Introduction

Project 3 focused on developing an XR (Extended Reality) solution to address challenges in Hong Kong's second-hand furniture market. Our team created a platform that enables sellers to scan furniture items into 3D models and allows buyers to visualize these items in their homes using AR (Augmented Reality) before purchase. We approached this with a human-centered design methodology, ensuring our solution addressed real user needs while being practical to implement in Hong Kong's unique living environment.

Project Description

The project required us to:

- Conduct user research to identify challenges in the second-hand furniture market
- Define the problem space and construct a Point of View (POV)
- Develop personas to represent key stakeholders
- Create a working XR prototype addressing the identified challenges
- Conduct usability testing and gather feedback
- Present our solution and findings

Empathize

We interviewed 17 participants to understand their experiences with second-hand furniture. Our research revealed several key insights:

- **Approximately 90%** had bought or sold second-hand furniture, primarily using platforms like Carousell
- **Key challenges identified**:
    - Difficulty assessing furniture condition from photos alone
    - Transportation issues with large items
    - Size mismatches with intended spaces
    - Distance between buyers and sellers limiting in-person viewing

We categorized these challenges into five main areas:

1. Size and fit issues
2. Quality and condition concerns
3. Pricing transparency problems
4. Logistics and delivery complications
5. Trust and communication barriers

Our field observation at Pioneer Centre furniture stores further revealed:

- Customers struggled with measuring spaces before purchase
- Store staff couldn't help with measurement issues
- Traditional furniture shopping had high time costs

Most significantly, our research confirmed strong user needs:

- **100%** of participants wanted to visualize furniture in their space before purchase

- **~70%** expressed interest in an AR preview application
- **~82%** preferred 3D models over photos for assessing furniture

Scenario Appropriateness

Hong Kong emerged as an ideal scenario for XR implementation in the second-hand furniture market because:

1. **Space constraints**: Hong Kong apartments are notoriously small, making furniture fit critical
2. **Active second-hand market**: Economic and sustainability factors drive a robust second-hand culture
3. **Tech adoption**: High smartphone penetration enables AR technology adoption
4. **Transportation challenges**: Narrow corridors, small elevators, and dense urban environment make moving furniture difficult
5. **Visualization needs**: Difficulty in judging size and fit from photos alone creates a perfect use case for AR

Ideation

Based on our research insights, we developed three personas to represent key stakeholders:

1. **Summer**: University student with limited budget moving into a dorm
2. **Sam**: 30-year-old working professional furnishing an apartment for his family
3. **Michelle**: 44-year-old second-hand furniture reseller needing better ways to display inventory

We constructed our POV statement:

> "Hong Kong residents need accurate visualization of furniture before buying due to space constraints, while sellers need better ways to present items beyond 2D photos."

Through storyboarding and speed dating exercises, we refined our solution concept to address the core needs of both buyers and sellers.

Prototype Development

We developed an XR platform with the following key features:

1. **3D Scanning Functionality**
    - Allows sellers to create virtual furniture models using smartphone cameras
    - Captures textures and dimensions accurately
    - Generates shareable 3D assets
2. **Virtual Marketplace**
    - Browsing interface for 3D furniture models
    - Filtering by dimensions, style, and price
    - Detailed view of furniture from all angles
3. **AR Placement Tool**

    - Enables buyers to visualize furniture in their homes
    - Accurate scaling based on real dimensions
    - Option to change colors and finishes

4. **Size and Fit Verification**
    - Visual indicators for space constraints
    - Measurement tools for comparing dimensions
    - Collision detection with existing room elements

We implemented the prototype using:

- Unity for AR development
- ARCore/ARKit for spatial tracking
- Photogrammetry techniques for 3D scanning
- Cloud storage for 3D model repository

Practicality Assessment

We ensured our solution remained practical for the Hong Kong context by:

1. **Minimizing hardware requirements**: Using existing smartphones rather than specialized equipment
2. **Addressing real pain points**: Focusing on the visualization challenges unique to Hong Kong's small living spaces
3. **Considering technical limitations**: Designing scanning processes that work in limited physical space
4. **Planning for scalability**: Creating a platform that could expand to other markets and product categories

Testing and Results

We conducted usability testing with participants representing our different personas to evaluate the effectiveness of our prototype.

