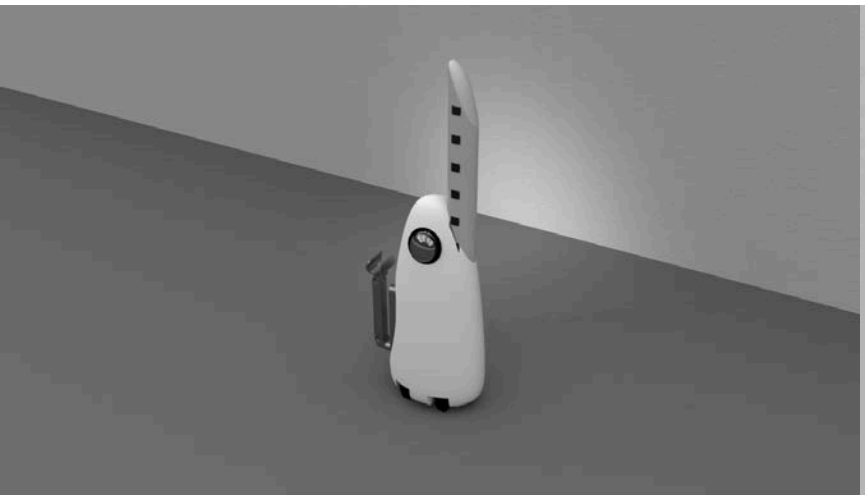

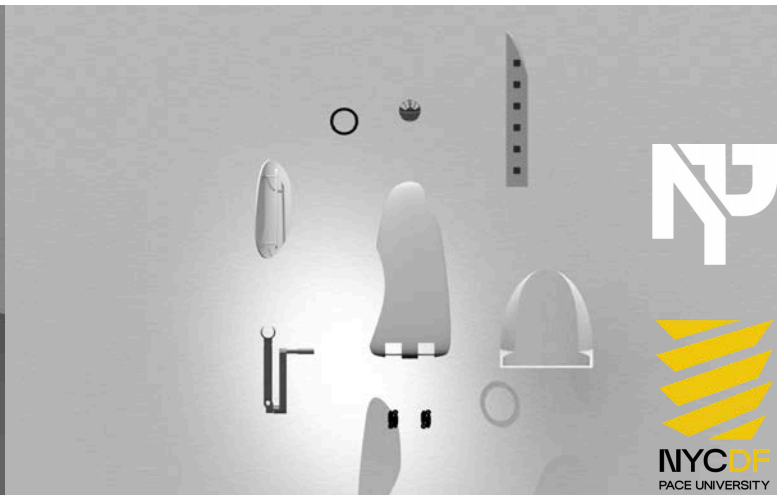

NYCDF
PACE UNIVERSITY

May 2025

TARA: Trainer Assistant Robot for Athletes

Redefining Rehabilitation in Collegiate Sports Through Intelligent Automation

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Team Introduction and Challenge

Design Challenge

How might we design intelligent rehabilitation support systems that personalize care for student-athletes and extend trainers' capacity in 2035?

This challenge emerged from extensive research revealing systemic issues in collegiate sports rehabilitation, where limited resources meet high demand, resulting in suboptimal recovery outcomes and athlete well-being.

Meet the Designers

Niels Callewaert
Job Title

Prarthana Centhil
Job Title

Thy Tran
Job Title

Problem Analysis and Key Insights

The Current Landscape

Our research uncovered critical challenges in collegiate sports rehabilitation:

Key Statistics

- 540,000 NCAA student-athletes compete annually
- 490,000 experience at least one injury per year
- 147,000 face repeat injuries
- 98% of trainers report athletes don't fully follow rehabilitation plans
- 1:100 average athlete-to-trainer ratio exceeds recommended standards

Primary Pain Points

1. **Limited Trainer Capacity**
   - Overwhelming caseloads prevent personalized attention
   - Administrative tasks consume 40% of trainer time
   - Documentation requirements detract from patient care

