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# Titanic Escape Room: Orchestrating Motion, Safety, and Story

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## ABSTRACT

*This study analyzes the Titanic escape room project as a paradigmatic instance demonstrating a viable resolution to this challenge. Amid the rapid expansion of the experience economy and the market for location-based entertainment (LBE), the creation of high-tech immersive spaces, such as escape rooms, presents a multifaceted challenge in integrating narrative, technology, and safety. Using a single case-study methodology, the work deconstructs the project's architecture through the prism of three theoretical constructs: the disappearing computer (calm technology) from human–computer interaction (HCI), human-in-the-loop (HITL) systems, and multilevel safety models adopted from human–robot interaction (HRI). Results indicate that seamless immersion is achieved via technological invisibility, wherein a sophisticated show-control network functions as a dynamic narrative engine. Interactivity is ensured via HITL models that actively treat the player as a system component. Narrative-directed perceived safety, separated from absolute physical safety, ensures the safety of physical effects using a multilayered architecture. The article proposes an integrated conceptual model synthesizing these approaches, discussing how it is practically meaningful when someone designs and evaluates complex interactive entertainment systems. Researchers and practitioners in engaging design, control, and human-computer interaction who design or analyze complex interactive spaces will find this paper helpful.*

Keywords: experience economy, immersive experience, escape room, show-control systems, human–computer interaction, calm technology, human-in-the-loop, safety of interactive systems.



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## 1. Introduction

Contemporary economies exhibit a persistent shift from the consumption of goods and services toward the pursuit of unique and memorable experiences. This paradigm—formulated as the experience economy—posits that experiences constitute a distinct economic offering, purposefully produced to engage consumers personally (Garaus et al., 2025). The trend is especially pronounced among younger cohorts since access to experiences means more than ownership of goods for location-based entertainment (LBE). Analytical forecasts indicate that the global LBE market is expected to grow from $ 5.04 billion in 2024 to $ 15.11 billion by 2034, with a compound annual growth rate (CAGR) of 11.6% (Zion Market Research, 2025). Among escape rooms, this segment is the most dynamically expanding in the market, offering participants interactive, narrative-oriented adventures (Fortune Business Insights, 2024).

Creating high-quality LBE projects, such as the Titanic escape room, represents, however, a demanding design challenge, as well as an engineering challenge. Puzzle quality is not the only factor determining success. Success also depends on how well one can integrate deep narrative storytelling, multisensory technologies, automation, and strong safety systems harmoniously (Arndt, 2023). The central task is to orchestrate these components to form a coherent, seamless, and safe user experience in which each element operates in concert to sustain the magic of immersion (Ross, 2025).

To analyze this complex task, the present study introduces a theoretical framework grounded in the concept of ubiquitous computing, also known as calm technology, proposed by Mark Weiser. Its key axiom states: The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it (Mqroth, 2025). For Weiser, the ideal computer is a quiet, invisible servant that recedes into the background, allowing the user to focus on the task rather than the tool. This paradigm is advanced as a terminal design objective for immersive entertainment spaces.

Accordingly, the aims of this study are:

1.To analyze the Titanic escape room as a practical realization of Weiser's calm-technology paradigm.

2.To deconstruct its architecture using concepts from show-control systems, human-in-the-loop (HITL) interaction models, and safety models from human–robot interaction (HRI).

3.To propose an integrated conceptual model for the design and evaluation of similar systems.

The scientific novelty lies within an interdisciplinary synthesis, with a new, holistic analytical frame created by applying robotics and HCI theories to themed entertainment. It is technological convergence that is catalyzed by the growth of the LBE market, not merely an economic trend. Engineers address problems due to the need for more engaging interactive experiences. These problems exist just at the intersection of HCI, automation, and safety engineering, plus domains that have customarily evolved in isolation. Consequently, the escape room functions not merely as a game but reflects future forms of human-computer interaction within physical spaces.

## 2. Materials and Methodology

This research employs a qualitative methodology, specifically a single-case study. This method is ideal for a thorough examination of a complex issue in its actual context, as it enables a detailed analysis of the relationships between design, technology, and user experience. 60Out Escape Rooms developed the Titanic escape room. That escape room is studied now.

The study draws on two types of data sources to inform it.

