Star River Notes – Final Evaluation and Reflection Report

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1. Objectives and Validation Metrics

The ***Star River Notes*** project envisions a three-dimensional digital note-taking system — an immersive spatial knowledge mapping tool that allows users to create, connect, and visualize ideas in space, as if exploring a "knowledge universe."
Throughout three interactive prototype iterations, the evaluation objectives evolved as follows:

Iteration Version	Main Testing Goal	Validation Metrics
IP1 – Spatial Usability	Test whether participants can complete node linking and navigation tasks	≥ 80% of users complete "create + connect" tasks
IP2 – Interaction Clarity	Evaluate the interaction logic and user confidence after removing ESC mode (SUS)	SUS ≥ 68; ≥ 60% of users clearly understand interaction logic
IP3 – Tutorial & Feedback	Verify the effectiveness of tutorial system, gesture control, and hover feedback	≥ 80% of users can independently find the tutorial; ≥ 60% successfully use gestures naturally; SUS ≥ 68

These indicators assessed both objective performance and subjective perception.

2. Results

2.1 Round 1 (IP1) – Preliminary Usability Test

Task performance: Most participants successfully linked nodes, but required detailed guidance.

Navigation experience: Able to locate target nodes, but ESC mode switching disrupted flow.

Findings: Spatial layout aided comprehension of structure, yet interaction logic remained unintuitive.

2.2 Round 2 (IP2) – *Star River Notes 2.0*

Improvements: Removed ESC dependency; unified click logic; enabled direct editing and dragging.

Remaining issues: Lacked built-in tutorial; no visual highlighting; ground-penetration bug.

SUS results: 82.5, 40.0, 47.5, 57.5, 47.5 → Average 55.0 ("usable but needs improvement").

Interpretation: Usability improved notably from Round 1 but remained below the industry benchmark of 68.

2.3 Round 3 (IP3) – *Star River Notes 3.0*

New features: Gesture interaction, tutorial page, hover highlighting, cinematic video projection.

Task performance: Most users completed all core tasks (create, connect, store, play video) with minimal help.

Qualitative results: Tutorial reduced confusion; hover feedback improved accuracy; gesture dragging enhanced immersion but interaction volume was limited due to laser design.

Results: SUS 70.0, 72.5, 72.5, 75.0, 70.0 → Final score 72.0. The overall experience felt more natural. However, early test sessions were affected by a major gesture bug that disabled clicking, severely impacting one test.

3. Analysis and Insights

3.1 Iterative Progress

The design evolved through three UCD-based iterations—from testing spatial usability to refining interaction clarity and optimizing feedback.
In IP1, node creation and linking validated the spatial note system's usability, showing that 3D structure improved conceptual understanding but excessive mode switching reduced efficiency.
IP2 removed mode switching, unified click logic, and added direct editing, which lowered error rates and improved learnability, as confirmed by SUS and think-aloud results.
IP3 introduced tutorials, hover highlights, and gesture control, allowing faster onboarding and clearer feedback. Gesture and projection features enhanced immersion, pushing the system toward a mature XR experience.

Remaining issues include lack of collaboration, limited gesture precision, and poor discoverability of advanced features. Overall, *Star River Notes* progressed from "usable" to "pleasant to use," but still needs refinement in feedback, guidance, and multi-user interaction for more natural and scalable use.

3.2 Usability Trends

Usability consistently improved in cognitive load, learning curve, and user perception.
Cognitive load: Spatial layouts clarified hierarchies and relationships, easing mental effort, though high node density still requires filtering tools.
Learning curve: Tutorials greatly improved onboarding—most IP3 users mastered tasks quickly, though minor alignment issues persisted. Future iterations could add progressive, context-aware guidance.
User perception: Participants praised the "knowledge universe" metaphor for enhancing exploration and creativity, though feedback precision needs work. Overall, the system evolved from an experimental prototype into a viable immersive note-taking tool, with room to improve precision, scalability, and collaboration.

4. Evaluation of Aims

Testing Objective	Achievement	Evidence Summary
O1 – Usability / Learnability	Achieved	Users completed tasks efficiently; gesture control was smooth and natural.
O2 – Navigation & Understanding	Partially Achieved	Spatial relations clear, but ground-generation bug affected some operations.
O3 – Structural Understanding / Load	Achieved	Spatial layout reduced cognitive load; tutorial interface usable.
O4 – Interaction Clarity	Partially Achieved	Unified click logic and hover feedback well-received; gesture system still ambiguous.
O5 – Functional Completeness	Partially Achieved	Storage and deletion stable; undo/preview missing.
O6 – Guidance & Feedback (IP3)	Achieved	Tutorial system effective; hover highlight experience positive.

Overall, *Star River Notes* evolved into an intuitive, feature-complete spatial note prototype but still falls slightly short of commercial usability standards.

5. Final Reflection

5.1 Prototype Session Review

In *Star River Notes 2.0*, removing mode switching and unifying click logic improved flow and clarity, enabling smoother node creation and linking. Yet unclear button prompts, ground-spawn bugs, and the lack of a tutorial hindered ease of use, reflected by a 55/100 SUS score. *Star River Notes 3.0* addressed these issues through tutorials, hover feedback, and gesture control, leading to smoother interaction and confirming the value of iterative refinement.

5.2 Methodological Reflection

A mixed-method approach—task observation, think-aloud, and SUS surveys—revealed usability barriers and quantified improvement across iterations. Despite solid structure, small sample size and brief sessions limited representativeness. Future evaluations could include NASA-TLX or longitudinal testing to capture cognitive load and long-term learning.

5.3 Concept Evaluation

The "Knowledge Universe" metaphor effectively visualized relationships and enhanced macro-structural awareness, outperforming 2D notes in comprehension and aesthetics. However, 3D input was less efficient for simple tasks, and dense nodes caused clutter. Key concepts like mixed-reality and collaboration remain unrealized but show strong exploratory potential.

5.4 Improvements and Extensions

Next steps include optimizing feedback (undo/preview), evolving guidance into context-aware tutorials, improving gesture precision, enabling multi-user collaboration, and expanding to AR and desktop platforms. These will transform *Star River Notes* into a scalable, collaborative knowledge space that merges spatial cognition with practical usability.

6. Conclusion and Future Work

Through three prototype iterations and user testing, *Star River Notes* evolved from a concept prototype into a mature system with strong usability and immersion. Significant improvements were achieved in interaction logic, guidance design, and feedback mechanisms, as evidenced by the SUS score increase from 55 to 72, validating the effectiveness of the optimization strategy.

Future work will focus on three directions:

Perfecting gesture recognition and visual feedback to enhance precision; Introducing multi-user collaboration and real-time sharing; Expanding into AR and desktop platforms to create a cross-device immersive knowledge management experience.

References

Bowman, D. A. (2005). *3D user interfaces : theory and practice*. Addison-Wesley.

Jordan, P. W. (1996). *Usability Evaluation In Industry* (1st edition.). CRC Press. https://doi.org/10.1201/9781498710411

Norman, D. (2013). *The Design of Everyday Things: Revised and Expanded Edition* (Rev. and expanded ed.). Basic Books.

McMahan, R. P. (2011). *Exploring the Effects of Higher-Fidelity Display and Interaction for Virtual Reality Games*. ProQuest Dissertations & Theses.

Sanchez-Vives, M. V., & Slater, M. (2005). From presence to consciousness through virtual reality. *Nature Reviews. Neuroscience*, *6*(4), 332–339. https://doi.org/10.1038/nrn1651