2. **Inconsistent Rehabilitation**
   - Athletes often self-manage recovery between sessions
   - Lack of continuous monitoring leads to incomplete healing
   - Varied compliance with rehabilitation protocols

3. **Assessment Challenges**
    - Subjective pain reporting leads to misdiagnosis
    - Time constraints limit comprehensive evaluations
    - Insufficient progress tracking capabilities

4. **Cultural and Communication Barriers**
    - Diverse athlete populations require culturally responsive care
    - Language and communication style differences affect treatment outcomes
    - Traditional rehabilitation approaches don't address holistic needs

Research Methodology

Our design process incorporated:

- 1 **trainer interview**
- **Literature review** of 40+ sports medicine publications
- **Technology assessment** of existing rehabilitation tools

Key Insights

1. **Automation Opportunity:** Routine tasks that consume 60% of trainer time can be automated without compromising care quality
2. **Personalization Need:** Athletes respond better to rehabilitation when it acknowledges their individual circumstances and cultural backgrounds
3. **Data Integration Gap:** Current systems don't effectively capture or utilize rehabilitation data for predictive insights
4. **Human-Robot Collaboration:** Trainers see technology as a complement to, not replacement for, human expertise
5. **Scalability Potential:** Standardized assessment protocols can be delivered consistently across diverse settings

Future Scenario

Sports Rehabilitation in 2035

Vision Statement

By 2035, every student-athlete will have access to personalized, data-driven rehabilitation support that accelerates recovery, prevents re-injury, and enhances long-term athletic performance and wellbeing.

2035 Context Visualization

Figure 1: Rehabilitation Center 2035

Imagine a rehabilitation facility where smart technology seamlessly integrates with human expertise. Athletes move through personalized recovery stations guided by AI assistants, while trainers focus on complex cases and emotional support. Real-time biometric monitoring provides instant feedback, and holographic displays show recovery progress in intuitive, culturally relevant formats.

STEEPLE Analysis of 2035 Context

Social

- Increased awareness of mental health in sports recovery
- Growing diversity in collegiate athletics demanding inclusive care
- Community-based rehabilitation models flourishing
- Peer support networks integrated into recovery processes

Technological

- AI-driven predictive injury modeling becomes standard
- Quantum computing enables real-time biomechanical analysis
- Wearable technology provides continuous health monitoring
- Virtual reality enhances rehabilitation exercise engagement

Economic

- Healthcare costs shift toward prevention rather than treatment
- Insurance models evolve to cover predictive care technologies
- Remote rehabilitation reduces institutional overhead costs
- Digital health platforms create new economic opportunities

Environmental

- Sustainable healthcare practices prioritize energy-efficient equipment
- Modular, adaptable facility designs reduce construction waste
- Digital health records minimize paper consumption
- Local manufacturing of medical devices reduces carbon footprint

Political

- Regulatory frameworks established for AI in healthcare
- Student-athlete rights include access to advanced rehabilitation
- Privacy legislation governs health data usage in sports
- International standards emerge for digital health equipment

Legal

- Liability frameworks adapt to include technology-assisted care
- Intellectual property protections for health data innovations
- Professional certification requirements incorporate digital health literacy
- Consumer protection laws ensure equitable access to rehabilitation technology

Ethical

- Technology design prioritizes human dignity and agency
- Algorithmic fairness standards prevent bias in treatment recommendations
- Data ownership remains with athletes while enabling research
- Transparency requirements ensure explainable AI decision-making

Detailed Design Solution

TARA: Trainer Assistant Robot for Athletes

Why TARA?

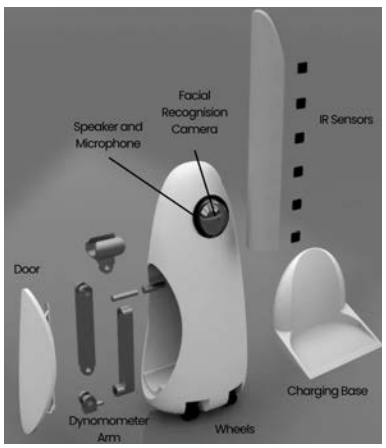
TARA was conceived to bridge the critical gap between rehabilitation demand and available resources. Our solution recognizes that while human expertise remains irreplaceable, technology can augment trainer capabilities and ensure consistent, high-quality care for all athletes.

