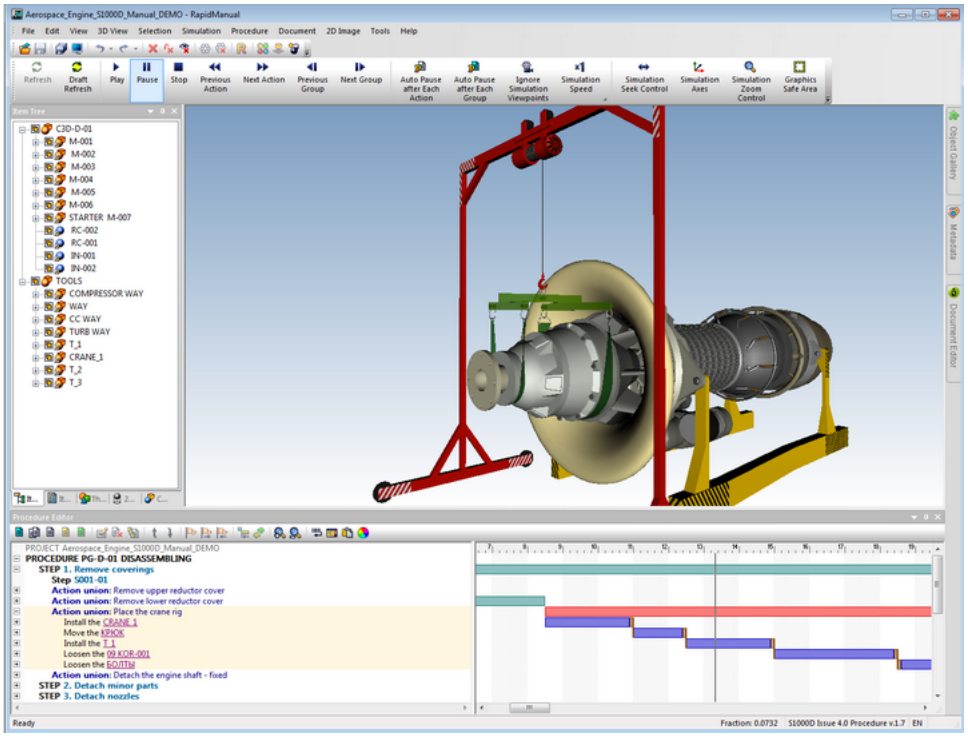


Existing Solutions / Related Work

- Reality Composer (Apple)
  - Cross-device authoring between iOS and MacOS
  - High-level design
  - Suited for entertainment, commercial use

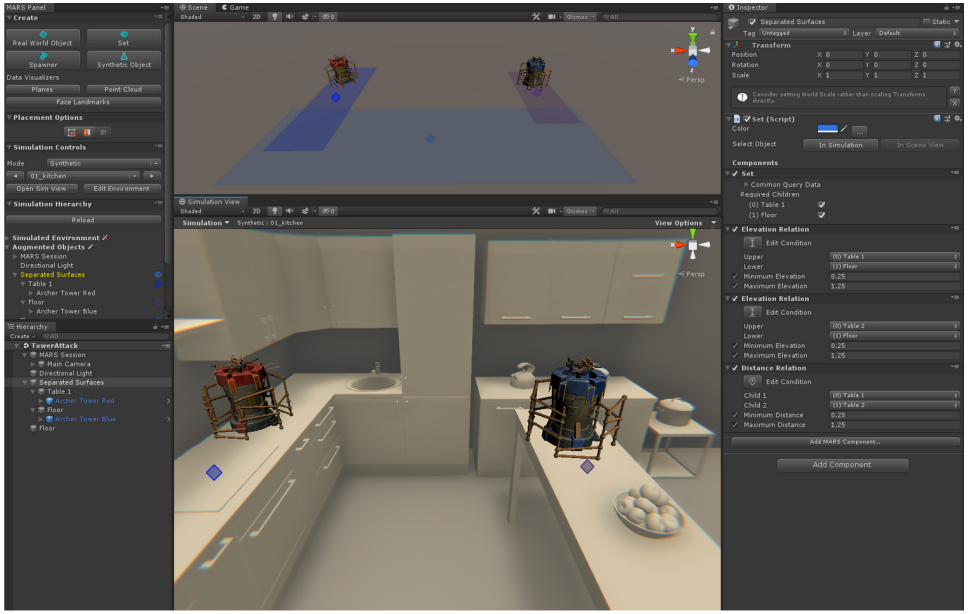
Existing Solutions / Related Work

- RapidManual (Cortona3D)
  - Originally a CAD authoring tool
  - Used by RE‘FLEKT
  - Low-level, detailed design
  - Does not include AR features



