Scenario-Based Design to Envision How GenAI Can Support Sound Design Practices

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ABSTRACT

Sound design involves crafting communicative sonic interfaces such as warning and confirmation signals. An interactive sound design method using musical tension and release with a supporting tool has been explored for practitioners without musical expertise; however, there remain needs for further development of the tool, regarding recommended samples and translated musical knowledge. This paper reports on a project that investigates the use of generative AI applications in sonic interaction design through practitioner-based scenarios. We present two case studies that highlight domain challenges based on a prior study of sound and UX designers, develop two practitioner scenarios from the contexts, and create a prototype of an AI-powered sound design tool with four GenAI applications and four supporting features, tailored to the scenarios. We finally provide reflections on the overall design process and the prototype. This study contributes by extending domain needs into a tangible AI-driven interface through scenario-based design.

CCS CONCEPTS

• Applied computing → Sound and music computing; **• Human-centered computing → Systems and tools for interaction design**; **• Computing methodologies → Artificial intelligence**.

KEYWORDS

Sonic Interaction Design, Creativity Support Tools, Generative AI, Scenario-Based Design

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1 INTRODUCTION

Embodied music cognition is an emerging focus in sonic interaction design, with tonal cognition playing a key role in users' auditory engagement [4, 22]. Recent work on sonic interaction design with tonal cognition has identified functional needs for practitioners through supportive design tool evaluations [10, 11]. This approach parallels the artistic applications of creativity support tools (CSTs) in enhancing human creativity [13], which are increasingly augmented by generative AI [5, 6, 16]. To effectively address domain context and anticipate future possibilities in designing technologies and corresponding CSTs, methodologies like scenario-based design have been employed, often incorporating AI usages [1, 2, 12, 17, 36]. As Wolf [36] suggests, user scenarios that integrate current data and speculate about new systems offer a bidirectional framework that extends beyond field investigations. This strategy is ideal for designing an AI-powered CST for sonic interaction design with tonal cognition to address the domain challenges and uncover new design opportunities informed by a recent study of sound and UX designers. This article considers this strategy through practitioner scenarios based on domain contexts, leading to the creation of a CST with AI features that effectively overcomes the domain challenges.

This design approach is appropriate for this ongoing project because the domain challenges can be further detailed through case studies, which can then be expanded into practitioner-focused scenarios. These scenarios illustrate detailed journeys, showing how practitioners actually confront these challenges, moving beyond conceptual design opportunities. The realistic details in these scenarios will aid in the development of the CST, translating conceptual directions into actionable insights. Finally, incorporating generative AI features within the sonic interaction design tool aligns with broader trends in CST research, positioning this study as a design reference for the sonic interaction and CST communities.

In this research, we present an ongoing project to develop an AI-powered CST for sonic interaction design with tonal cognition, using scenario-based design to draw practitioners' functional needs based on domain challenges. We detail two case studies that illustrate domain contexts—the need for recommended samples and translated musical knowledge—based on empirical data from a prior study of sound and UX designers [11]. Two scenarios were developed from the perspectives of key practitioners, sound and UX designers, within the design logic decision phases for storyboard and chord progression, which are most relevant to the targeted challenges, described in Figure 1. We then create a web-based prototype through these scenarios that includes four applications of generative AI: ideation for writing the storyboard, generating

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chord progression, creating note arrangements, and visualising of story phases, and four supporting features: notes interpretation of chords, chord listening, options for advanced users, and an onboarding section. We finally provide design reflections on the overall scenario-based design process and the prototyped CST. This study contributes to sonic interaction design by defining domain challenges, exploring future opportunities through practitioner-based scenarios, developing a generative AI-powered prototype, and reflecting on the design process and prototype, along with further design directions.