What is TARA?

TARA (Trainer Assistant Robot for Athletes) is an intelligent rehabilitation assistant that:

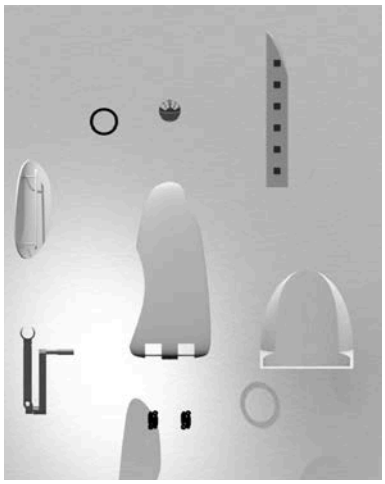
- Automates routine assessments and data collection
- Provides real-time exercise guidance and feedback
- Generates personalized recovery reports
- Integrates seamlessly with existing training management systems

How TARA Works



Core Components

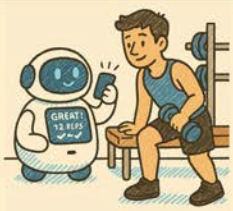
1. **Advanced Sensing System**
   a. Infrared scanner detects inflammation and tissue injuries
   b. Pressure sensors measure muscle strength and resistance
   c. Facial recognition camera ensures personalized interactions
   d. Spatial awareness cameras monitor exercise form
2. **Interactive Feedback System**
   a. Voice guidance with multiple language support



b. Visual feedback display for exercise demonstrations
c. Haptic response for tactile guidance
d. Real-time performance metrics

3. **Data Integration Platform**
   a. Seamless connection with TeamWorks app
   b. Automated report generation
   c. Progress tracking visualization
   d. Predictive analysis capabilities

How TARA Works

1. Arrival & Preparation Athlete walks into the rehab center	2. Check-In & Identity Verification Athlete approaches the robot and taps ID card or scans face	3. Initial Assessment Robot scans the athlete's shoulder using motion/thermal sensors	4. Data Analysis Robot processes and compares data with past sessions
			
Upon arrival, the robot accesses the athlete's records and sends a brief pre-session questionnaire to their phone.	The robot greets the athlete, verifies identity, and collects responses from the questionnaire.	Performs vital sign checks, range-of-motion scans, and pain feedback collection.	Quickly identifies trends, improvements, or concerns and prepares a visual report.
5. Handoff to Athletic Trainer Trainer reviews tablet with report summary	**6. In-Session Support** Athlete performs exercises while robot observes	**7. End-of-Session Assessment** Robot performs a final scan after therapy	**8. Home Program Setup & Session Closure** Robot and trainer review exercise plan on a tablet together
			
Robot transmits key findings and highlights areas for human review or treatment adjustment.	On-screen display shows encouragement + real-time metrics like reps, alignment	Graph showing improvement curve + fatigue warning	Suggests home program, sends visual guides to athlete's phone, and schedules next session.

Operational Workflow

1. **Pre-Session Preparation**
   a. Athlete schedules via TeamWorks app
   b. Completes digital intake questionnaire
   c. TARA prepares personalized assessment protocol
2. **Session Initiation**

a. Facial recognition welcomes athlete
b. Reviews previous session data
c. Conducts targeted assessments

3. **Trainer Handoff**
   a. Data transfers to trainer device
   b. AI-generated insights highlight key concerns
   c. Trainer reviews and interprets findings
4. **Guided Exercise Phase**
   a. Trainer demonstrates new exercises
   b. TARA monitors subsequent repetitions
   c. Real-time feedback ensures proper form
   d. Alerts trainer to concerning movements
5. **Session Completion**
   a. Trainer provides summary and next steps
   b. TARA documents session details
   c. Generates athlete and trainer reports
   d. Data updates longitudinal record

Who Uses TARA?