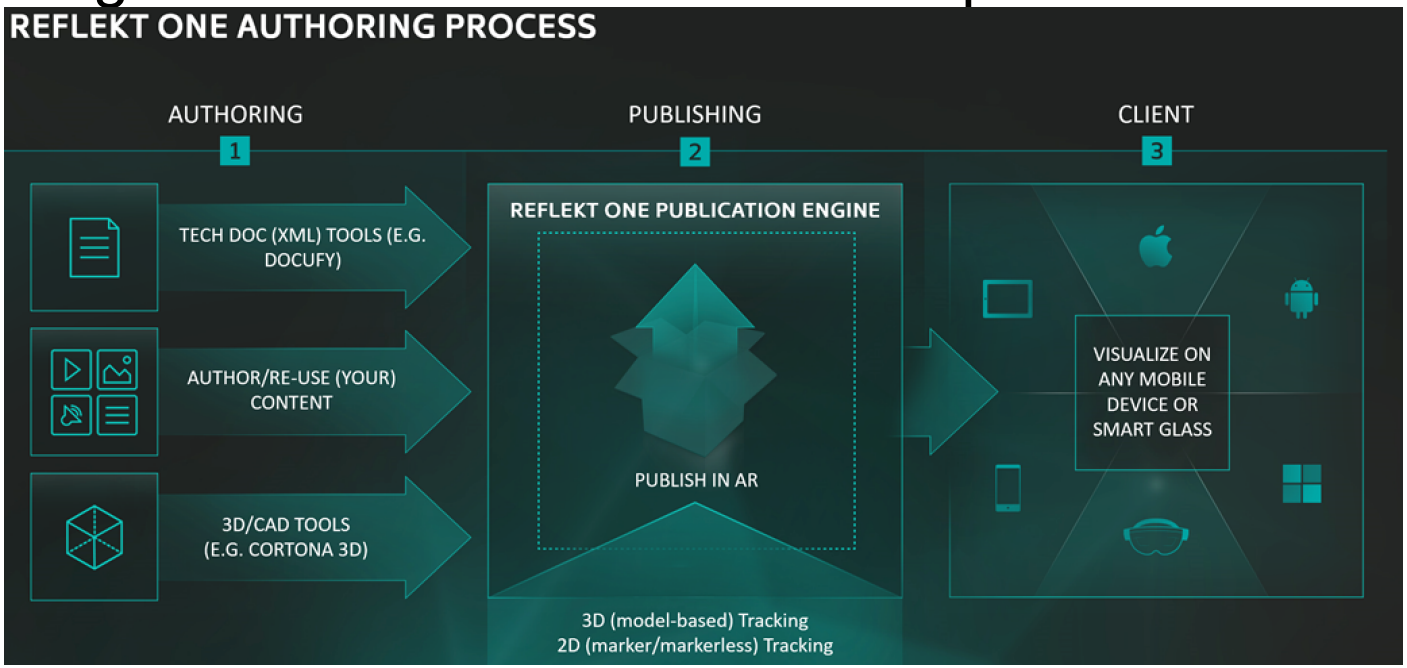
Existing Solutions / Related Work

- MARS (Unity Technologies)
  - Development will end in 2020
  - Toolkit for Unity Editor, used for AR authoring
  - Good use of AR elements and visualization
  - Easy to utilize



