

# Augmented Reality Flatpack Furniture Assembly

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## The Problem

- ❖ AR is ‘one of the leading technologies of the 21st century’ (Arena et al. 2022)
- ❖ Head mounted displays becoming consumer products
- ❖ What potential uses could they have for consumers?

# Flatpack Assembly

- ◆ AR could be used to guide consumers on flatpack furniture assembly
- ◆ Assembling furniture is known to cause issues for many people.
- ◆ 67% of adults admitted to having difficulty with assembling flatpack furniture. (Richardson 2011)



# The Aim

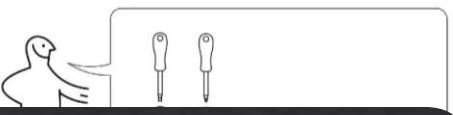
- ❖ AR has previously been studied in industrial contexts
- ❖ Can reduce error by 82%  
(Tang et al. 2004)
- ❖ If it has this effect on industrial assembly, why can't it do the same for consumer assembly?



(Wu et al. 2023)

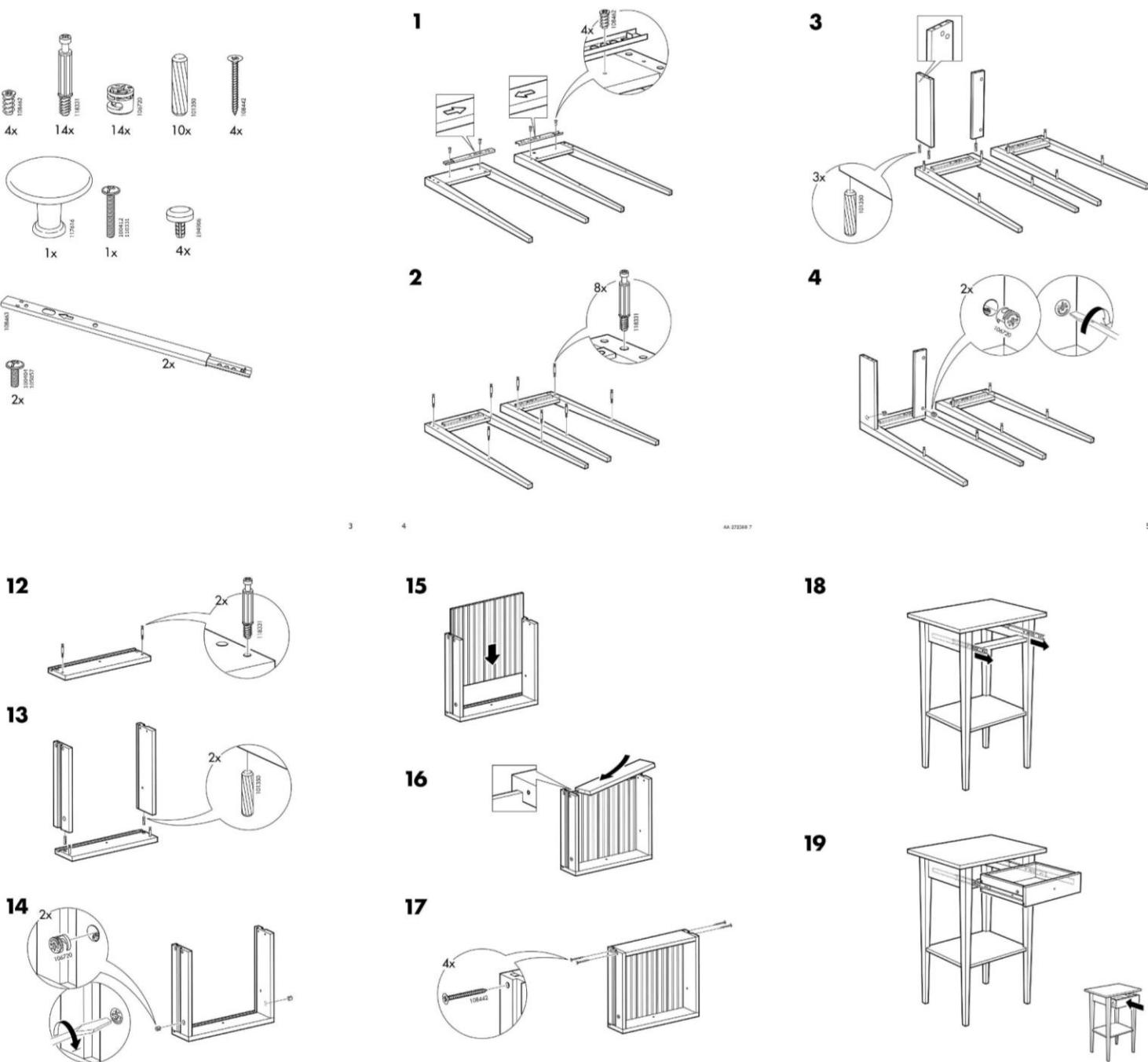
**Can AR instructions be more effective at guiding consumers in flatpack furniture assembly than paper instructions?**