Primary Users

Student-Athletes

- Division I-III collegiate athletes
- Ages 18-22 across all sports
- Diverse cultural and linguistic backgrounds
- Varying injury types and recovery stages

Athletic Trainers

- Certified professionals managing multiple athletes
- Working in resource-constrained environments
- Requiring efficient documentation tools
- Seeking enhanced diagnostic capabilities

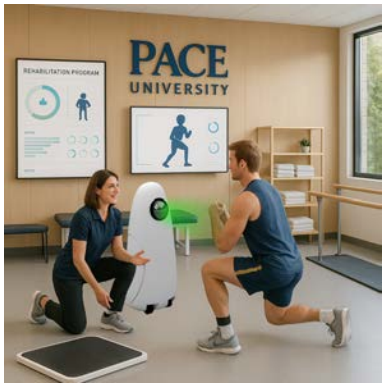
Secondary Stakeholders

- Coaching staff monitoring athlete recovery
- Athletic department administrators tracking outcomes
- Healthcare researchers analyzing rehabilitation data
- Parents/guardians staying informed about athlete care

When and Where TARA Operates

Temporal Context

- Daily rehabilitation sessions during peak hours
- Emergency assessments for acute injuries
- Weekend availability for flexible scheduling
- Seasonal adaptations for sport-specific needs



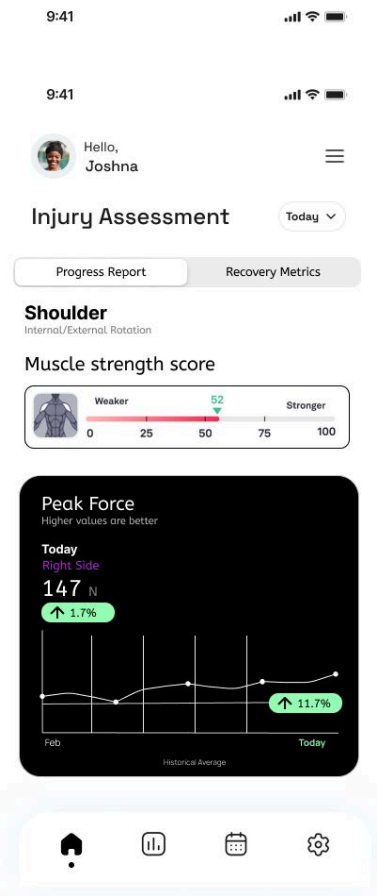
Spatial Implementation

- Primary location: Athletic rehabilitation centers
- Secondary deployment: Practice facilities
- Mobile units for field-side assessments
- Remote consultation capabilities

User Interface Design

Athlete Interface

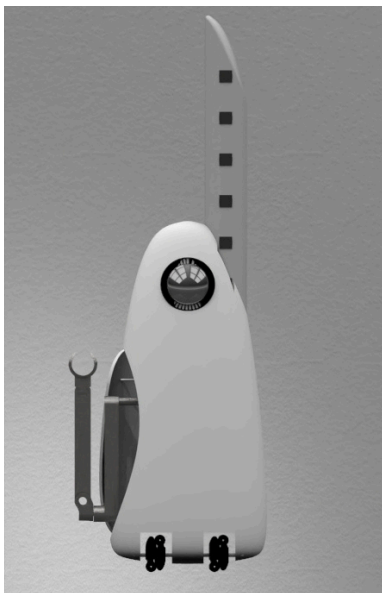
- Intuitive touchscreen with large, accessible controls
- Multi-language support with dialect recognition
- Visual and auditory feedback options
- Customizable display for vision accommodations



Trainer Interface

- Professional dashboard with comprehensive analytics
- Real-time session monitoring capabilities
- Rapid documentation tools
- Integration with electronic health records