1.For a primary source, personal experience and detailed technical documentation plus design documentation for the Titanic escape room do obtain foundational data. Engineering problems and design choices become visible using this paper. One can also see the technical systems that engineers put in place.

2.To establish a theoretical basis, the systematic literature review was conducted throughout leading academic databases, which included IEEE Xplore, ACM Digital Library, Scopus, with Web of Science. Narrative design along with the experience economy as well as safety for human-robot interaction were focuses in the review. Also featured in the review were human-in-the-loop systems, human-computer interaction, and publications peer-reviewed in show-control systems. Industry agencies such as those that are leading like Zion Market Research (2025) released reports used in market context analysis.

Data analysis proceeded in several stages:

1.Content analysis: The primary source was systematically analyzed and coded to identify key themes, technological components, design principles (e.g., invisible technology, orchestration), and safety protocols.

2.Comparative thematic analysis: Themes identified in the case analysis were aligned with, and interpreted through, established theoretical constructs derived from the literature review. This process included mapping practical solutions described in the primary source to theoretical models of calm technology (Mqroth, 2025), HITL architectures, narrative models for escape rooms (Stolee, 2023), and multilayer safety models from HRI. This comparative approach generalizes practical insights into universal theoretical principles.

## 3. Results and Discussion

The fundamental design principle behind the Titanic escape room is characterized by hiding a modern inside a 1912 machine. A vital LBE design paradox appears in this formulation. Designers craft an environment that is both aesthetically and narratively coherent, despite being governed by an advanced contemporary technological infrastructure. Here, in fact, the infrastructure is a hidden show-control network employing a COGS controller for logic, utilizing the DMX protocol specifically for lighting, with nodes now based on Arduino and Raspberry Pi for actuation control and sensor acquisition.

This design philosophy is a direct practical instantiation of Mark Weiser's calm-technology concept. Technology is deemed successful precisely because participants do not notice it. Its sole purpose is to facilitate the player's primary task (engagement with the narrative) without intruding upon consciousness. The computer disappears into the environment, becoming an unobtrusive yet indispensable component of the experience. This perspective reframes the success metric for immersive design: the key indicator becomes the degree of technological invisibility. The engineering task transforms from a purely functional implementation into one of perceptual and cognitive design, where the principal goal is to manage user attention and sustain belief in the diegesis. Immersion quality is inversely proportional to the technology visibility index: the experience fractures the moment a player thinks the sensor didn't trigger, because that thought ejects them from the narrative frame and renders the technology visible.

HCI principles are directly applicable to the design of physical artifacts. Explicit affordances are possessed by elements like massive as well as heavy cast-iron valves or a hand-cranked generator; their physical properties intuitively suggest how to interact with them (Interaction Design Foundation, n.d.). A latent function is the basis of the process. It involves position sensors along with software logic. Such construction minimizes cognitive load for two reasons: it enables naturalistic interaction within the environment and does not require people to comprehend systemic complexity. An impeccable, instantaneous system response (something must happen now, not after the computer thinks) is crucial to sustaining the illusion of direct physical causality. Consequently, a critical engineering specification for LBE systems is not merely uptime but the minimization of latency and the elevation of reliability to a level indistinguishable from physical reality.

The central COGS control system acts as a conductor holding the score of the entire performance. This conforms precisely to the definition of a show-control system—a technology that interlinks and coordinates multiple entertainment subsystems (Ross, 2025). It synchronizes lighting, audio, mechanical effects, and media playback to produce a unified, coherent narrative.

The system transduces player actions into a rich, multisensory response. For example, a physical action—throwing coal into the firebox—initiates a complex sequence of visual (glowing embers), auditory (roaring flame), and atmospheric (steam) effects. Involving multiple senses yields stronger, more meaningful, and more memorable impressions, fostering a deep emotional bond between user and environment (Silva et al., 2025).

From a narrative-design standpoint, Titanic can be classified as a narrative game under the model proposed by Stolee (2023). The project possesses both a well-developed backstory (the widely known historical context) and a finely articulated player narrative that unfolds through physical interaction and puzzle solving. Technology here functions as the mechanism that ensures coherent development of the player's narrative within the given backstory. Thus, the show-control system operates not merely as a technical trigger but as a narrative engine. Its principal role is to enforce the grammar of the story, translating the player's action verbs into the adjectives and nouns of sensory feedback, thereby constructing a unique player narrative path in real time. When a player turns a valve, the system does not merely open a solenoid. It queries the game logic to determine what that action means at that moment. The system interprets player intent in a narrative context and responds with a sensory sentence that advances the plot. This process can be represented as a conceptual diagram (Fig. 1).