RE'FLEKT GmbH

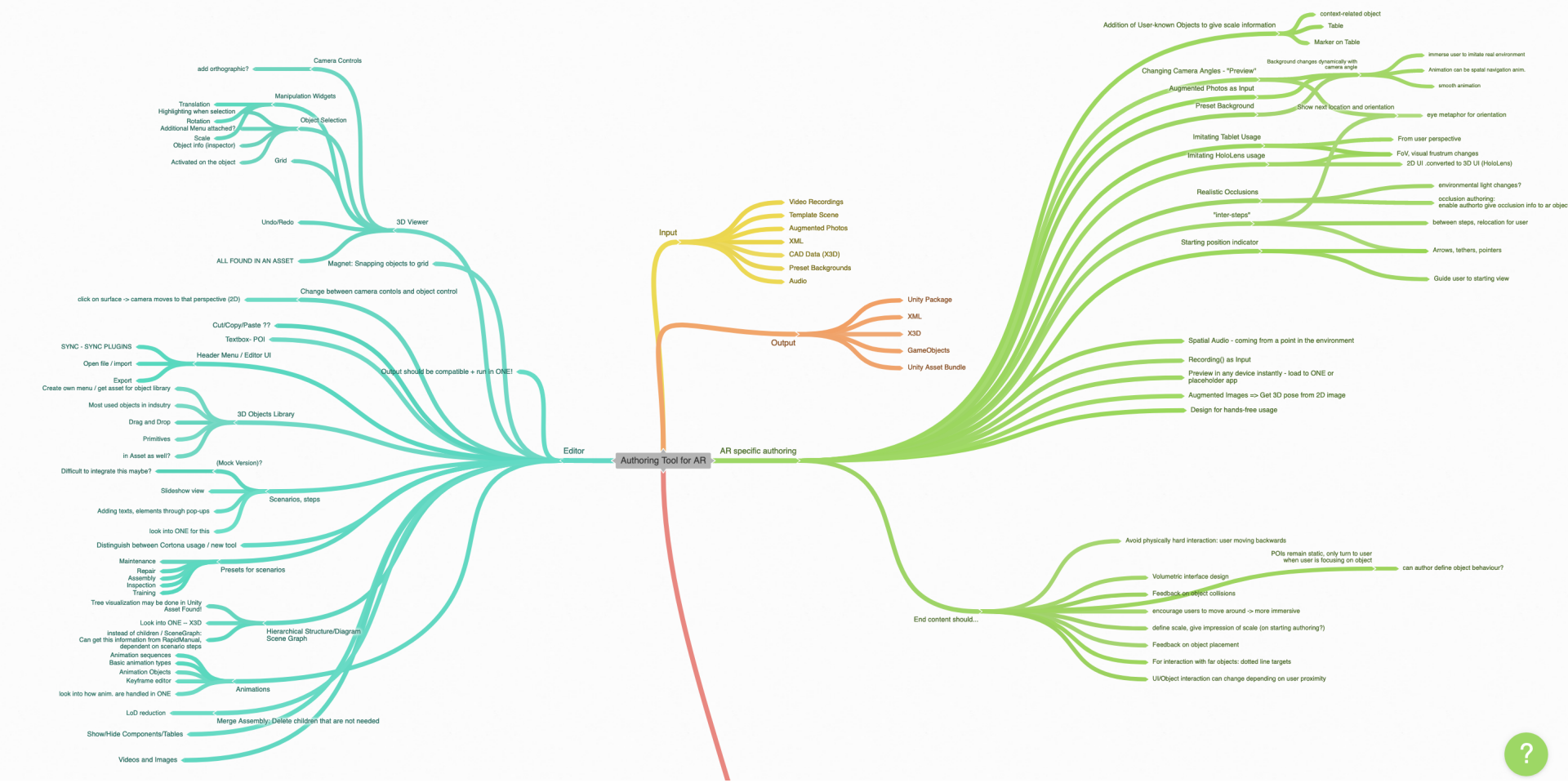
- Industrial Augmented Reality Solutions
- RE'FLEKT ONE: All-in-one solution for industrial use cases
- Integration into RE'FLEKT ONE Pipeline



Proposed Work / Approach

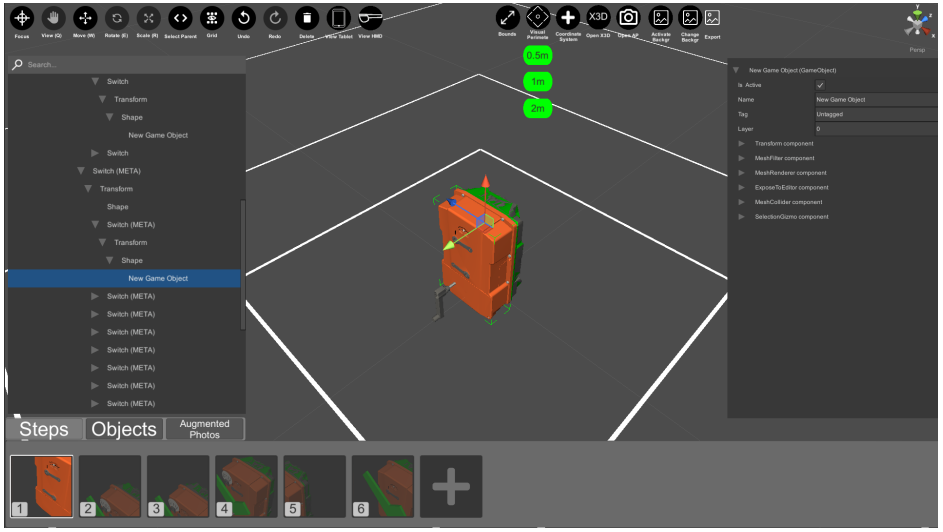
- Extensive Research
  - Industrial Augmented Reality
  - Research on Authoring Methods and Implementations
  - Contemporary Authoring Tools
  - Augmented Reality Interaction Techniques, Key Points
- Gather Feedback from UX Department
- Collect all Data in a Mindmap, Establish Priorities
- Create an Authoring Tool with Regards to Priorities
- Test the Solution with an User Survey in the company