Form, Scale, and Aesthetics



Physical Design

- Height: 48 inches (optimized for table/standing interactions)
- Width: 24 inches (compact for facility navigation)
- Weight: 85 pounds (stable yet mobile)
- Material: Medical-grade polymer with antimicrobial coating

Aesthetic Considerations

- Non-intimidating, approachable design language
- Calming color palette (soft blues and grays)
- Rounded edges for safety and comfort
- Professional appearance maintaining clinical credibility

Key Functionalities

Automated Assessment

- Infrared thermal imaging for inflammation detection
- Range of motion measurements

- Strength testing with quantified metrics
- Postural analysis and gait assessment

Exercise Guidance

- Demonstration of proper form
- Real-time feedback on technique
- Adaptive difficulty adjustments
- Progress celebration and motivation

Data Management

- Comprehensive session documentation
- Longitudinal progress tracking
- Predictive modeling for injury risk
- Customizable reporting formats

Communication Enhancement

- Multilingual capabilities
- Cultural sensitivity protocols
- Emotional intelligence in feedback delivery
- Emergency escalation procedures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Implementation Roadmap & Strategy

Timeline Overview

Phase 01

Foundation (2025-2027)

- Prototype development and testing
- Initial pilot programs at 5 universities
- Regulatory approval processes
- Insurance coverage negotiations

Phase 02

Early Adoption (2028-2030)

- Deployment to 50+ institutions
- Trainer certification program launch
- Data analytics platform development
- Integration with major health systems

Phase 03

Scaling (2031-2033)

- Nationwide availability in Division I schools
- International expansion initiation
- Advanced AI features implementation
- Comprehensive outcome research publication

Phase 04

Transformation (2034-2035)

- Standard of care integration
- Preventive capabilities maturation
- Advanced personalization features
- Next-generation hardware development

Stakeholder Roadmap

Institutional Leadership

- Year 1: ROI demonstration and pilot approval
- Year 2-3: Strategic integration planning
- Year 4-5: System-wide adoption and optimization

Athletic Trainers

- Month 1-3: Training and certification
- Month 4-12: Workflow integration and adaptation
- Year 2+: Advanced feature utilization and feedback

Student-Athletes

- Initial contact: Orientation and consent
- First month: Familiarization and baseline establishment
- Ongoing: Regular session participation and progress tracking

Technology Partners

- Pre-launch: System integration and testing
- Launch: Deployment support and monitoring
- Post-launch: Continuous improvement and updates

Value Proposition and Impact

For Student-Athletes	• Personalized care adapting to individual needs • Consistent rehabilitation quality across all sessions • Reduced recovery time through optimized protocols • Enhanced engagement through technology integration • Improved long-term health outcomes
For Athletic Trainers	• Extended capacity to serve more athletes effectively • Reduced administrative burden and documentation time • Enhanced diagnostic capabilities and decision support • Improved job satisfaction through focus on complex care • Data-driven insights for better treatment outcomes
For Institutions	• Cost-effective rehabilitation solution • Improved athlete retention and performance • Reduced liability through comprehensive documentation • Enhanced recruitment capability with advanced care offerings • Positive return on investment through injury prevention
For Society	• Democratized access to quality rehabilitation care • Advanced sports medicine research capabilities • Reduced healthcare costs through prevention • Workforce development in health technology sector • Model for future healthcare delivery innovation

Integration Strategy

Technical Integration

- API connections with existing TeamWorks platform
- Interoperability with electronic health records
- Cloud infrastructure for data management
- Mobile application for remote monitoring

Workflow Integration

- Minimal disruption to current trainer routines
- Phased implementation allowing adaptation
- Customizable settings for institutional needs
- Seamless handoff protocols between human and robot

Cultural Integration

- Inclusive design accommodating diverse populations
- Cultural competency training for AI interactions
- Community engagement and feedback mechanisms
- Representation in development and testing phases

Regulatory Compliance

- HIPAA-compliant data management
- FDA approval for medical device classification
- State licensing considerations
- Insurance coverage optimization

Conclusion and Next Steps

Key Achievements

TARA represents a paradigm shift in collegiate sports rehabilitation, offering a scalable solution to systemic capacity challenges while maintaining the human-centered care that athletes deserve. Our design process revealed that technology can effectively augment human expertise when thoughtfully integrated into existing workflows.