# HEMNES



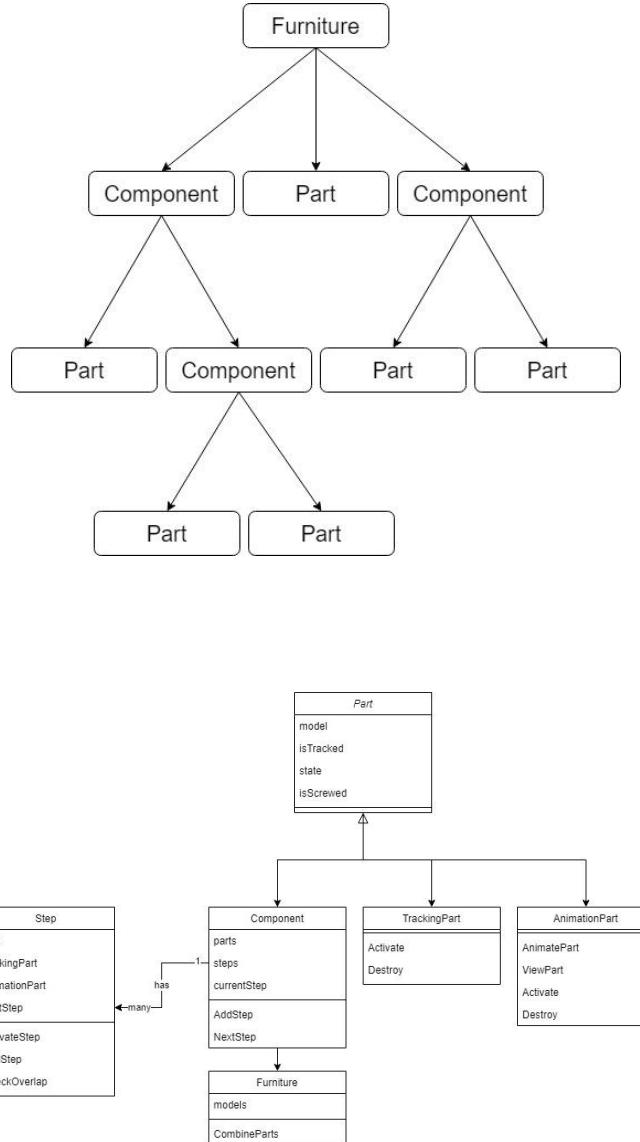
## Design

- ❖ Main requirements source was IKEA instructions
  - ❖ Requirements include:
    - ❖ Showing which part to add
    - ❖ Showing where a part should be added
    - ❖ Showing the orientation of a part
    - ❖ Displaying if a part should be screwed in
    - ❖ Giving close up views of smaller parts



# Communicating Instructions

- ❖ Object tracking was chosen as a good option for showing users how to correctly assemble a piece of furniture.
- ❖ Users can be shown in real time what to do, and if what they are doing is correct
- ❖ Animations to show the path of how a part should be added



# The System

- ❖ Framework based on the composite design pattern
- ❖ Furniture has a list of steps
- ❖ Steps have a part and a next step
- ❖ Steps can be components
- ❖ Components break down into more parts
- ❖ Tracking parts and animation parts are used to demonstrate the instructions

# Platform

- ❖ Development platform chosen was Unity
- ❖ Comes with many built in AR packages
- ❖ VisionLib object tracking package has Unity integration



**Unity**

DEMO

# Evaluation

- ❖ Evaluated using a think aloud experiment
- ❖ Participants of three groups assembled IKEA HEMNES bedside table:
  - ❖ Paper instructions group
  - ❖ Animation instructions group
  - ❖ Tracking instructions group
- ❖ Any issues the participants had were recorded
- ❖ Errors in assembly were recorded
- ❖ Issues and errors were categorised:
  - ❖ Part identification
  - ❖ Location
  - ❖ Orientation
  - ❖ Progression



Part	Part Identification	Location	Orientation	Progression	Error	Other
1						
2						
3						
.						
.						
.						

# Issue Scores



Issue scored 1:

Issue was very insignificant and did not hinder overall progress



Issue scored 2:

Issue caused some delay but was handled by participant



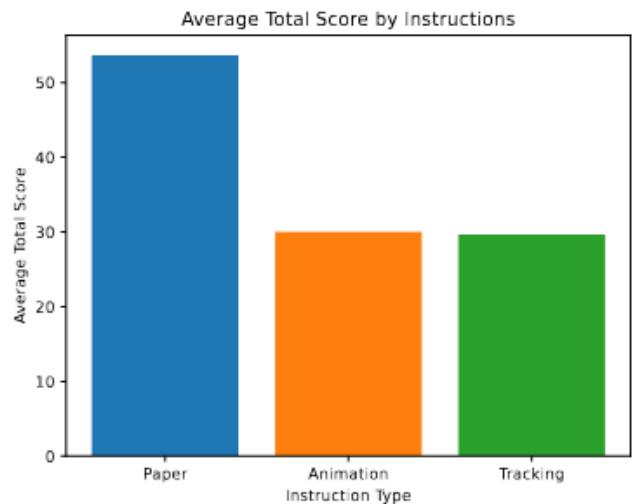
Issue scored 3:

Issue caused significant delay and stopped progress, these issues required assistance to deal with

# Tracking Issues

**“Tracking had to be forced into position rather than being a guide on position”**

- ❖ Tracking proved to be very difficult to work with
- ❖ Two participants gave up trying to use tracking feature
- ❖ One tried all the way through but only successfully used it three times
- ❖ Tracking instructions without tracking are very similar to animation instructions



# Results

- ❖ Paper instructions caused more errors than AR
- ❖ A trend appeared with AR instruction having a lot of issues at the start and then dropping quickly
- ❖ Paper instructions had consistent level of issues
- ❖ AR errors were regularly happening at new features/step types
- ❖ Paper issues were similar throughout

# Conclusion

- ❖ Most development time and effort went to object tracking instructions
- ❖ Animation was more effective and enjoyable for participants
- ❖ Biggest issue with AR was the learning curve
  - ❖ New technology to participants
  - ❖ User guide and improved user interface required
- ❖ Tracking is not ready in current state
  - ❖ Inaccurate
  - ❖ Demanding on the Hololens
- ❖ Future research could use image tracking as a temporary solution

# Bibliography

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