User Feedback

Through our testing sessions, we gathered valuable insights:

Key Strengths Identified:

- **AR Visualization**: Users particularly appreciated seeing furniture in their actual space before purchase. One participant noted, "This would have saved me from buying that sofa that didn't fit through my door!"
- **Time Efficiency**: Testers highlighted the time savings compared to visiting physical stores. A user commented: "I could browse dozens of items in the time it would take me to visit one store."
- **Spatial Understanding**: Users found the size and fit verification features especially valuable in Hong Kong's limited living spaces. "Finally I can be sure something will fit before buying it," said

one participant.

- **Scanning Capability**: Sellers were impressed with the ability to create 3D models from their smartphones. "This makes my listings stand out completely," noted a participant who frequently sells furniture.

Areas for Improvement:

- **Scanning Complexity**: Some users found the scanning process technically challenging and suggested simplifying the interface.
- **AR Accuracy Concerns**: Several participants expressed hesitation about fully trusting the AR visualizations for final purchase decisions.
- **Need for Clearer Instructions**: Users requested more guidance for the AR placement features.
- **Texture Rendering Quality**: Some feedback indicated that material textures needed improvement for realistic visualization.

Learning and Execution Process

Technical Implementation

We developed the platform with careful attention to several technical challenges:

1. **3D Scanning System**
    - Implemented a guided scanning process with visual feedback
    - Developed algorithms to clean and optimize 3D meshes for mobile devices
    - Created texture mapping procedures for realistic rendering
2. **AR Implementation**
    - Built a plane detection system for identifying floor and wall surfaces
    - Developed accurate scale representation using ARCore/ARKit measurements
    - Implemented lighting estimation for realistic rendering in different environments
3. **Marketplace Integration**
    - Created a database structure for 3D models and metadata
    - Developed compression techniques for efficient model transfer
    - Implemented search and filter algorithms optimized for furniture attributes
4. **User Experience Flow**
    - Designed intuitive navigation between scanning, browsing, and placement functions
    - Implemented user profiles to save favorite items and placement configurations
    - Created a messaging system for buyer-seller communication

Design Process Appropriateness

Our design process followed a systematic approach:

1. **Human-centered research**: Starting with extensive user interviews and field observations
2. **Persona development**: Creating representative user types to guide design decisions
3. **Iterative prototyping**: Building progressive versions with user feedback
4. **Contextual consideration**: Designing specifically for Hong Kong's unique spatial constraints
5. **Technical feasibility testing**: Ensuring solutions worked with available technology

Use of AI

1. **Brainstorming Support**:
    - We used AI tools like ChatGPT to generate initial ideas during our brainstorming sessions
    - This helped us explore a wider range of potential features and interaction patterns
    - All AI-generated ideas were critically evaluated by the team before incorporation
    - We found this particularly useful for considering edge cases we might have overlooked
2. **Unity Learning Assistance**:
    - As our team had varying levels of Unity experience, we used AI to accelerate the learning process
    - We queried AI systems for explanations of complex AR concepts and Unity implementation techniques
    - AI helped troubleshoot specific coding challenges we encountered during development
    - It provided code examples that helped us understand AR functionality implementation

Presentation and Feedback

Our in-class presentation focused on:

- Demonstrating the research-backed design process
- Showing our prototype through a video demonstration
- Presenting user testing results
- Discussing future improvements and market potential

Personal Contributions and Achievements

My primary contributions to this project included:

- Leading the user research phase and conducting 8 of the 17 interviews
- Developing the AR placement functionality
- Creating the testing protocol for usability evaluation
- Editing the demonstration video
- Analyzing user feedback and identifying key improvement areas

Personal Reflection

Working on this XR project taught me valuable lessons about designing spatial computing experiences:

1. **Context is critical**: Hong Kong's unique spatial constraints made certain features essential that might be less important in other markets. I learned to design specifically for the environmental context rather than making generic solutions.

2. **Technical limitations balance**: I discovered the importance of balancing technical capabilities with user expectations. While photogrammetry can create detailed 3D models, we needed to simplify the process for average users while maintaining acceptable quality.

3. **Trust in new technology**: Users were enthusiastic about AR but still hesitant to fully trust it for major purchase decisions. I learned that adoption of new technology requires building trust through accuracy and reliability.

4. **Interdisciplinary design**: This project required blending knowledge from UX design, computer vision, 3D modeling, and e-commerce. I gained appreciation for how interdisciplinary approaches create more robust solutions.

I found the AR placement development particularly challenging and rewarding. Creating a system that accurately represented furniture scale within real environments required solving complex technical problems while maintaining an intuitive user experience.

For future improvements, I would focus on simplifying the scanning process and improving the realism of materials and lighting in the AR visualization. I believe these enhancements would address the main concerns raised during user testing and further increase confidence in the platform.