Immediate Next Steps

Institutional Leadership

- Year 1: ROI demonstration and pilot approval
- Year 2-3: Strategic integration planning
- Year 4-5: System-wide adoption and optimization

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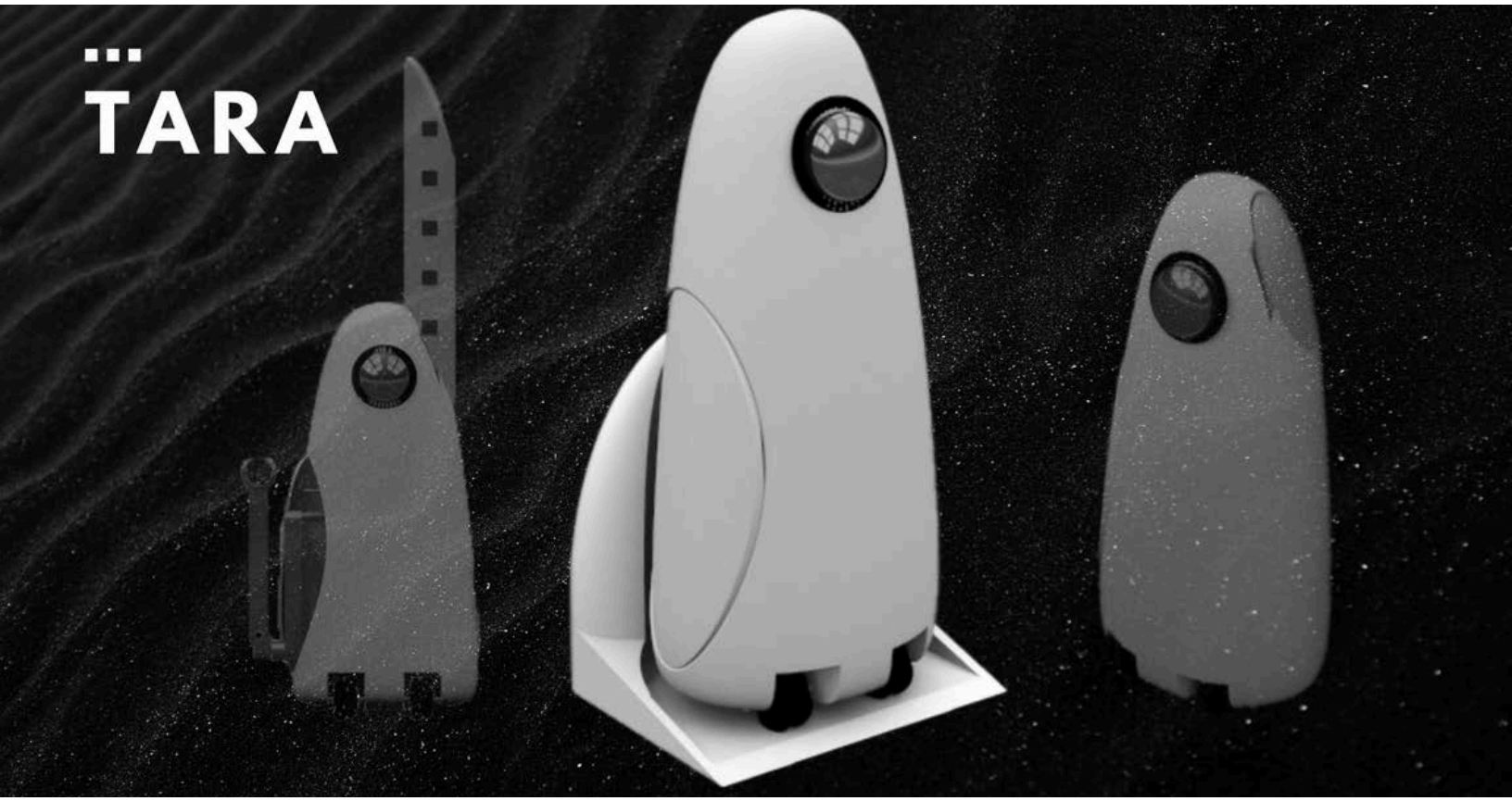
Long-term Vision