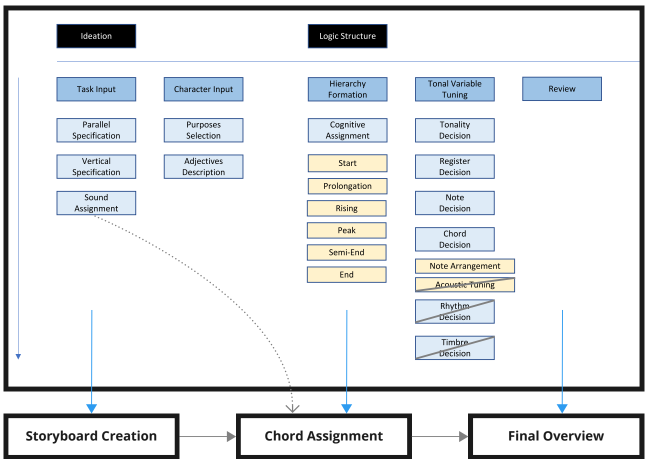

Figure 1: Design logic decision phases for storyboard and chord progression in the sonic interaction design with tonal cognition, suggested by Choi et al. [11], aligned with three steps of current interface (see section 5). Rhythm, Timbre, and acoustic tuning were not considered, though rhythmic samples were applied for chord listening (see Table 1).

2 RELATED WORK

We first examine tonal cognition in sonic interaction design as embodied music cognition, highlighting related musical principles, design methods, and similar AI-based CST cases. Then, we elaborate on the role of scenario-based design methodology for this investigation.

2.1 Tonal Cognition and Sound Design CST

Tonal music is structured around three harmonic functions—tonic, dominant, and subdominant—where chords interact hierarchically with the tonic, enabling the perception of tension and release through tonal cognition [3, 19]. Korsakova-Kreyn [20] identified two levels of embodied music cognition: surface-level corporeal articulation and deep-level tonal cognition, and Vickers [35] also connected the cognitive dynamics by tonal principles to embodied cognition in sonification. Newbold et al. [27] suggested a design method using tonal cognition for movement sonification and explored this concept through user studies [26, 28]. Choi et al. [11] ultimately addressed tonal cognition in sonic interaction design by combining user flow with harmonic functions, focusing on the shared hierarchical cognitive structure, and developed a corresponding CST prototype. This work can be referenced alongside similar CST studies in art practices, such as user experience [14, 23] and music [34], where generative AI has been effectively employed to facilitate designer collaboration with AI capabilities. This also aligns with current generative AI trends in HCI, shifting the AI's role from decision-maker to human supporter, tailored to specific needs [25]. For instance, Lee et al. [21] explored CSTs utilising two different types of generative AI design guides, and Kamath et al. [18] specifically investigated two generative AI models as CSTs for sound designers, highlighting their potential as supporters in CST research relevant to the current study.

2.2 Scenario-Based Design

Scenario-based design, as described by Rosson and Carroll [33], focuses on how individuals use a system to accomplish tasks through narrative descriptions of imagined usage scenarios. Common ingredients of a scenario include actors or agents (human and nonhuman, including agentic machines), agendas that support actions, a setting or a context, and sequences of actions and events akin to a plot [7, 36]. These scenarios craft a storyline of sequenced actions within particular contexts and technology worlds, serving as an intermediate representation that connects micro-level user activities with the system's overall objectives [15, 36]. This approach is relatively lightweight yet effectively captures the essence of interaction design [33]. Similarly, Rosson and Carroll [33] differentiate scenario-based design from solution-first design, which can lead to an oversimplification of the problem space and the inappropriate reuse of previous solutions. Carroll [7] also highlighted that sketching scenarios enables analysts and designers to reflect by exploring dynamic contextual settings, uncovering possibilities beyond what is already known. The present study uses scenario-based design, informed by domain challenges from previous research, to analyse and refine an AI-powered CST for sonic interaction design and to guide future directions through the making of the scenarios and reflection on the process.

3 DOMAIN CHALLENGE

We present two case studies where researchers have explored current practices in sonic interaction design to provide the background for the following scenarios. We highlight design opportunities for our CST to support key practitioners, specifically sound and UX designers, by addressing two challenges: the need for recommended samples as design foundations and translated musical knowledge to foster intuitive understanding. The case studies are grounded in empirical data collected from a previous user study with sonic interaction design practitioners [11], along with additional supporting references.

