ITAS 164 – Project management

The Arcane Armory: A Smart, Interactive Weapon & Character Management System for D&D Campaigns

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1. Justification

The Arcane Armory addresses a critical pain point in tabletop role-playing games: the constant disruption of immersion and game flow caused by players managing multiple physical and digital tools during gameplay. Current solutions force players to choose between the tactile satisfaction of traditional tabletop gaming and the convenience of digital character management, fragmenting attention across individual devices and breaking the collaborative atmosphere that makes tabletop gaming special.

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2. Needs Analysis

Tabletop RPG players frequently juggle paper character sheets, phones, and rulebooks during gameplay, which slows down combat encounters and breaks immersion. Players spend valuable session time searching for information, calculating modifiers, and tracking temporary status effects across multiple characters.

Existing Competition:

Several solutions currently exist in the market:

- **D&D Beyond:** A comprehensive digital toolset that is powerful and feature-rich but primarily individual-focused. Each player needs their own device (phone, tablet, or laptop), which keeps players looking down at screens rather than engaging with the table and each other.
- **Roll20 and Foundry VTT:** Excellent for online play but designed for virtual tabletops, not physical in-person sessions. They replace the tactile experience rather than enhance it.
- **YouTube DIY Projects:** Various makers have created Raspberry Pi character trackers, but these typically focus on single-player use, lack physical controls, or are overly complex with features like full rules automation that are beyond reasonable scope.

How The Arcane Armory Differs:

This project creates a unique middle ground by:

- Providing a **shared physical tabletop display** that all players can see simultaneously
- Supporting **multiple players** (3-4 characters) on one screen in real-time
- Visually tracking HP, spell slots, status effects, and initiative order with clear, at-a-glance information
- Integrating **custom physical controls** (buttons and rotary encoders) for tactile interaction
- Offering **campaign-specific customization** without requiring individual devices for each player
- Maintaining **affordability** compared to equipping 4+ players with tablets

This creates a more immersive, collaborative experience that enhances traditional tabletop play rather than replacing it with screens.

3. Potential Limitations & Risks

Risk Assessment & Mitigation Strategies

Risk	Likelihood	Impact	Mitigation Strategy
Component shipping delays	Medium	High	Order all parts in Week 1; identify backup suppliers; have USB buttons as emergency alternative
Display compatibility issues	Low	Medium	Test with lab equipment in Week 2; verify HDMI output before design commitment
Scope creep (feature bloat)	High	High	Lock feature list by end of Week 3; maintain strict feature freeze; prioritize MVP
GPIO timing/latency issues	Medium	Medium	Early hardware testing in Week 7; use interrupt-driven input rather than polling
3D print failures or design issues	Medium	Low	Print test pieces early; allow buffer time for reprints; simplify design if needed
Team member illness/absence	Low	High	Modular code design; comprehensive documentation; regular Git commits with clear messages
Database corruption or data loss	Low	Medium	Implement regular backups; use version control for data schemas; test data validation thoroughly
Button wear/failure	Low	Low	Purchase quality components; include spare buttons in budget; design for easy replacement

Technical Limitations

- **Hardware Constraints:** Raspberry Pi processing power limits simultaneous features; prioritize core functionality over visual effects
- **Display Size:** 10-inch screen constrains amount of information displayable; requires thoughtful UI design
- **Network Dependency:** If implementing web access from phones, requires stable WiFi; plan for standalone operation as primary mode

Scope Boundaries

Out of Scope (to prevent feature creep):

- Full D&D rules automation and validation
- Online multiplayer or remote player support
- AI-powered dungeon master assistance
- Dice rolling automation (players use physical dice)
- Character creation wizard (characters imported or manually entered)
- Integration with D&D Beyond or third-party APIs
- RFID functionality

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4. Requirements for a Successful Solution (Defined Scope)

Functional Acceptance Criteria:

- **Multi-Character Display:** System simultaneously displays character data for minimum 3 characters with HP, spell slots, and character names clearly visible
- **Physical Input Reliability:** All buttons register inputs within 0.5 seconds with 95%+ accuracy during testing
- **Initiative Tracking:** System clearly indicates current turn in initiative order and allows cycling through turns via rotary encoder
- **Character Switching:** Dedicated buttons successfully switch between displayed characters without data loss or lag
- **Data Persistence:** Character data saves automatically and loads correctly across system restarts and power cycles (verified through minimum 5 save/load cycles)
- **Session Stability:** System operates continuously for minimum 3-hour gaming session without crashes, freezes, or requiring restarts (verified in user testing)
- **Display Readability:** All text and UI elements readable from 3 feet away in normal lighting conditions (verified by user testers)

Quality Acceptance Criteria:

- **Professional Presentation:** Device housed in completed 3D-printed enclosure with no exposed wiring, secure component mounting, and clean finish
- **Safety Standards:** All electrical components properly insulated, power supply secured, no risk of short circuits or electrical hazards
- **Code Quality:** Python code follows PEP 8 standards, includes inline comments, modular functions, and organized file structure
- **Documentation Completeness:** User manual enables a new user to set up and operate the system without external assistance; technical documentation enables future maintenance or modification
- **User Validation:** Minimum 3 out of 4 user testers rate the system as "improves gameplay experience" and "would use in regular gaming sessions"

Demonstration Requirements:

- Live demonstration showing all core features during final presentation (not pre-recorded)
- Demonstration includes realistic gaming scenario: adjusting HP during combat, tracking initiative order, switching between characters
- System handles demonstration without crashes or errors
- Presentation includes before/after comparison showing problem solved and user feedback testimonials

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Assumptions:

Technical Assumptions:

- **Component Compatibility:** We assume all ordered components (display, buttons, encoders) will be compatible with Raspberry Pi GPIO without requiring custom drivers or extensive troubleshooting
- **Display Output:** We assume the 10-inch HDMI display will work with Raspberry Pi 4 without requiring custom resolution configurations beyond standard settings
- **Python Libraries:** We assume required libraries (Pygame, RPi.GPIO, SQLite) will function as documented and be sufficient for project requirements
- **3D Printing Access:** We assume regular access to school 3D printers with reasonable queue times (under 48 hours) and print success rate of 70%+
- **Power Stability:** We assume standard USB-C power supply will provide stable power without brownouts or requiring additional power management

User & Testing Assumptions:

- **Tester Availability:** We assume access to at least one D&D gaming group (3-4 players) willing to participate in user testing during Week 9-10
- **User D&D Knowledge:** We assume test users have basic D&D 5th Edition knowledge and won't require extensive rules explanation during testing
- **Feedback Quality:** We assume user testers will provide honest, constructive feedback focused on usability rather than requesting out-of-scope features
- **Gaming Environment:** We assume testing will occur in typical gaming environments (indoor lighting, table space, standard power access)

Project Management Assumptions:

- **Team Stability:** We assume all team members remain available throughout the semester without major health issues or schedule conflicts requiring extended absence
- **Communication:** We assume team members will respond to messages within 24 hours and attend scheduled meetings or provide advance notice

- **Workload Distribution:** We assume roughly equal contribution from team members with specialization based on skills (hardware, software, design)
- **Version Control:** We assume team members will commit code regularly to Git repository with descriptive messages, enabling parallel development

Scope Management Assumptions:

- **Feature Freeze:** We assume feature list will be finalized by end of Week 3 with no major additions after that point
- **MVP Focus:** We assume team will maintain discipline to focus on MVP requirements and resist adding "nice-to-have" features that jeopardize core functionality
- **Stretch Goals:** We assume stretch goals (touchscreen, status effects, web interface) will only be attempted if MVP is completed with 2+ weeks remaining
- **Risk Tolerance:** We assume instructor and stakeholders understand project involves hardware prototyping with inherent uncertainty and will accept reasonable pivots if major technical roadblocks occur

External Dependency Assumptions:

- **Shipping Timeframes:** We assume components ordered in Week 1 will arrive within 2 weeks (by Week 3) allowing time for reorders if necessary
- **Lab Equipment:** We assume school lab will maintain operational soldering stations, multimeters, and computers for development throughout semester
- **Instructor Support:** We assume instructor will be available for technical consultation during lab hours and respond to email questions within reasonable timeframes
- **Documentation Resources:** We assume Raspberry Pi documentation, Python libraries, and online tutorials will remain accessible throughout project duration

Handling Assumption Failures:

If key assumptions prove incorrect, the following contingency approaches will be applied:

- **Component incompatibility:** Pivot to USB-based buttons as backup; simplify enclosure design
- **Tester unavailability:** Conduct internal team testing and supplement with online D&D community feedback
- **Team member absence:** Redistribute tasks among remaining members; reduce stretch goals to maintain MVP focus
- **Timeline slippage:** Cut lowest-priority MVP features (e.g., advanced initiative features) to ensure core functionality delivers on time

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Conclusion

The Arcane Armory represents a unique opportunity to combine hardware engineering, software development, and user experience design into a practical tool that enhances social gaming experiences. With clearly defined scope, realistic milestones, and a balanced three-person team structure, this project is both ambitious and achievable within the course timeframe. By focusing on the MVP and maintaining strict feature discipline, we can deliver a polished, functional product that demonstrates technical proficiency while solving a real problem for the tabletop gaming community..