Carter Ferris, Hampton Chappell, Nick Swanson
Dr. Mohsen
ISYE 4803

9 September 2025

XR Project Proposal

Problem Statement

Gearbox assembly is a difficult process where precision, repeatability, and safety are essential. Traditional training relies on shadowing, paper SOPs, and undocumented information and skills. This leads to long training, inconsistent torquing sequences, occasional assembly errors, and production variability during training of new employees. Additionally, as processes are updated, new trainings will be released and required of existing employees to maximize assembly efficiency. Our goal is to reduce the time-to-competence for new trainees, reduce retraining time, and enhance new process adoption for existing employees through VR interactive training and live, AR, to-scale model projection. This problem deals directly with many engineering applications like manufacturing process engineering, training and ergonomics, and quality engineering.

Target Users & Stakeholders

- **Primary Users:** new assemblers and cross-trained technicians on gearbox lines
- **Secondary Users:** process engineers, quality engineers, training coordinators, and supervisors
- **Stakeholders:** plant operations, industrial engineers, and HR/Learning & Development

XR Solution Overview & Technical Components

VR Assembly Trainer (off-line): In virtual reality, we will use a guided, simulation-based experience for learning the full assembly of a representative gearbox. Users will be able to practice component identification, fitment order, bearing/seal installation, alignment, torque patterns, adhesive application windows, and quality control checks. This will be achieved through multiple key components from our course like animation to make the gearbox move, Unity scene design to create the VR interfaces, C#/MonoBehavior to make the gearbox parts interactable, and various lessons from module D to improve the user experience.

Live AR Work-Assist: On the shop floor, augmented reality will overlay step-by-step instructions, and 3D ghosting of parts anchored to the physical fixture/workbench. Interactive UI overlays will include assembly checklists and a photo capture widget for easy quality control and documentation. The key components used from the course in our AR design will be tracking &

anchoring to place the overlays, multimodal input to interact with the displays, and C# for custom behavior.

Success Criteria

VR Assembly Trainer

- The user should be able to reference the assembly manual in the VR environment
- The user should be able to assemble a gearbox in virtual reality
    - Assembly will consist of at least 5 independent steps, each with a different tool, and differing step process variations for gearbox type

AR work assist

- System should be able highlight tool locations on a workbench for the user
- System should be able to display internal components and ghosting of where components go based on assembly stage
- The user should be able to reference the Assembly manual in the AR environment and move it around the workspace and toggle it
- The system will show an overview of the assembly checklist and process

Functionality and Stability

- Both VR and AR environments should be stable and consistently perform as intended across all use cases

Timeline & Milestones

- Week 3: Proposal submitted; course instructor meeting scheduled.
- Week 4: VR core loop (grab/place, sequence gates); initial torque tool; placeholder models; gearbox assembly process defined
- Week 5: VR polish (hints, error scenarios); Round-1 VR test; iterate.
- Week 6: AR idea sketches; final VR tweaks; Round-2 VR test; iterate.
- Week 7: Midterm Prototype
- Week 8: AR anchoring (image target + persistent anchor); UI panels; scan-to-start.
- Week 9: AR overlays; Round-1 AR test; iterate.
- Week 10: AR polish; Round-2 AR test; iterate.
- Week 11: Finalize AR system; begin full system tests.
- Week 12: End-to-end dry run; documentation drafts.

- Week 13: Final demo; report; reflective analysis; peer evaluation submission.

Team Roles

Hampton Chappell: Backend Development (C# Scripting and Logic Implementation)

Carter Ferris: Scene Design and Implementation (Environment Design and Finishing)

Nick Swanson: Asset Management and Gearbox Specialist (Asset Acquisition, Configuration, and Maintenance)

*All team members expect to contribute across all three roles, and will not be limited to the scope of their own assignment. Roles simply denote, based on interest and experience, who is responsible for pushing/heading each initiative.