3.1 Case Study 1: Recommended Samples

Expert practitioners in sonic interaction design projects, particularly sound and UX designers, typically start with objective frameworks, which they then customise to fit their specific purposes [8, 11]. They rely on pre-developed samples as foundational settings within an intuitive workflow [11, 29, 37]. For example, sound designers referenced EQ presets with specific parameter settings as guidelines, while UX designers mentioned recommendation features in current design applications [11]; however, the low-fidelity prototype by Choi et al. [11] lacked intuitive guidelines for design logic in storyboard creation and musical variable arrangement, requiring participants to articulate every aspect of the logic decision phases manually. Addressing this challenge would provide practitioners clear design foundations, guiding them smoothly in establishing their design logic across task phases and corresponding chord progressions. This could be a significant step toward supporting designers by integrating generative AI to recommend samples for logic creation in their storyboards and chord progressions. This raises important questions, prompting designers to work on logical frameworks: How might generative AI systems offer recommendations as options for logic formation in storyboards and chord progressions? Additionally, how might users further interact with generative AI systems to build on these initialised foundations for their design logic decision?

3.2 Case Study 2: Translated Musical Knowledge

The musical backgrounds of sound designers vary, which affects their understanding of tonal principles in the sonic interaction design that relies on tonal cognition [11, 31]. While some designers may have majored in music and use sound engineering jargon, the average level of musical knowledge among them is often limited [11]. This issue is further complicated by the interdisciplinary backgrounds of UX designers involved in sound design projects [32]. For instance, participants in the recent work by Choi et al. [11] had diverse musical backgrounds, ranging from formal education to ongoing hobbies, or just minimal experience. Their understanding of musical terms varied individually, though there was some consensus on domain-specific jargon. UX designers mentioned participating in brief sonic interface design projects, but often had to describe sound linguistically due to their limited familiarity with sound design and musical knowledge; however, the low-fidelity prototype by Choi et al. [11] directly employed tonal music terms, making it difficult for them to establish design logic, potentially impacting the final outputs. Addressing this challenge would allow practitioners to approach sound design intuitively using everyday language within a more accessible framework. This could be a step forward in supporting practitioners by bridging plain language with musical jargon, enabling them to initialise communication with generative AI systems through prompts effectively. This raises important questions to support conversations between designers and AI to foster creativity: How might practitioners initiate communication with an AI system using plain language? And how might generative AI systems respond by translating these plain language inputs into relevant musical knowledge?

4 PRACTITIONER SCENARIO

This section outlines two practitioner scenarios for AI-powered CST in sonic interaction design with tonal cognition. From these scenarios, we identify essential features for the CST development, informed by domain challenges from the case studies. These scenarios are based on current practices, but also speculate on how the CST and its design method could reshape these situations.

4.1 Scenario 1: Nia as a Sound Designer

Nia is a sound designer working in the automotive industry, where her responsibilities range from tuning in-vehicle acoustics to creating simple sound signals for specific situations that require user attention. Although Nia is focused on interactive sound creation, she does not deeply consider the user's situational context; she primarily works from ideas suggested by other teams like UX designers or marketers. Nia's musical background is informal, having studied music as a hobby and regularly engaging in activities like playing instruments and composing with MIDI software using sound libraries.

When tasked with creating sound signals for automotive applications, Nia needs to consider the cognitive flow of users, particularly how different chords interact and influence user attention. To support this logic-making process, Nia uses an AI-powered tool that helps her design a storyboard, select suitable chords, and assign them to the relevant phases. She starts by writing the overall theme of the storyboard and then needs to detail each phase. While Nia understands the purpose of this step, she finds it challenging to determine the perspectives from which these details should be written. To simplify the process, Nia typically inputs only the theme and the number of phases into the tool. The tool then generates a suitable question to initialise the communication with the AI system, taking the burden away from Nia to formulate precise queries. The AI system's outputs are task-oriented, considering cognitive flows and aligning well with the later steps of chord selection and assignment. Satisfied with the results, Nia sometimes seeks further clarification or asks additional questions about user experience-related details in the text prompt. She also likes the flexibility to add more boxes for additional phases and to include AI-generated images that represent each phase's theme. This step supports the creation of a series of storyboard and descriptions as a design journey, useful to share with her team and stakeholders.