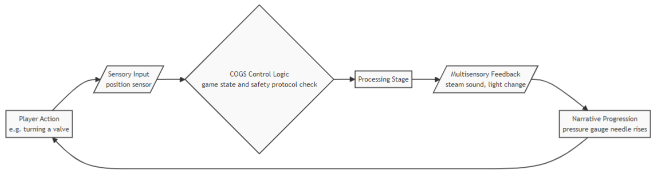
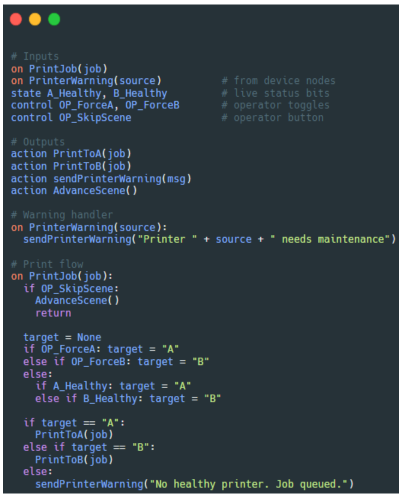



**Fig. 1. Conceptual diagram of the orchestration cycle of the show control system**

Escape rooms can be described as incubators for human-in-the-loop systems, where the unpredictable actions of players form the primary input source. The HITL paradigm, which integrates human input into the system's operational loop, provides a formal model for this interaction. In this model, the player is not merely a user but an integral—and often unpredictable—component.

Most interactions in Titanic follow an in-the-loop (blocking execution) pattern. The system explicitly suspends its operation and awaits human input—e.g., entering Morse code or turning a generator crank—before transitioning to the next scene. This design maximizes the player's sense of agency and renders their actions consequential. At the same time, the operator's ability to skip the radiogram-printing scene exemplifies post-processing or a supervisory control loop, as shown in Figure 2.



```
# Inputs
on PrintJob(job)
on PrinterWarning(source)           # from device nodes
state A_Healthy, B_Healthy          # live status bits
control OP_ForceA, OP_ForceB        # operator toggles
control OP_SkipScene                # operator button

# Outputs
action PrintToA(job)
action PrintToB(job)
action sendPrinterWarning(msg)
action AdvanceScene()

# Warning handler
on PrinterWarning(source):
  sendPrinterWarning("Printer " + source + " needs maintenance")

# Print flow
on PrintJob(job):
  if OP_SkipScene:
    AdvanceScene()
    return

  target = None
  if OP_ForceA: target = "A"
  else if OP_ForceB: target = "B"
  else:
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  if target == "A":
    PrintToA(job)
  else if target == "B":
    PrintToB(job)
  else:
    sendPrinterWarning("No healthy printer. Job queued.")
```

**Fig. 2. Event-Driven Control Logic for Redundant Printer Routing in an Interactive Narrative System**

Modeling the escape room as an HITL system shifts the design focus from building a static environment to engineering a robust, fault-tolerant system capable of interpreting and responding to the chaotic human factor. The problem is less about crafting puzzles than about enabling efficacious human–machine interaction under conditions of unpredictability. The system must be designed with the assumption that players will inevitably behave non-standardly. Its logic should therefore be less a rigid script and more a flexible dialogic agent that gracefully handles off-nominal inputs and guides users back to a productive trajectory without fracturing the immersive frame. This approach aligns the design process with the construction of systems for collaborative intelligence rather than mere automation. Table 1 systematizes key interactive events in the Titanic within the HITL model.