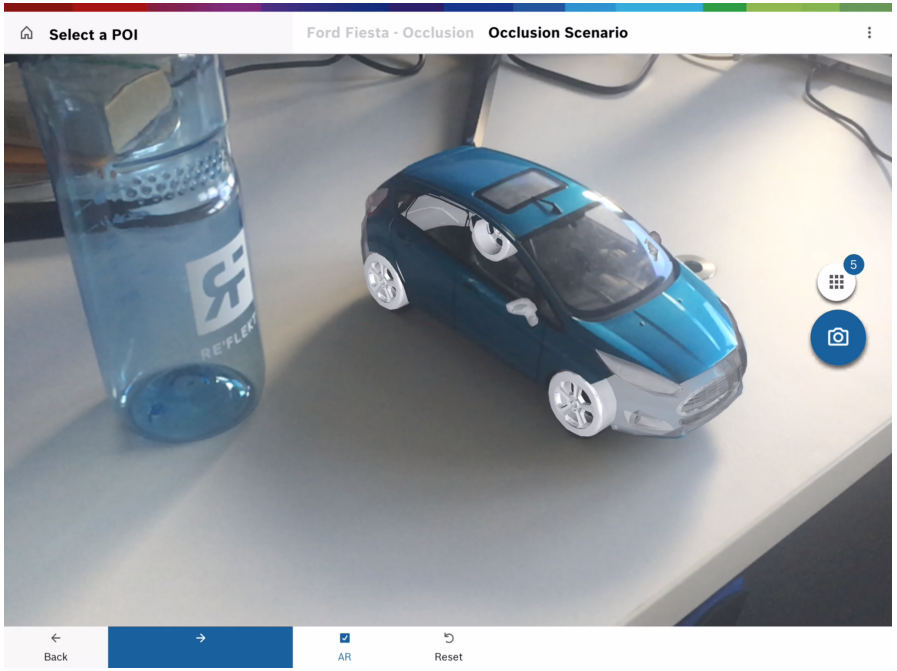
Mindmap and Prioritization



Implementation

- Editor
  - Runtime Handles
  - Runtime Hierarchy
  - Standalone File Browser
- AR Features
  - Preset Backgrounds
  - Bounds and Size Visualization
  - Handheld Device Emulation
  - HMD Emulation
  - Augmented Photos





Evaluation / User Study

- 7 people participated from UX (User Experience) and R&D (Research and Development) teams
- Online, one-to-one sessions due to coronavirus
- 20-30 minute walkthrough with screen sharing
- Questionnaire using Likert scale
- 3 Questions
  - Features of Authoring Tool
  - Authoring Tool Overall Evaluation
  - Feedback and Thoughts

Evaluation / User Study Results

Authoring Tool Features

Authoring Tool Features	Not useful	Needs Improvement	Neutral	Useful	Very Useful	Average Score	Percentage
Importing Data			1	2	4	4.43 / 5	88%
Object Selection		1	3	1	2	3.57 / 5	72%
Object Manipulation		1	3		3	3.72 / 5	75%
Camera Controls			3	2	2	3.86 / 5	77%
Adding Objects		1		1	5	4.43 / 5	88%
Visualization Tools				4	3	4.43 / 5	88%
Scenario and Step Integration				4	2	4.15 / 5	83%
Tablet View			2	2	3	4.15 / 5	83%
HMD View		1	1	2	3	4 / 5	80%
Augmented Photos			1	3	3	4.29 / 5	86%

Autoring Tool General Rating

Authoring Tool General Rating	Very Unpromising	Unpromising	Neutral	Promising	Very Promising	Average Score	Percentage
Editor Functionality			2	1	4	4.29 / 5	86%
Authoring Tool Features			1	2	4	4.43 / 5	88%
User Interface			4	2	1	3.57 / 5	72%
Usability			3	2	2	3.86 / 5	77%
Pipeline Integration Potential				2	5	4.72 / 5	94%

Discussion / Suggested Future Work

- RE‘FLEKT
  - Overall positive feedback
  - Support for future integration into the pipeline
  - Areas of improvement: Bugfixes, Output handling, Adding animation support, step descriptions, extra features on the mindmap
- Reseach Perspective
  - Implementation of proven practices into the authoring tool
  - Overall positive results indicate these methods are still relevant
  - New authoring tools/frameworks are on the way

Conclusion

- Two goals of the thesis achieved
  - Research about finding the best way to author for AR
    - By looking into existing solutions
    - By looking into previous scientific articles
    - Investigating surveys on industrial augmetned reality
  - Implementing the findings into an application
    - Using the research and AR author‘s needs
    - Creating a prototype as a starting point
    - Trying out the proposed AR features within the authoring tool
    - Testing the outcome through an user survey, which showed promising results

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