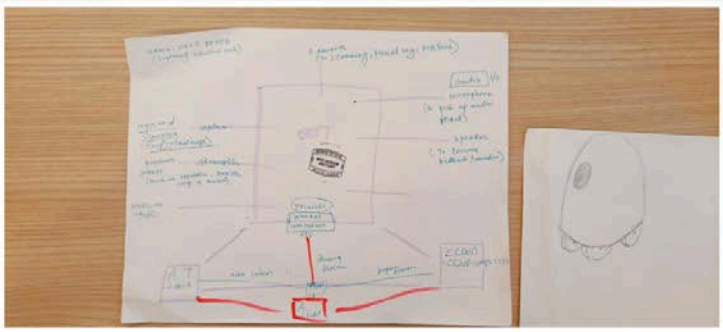
By 2035, TARA will be recognized as an essential component of collegiate sports rehabilitation infrastructure, contributing to a healthier, more sustainable athletic environment. Our vision extends beyond injury treatment to injury prevention, performance optimization, and long-term athlete wellbeing.

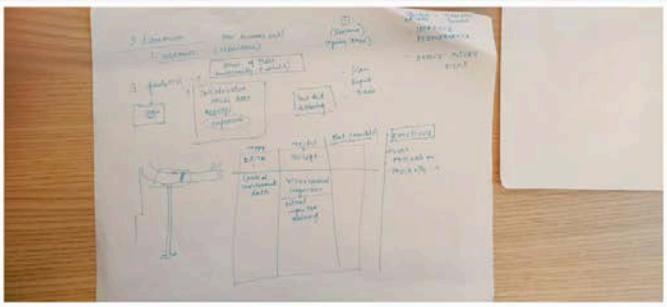
The success of TARA will be measured not just in reduced injury rates or improved efficiency metrics, but in the quality of life improvements for student-athletes and the enhanced capabilities of trainers to provide compassionate, personalized care at scale.