**Table 1. The matrix of human-in-the-loop interactions in the Titanic quest**

| Player Action (Stimulus) | System Components Involved | System Reaction (Sensory Output) | Narrative Consequence | HITL Pattern |
|---|---|---|---|---|
| Throws coal onto the scales | Mass sensor, COGS, DMX lighting, audio system, smoke machine | Red-orange light flashes, burning sound, steam release | The boiler pressure gauge needle rises | In cycle |
| Turns the generator handle | Rotation sensor, COGS, voltmeter with servo | The voltmeter needle increases in sync with the rotation | Power is restored for the puzzle | In cycle |
| Enters Morse code | Input sensor, COGS logic | Entered sequence is validated | Successful transmission prints a radiogram | In cycle |
| Operator skips the printing scene | Operator control panel, COGS | The printing task is bypassed | Scene progresses without a printed hint | Post-processing |

The use of high-impact physical elements, which create real safety risks for participants, features a door that flings open and compressed air that bursts sharply. The dramatic intensity from the moment must be kept while eliminating these risks. The implemented safety protocols of the Titanic are analogous in concept to multilevel safety architectures. These architectures are developed for HRI, in which humans, along with powerful robots, share workspaces. These architectures address two distinct yet interrelated facets of safety.

At the first level, engineered to prevent physical harm via technical controls, measures are absolute and non-negotiable. In the system under consideration, limitation of force and energy is achieved through a metered air discharge regulated by a specialized device and a flow restrictor, as well as strict bounding of impulse duration to keep exposure within safe limits, which is equivalent to the principle of power and force limiting (PFL) in collaborative robotics (Mudiyanselage et al., 2025). Safety is reinforced further once exclusion zones are monitored as well; the actuator's motion envelope governs access physically, including two sensing layers, monitoring safety along with motion, directly analogous to separation and speed monitoring, or SSM, in HRI, wherein the robot halts or slows when a human enters its safeguarded zone (Valori et al., 2023). Safety measures and duplication confirm system wholeness. That integrity is still maintained even in the event of single faults or of operator errors. To activate effects, multiple preconditions must be satisfied, such as no zone obstructions with latched closures confirmed. Any safety-sensor trip immediately locks out the effect and mandates a strict reset sequence for re-enablement.

The second level is perceived (psychological) safety. This concerns the user's subjective sense of safety. Unlike physical safety, it is intentionally deployed as a narrative instrument. The purpose of the air burst is to be maximally frightening (instantaneously reducing perceived safety) while remaining absolutely safe (keeping physical safety invariant). User trust and a sense of control are key determinants of perceived safety. System reliability guarantees that, although players may be startled, they trust that the environment is fundamentally safe. The safety-protocol logic for the door effect is shown in Fig. 3.

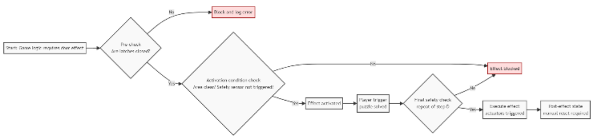


**Fig. 3. Block diagram of a multi-level security protocol for the flying door effect**

Designing high-impact immersive spaces thus requires conducting a sophisticated safety–experience trade-off analysis. This analysis must explicitly balance the inviolable requirement of physical safety against the deliberate manipulation of perceived safety to achieve narrative effect. It relocates safety design from a purely technical compliance exercise to the core of creative and experiential design. The design process must include the question: What is the maximum level of perceived risk we can create for the player while maintaining a constant, verifiable state of zero physical risk? This necessitates a new kind of risk assessment that accounts for psychological impact on par with physical hazards.

## 4.Conclusion

The analysis of the Titanic escape room shows that an experience successfully engages players through a system based upon HCI principles specifically calm technology's concept. Technological invisibility does help to sustain complete user immersion greatly. A multisensory narrative engine drives this with a centralized show-control architecture. The architecture operates under the umbrella of a human-in-the-loop model. From human-robot interaction's domain, such systems' physical interactions' safety and intensity can be governed tightly through a multilevel safety architecture.

This integrated model that is proposed here bears practical and theoretical importance. It unifies the disappearing computer, HITL, also HRI safety. For LBE designers and also engineers, it offers guiding principles that point toward more convincing, more reliable, and safer products. It offers academics another combined perspective to assess detailed human machine interactions. These systems increasingly influence public with private spaces. The principles that are advanced here in this study are applicable not only just to escape rooms but they are also applicable to a broad spectrum of interactive environments including museum exhibits as well as advanced simulators plus themed retail spaces.

For future research, directions offering improvements contain generative artificial intelligence integration for real-time narrative adaptation, biometric feedback employment to personalize experience intensity, and researcher development of standardized safety protocols for the rapidly growing LBE industry.

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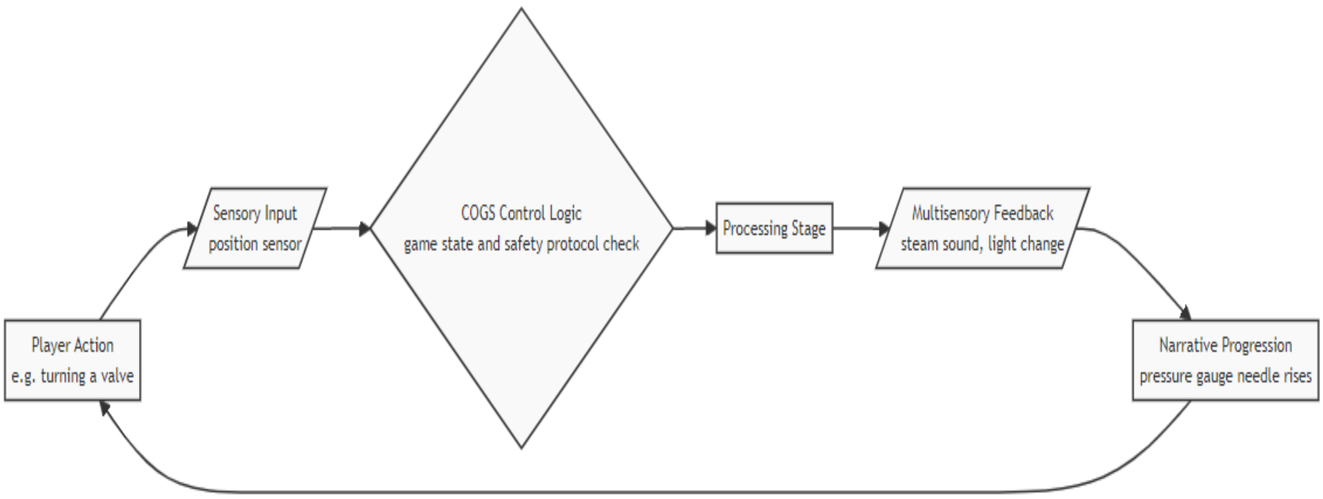


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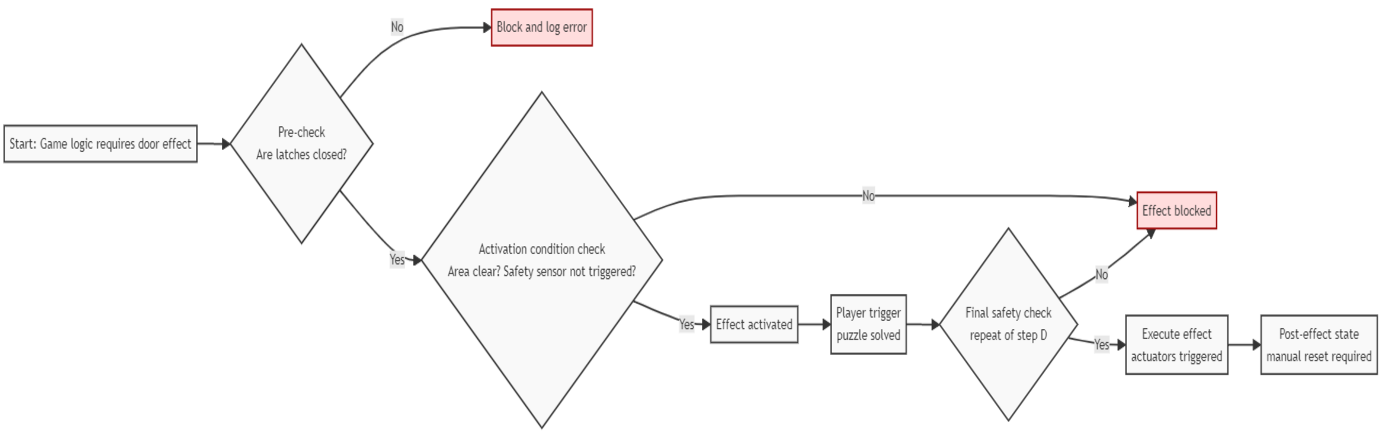


**Fig. 3. Block diagram of a multi-level security protocol for the flying door effect**