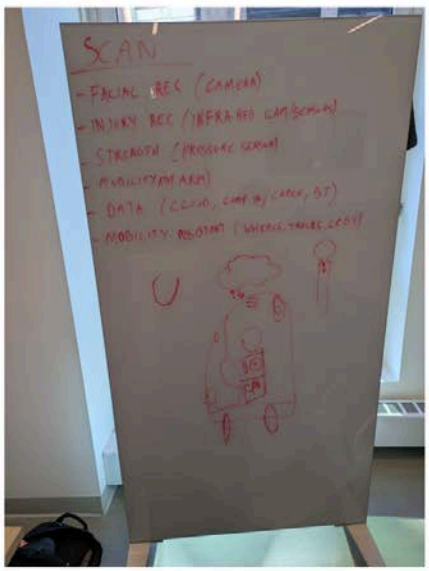


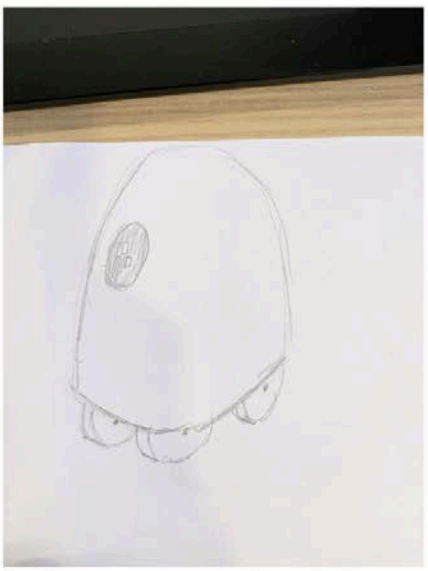
Appendix

A. Development Sketches

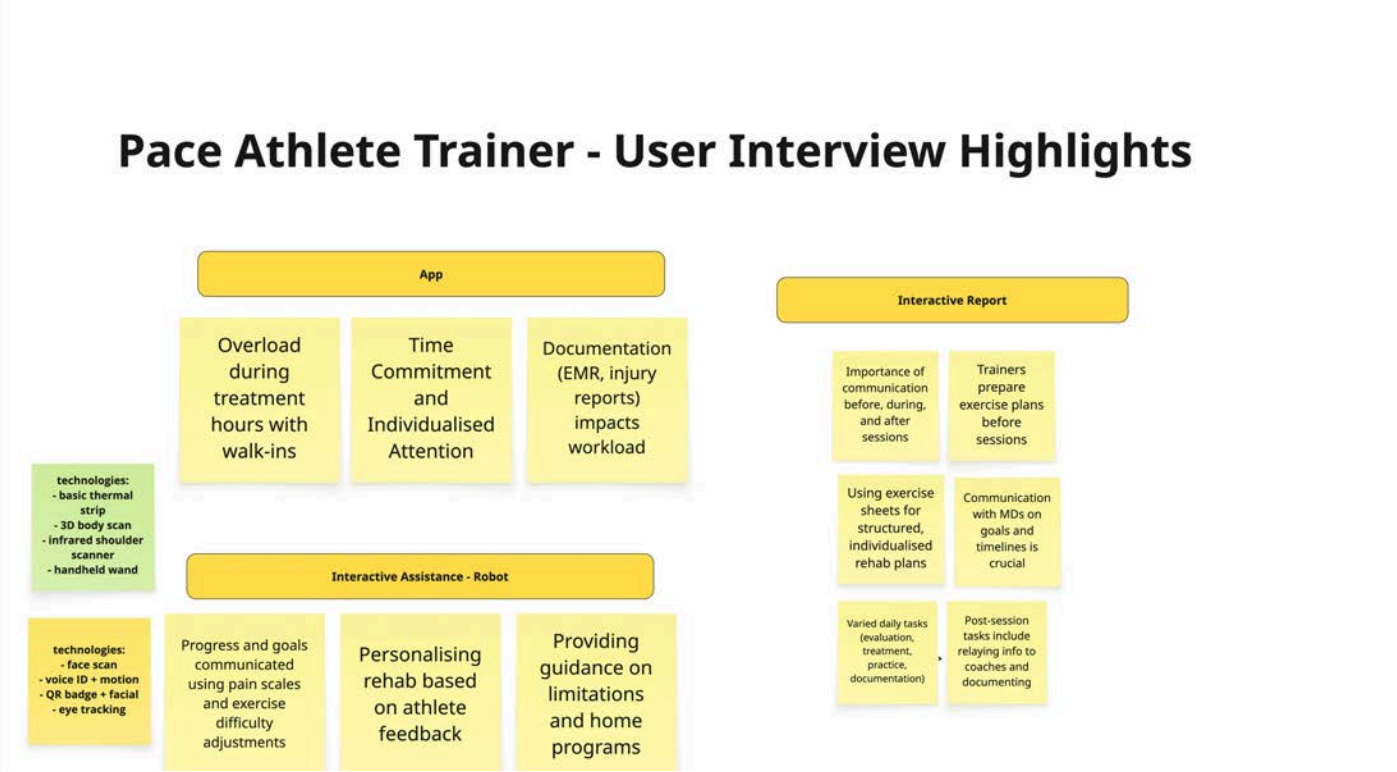








B. User Research Data



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This white paper was developed by the TARA design team: Niels Callewaert, Prarthana Centhil, and Thy Tran. For inquiries regarding implementation, partnerships, or technical specifications, please contact the design team through Pace University's Human Centered Design program - NYC Design Factory.

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