Once the storyboard is saved, Nia moves on to the next step: selecting chords for the relevant phases. She first ticks the boxes where she wants to apply sound signals and then inputs the chosen chords for each phase. While Nia has basic knowledge of tonal music, such as chord types, she is less familiar with tonal functionality and differences between musical keys. When her team member Joon, who majored in classical music composition, is unavailable, Nia opts for the tool's feature to choose and explain keys and functions automatically. Nia appreciates being able to define each sound's function in plain language—using terms like "start", "rising", "peak", or "end"—without focusing on harmonic details. The tool helps her translate this input into harmonic information, enabling the AI to offer options that meet her design objectives. Nia sometimes asks further questions and reflects on the AI system's suggestions, leveraging her basic knowledge of tonal principles to enhance her understanding. She occasionally uses the AI's note arrangement feature to fine-tune chord structures. After establishing the basic design logic in the storyboard and sound arrangement, Nia transitions to another MIDI software via the tool's connected API for sound creation and refinement.

4.2 Scenario 2: Yuna as a UX Designer

Yuna is a UX designer in the home appliance industry, primarily responsible for planning user experiences across various products, including those with multimodal interfaces. Though her main focus is on visual displays and the overall user experience, she occasionally contributes to auditory interface design projects. In these cases, Yuna lays the groundwork by providing design foundations before sound designers create the actual sounds. Yuna's musical background is very basic; she had some exposure to music as a child, but her engagement with music is limited to everyday listening and occasional karaoke. When working on a project involving auditory interfaces, such as creating simple sound signals for different situations, Yuna focuses on the cognitive aspects of users based on task flow within the storyboard. Though Yuna understands how different chords interact and influence user attention conceptually, she is not familiar with the music theoretical details.

To effectively design auditory interfaces, Yuna uses an AI-powered tool that helps her create a storyboard, select suitable chords, and assign them to relevant phases. She begins by writing the overall theme of the storyboard and then detailing each phase. The tool allows her to divide a phase into more specific sub-phases when needed. Given her background in human factors, Yuna draws on her extensive experience to detail phases that support end-users on every step of the process. When designing novel multimodal interfaces, she often uses the AI features to generate potential alternatives for each phase, repeating this process iteratively to refine the phases and overall storyboards, including descriptive images.

Once the storyboard is complete, Yuna moves on to the chord decision step. Her role does not require her to be specific about sound materialisation, but her ideas for the sound design must be understandable to other practitioners, especially sound designers. She first selects the boxes where sound signals are needed, often focusing on detailed divisions within larger phases, and then inputs suitable chords for the selected phases. Lacking musical knowledge, Yuna frequently relies on the tool's recommendation feature, assigning harmonic functions for each signal using plain language input and initialising communication with the AI system. For key selection, Yuna opts for the simplest settings and follows the "any" option, resulting in a random tonal structure. She finds it helpful that the tool allows her to initiate communication with the AI system aligned with her design purpose. Once the communication begins, she can refine the low-fidelity sounds through continuous querying. Among the suggested chords and keys, Yuna typically selects one of the options and uses the tool's note arrangement feature to explore different note combinations. She listens to all the options provided by the AI system to understand their sound intuitively, which proves valuable during meetings with sound designers. Once she is satisfied with the progress, she enters the storyboard immersive feature which also shows the musical arrangement for each phase, Yuna often uses this mode to present her progress and sound design rationale to the team.

5 A PROTOTYPE SYSTEM

Informed by the scenarios, we designed a prototype that can assist sound-design or UX practitioners to make decisions when creating storyboards and chord progressions. We mainly aimed to provide users with AI-recommended options based on conversations initiated through their plain-language input, reflected through the scenarios. We developed a web interface using Node.js and the OpenAI GPT-4o-mini API [30]. The interface is written in JavaScript and includes tone.js [24] for sound synthesis and tonal.js [9] for tonal music elements. Using our system involves three steps: storyboard creation, chord assignment, and a final overview for confirmation. These steps are illustrated in Figure 2, 3. We applied generative AI querying in four parts of our prototype: ideation for writing the storyboard, generating chord progression, creating note arrangements, and visualisation of story phases. Additionally, we added four supporting features: notes interpretation of chords, chord listening, options for advanced users, and an onboarding section to streamline the overall tool usage. This section elaborates the prototype design rationales from the scenarios, as well as the implementation details. The source code is available online[1].

5.1 AI applications

Our prototype applies generative AI to assist with four tasks related to recommended samples, with chord progression and note arrangement features also incorporating translated musical knowledge. In the storyboard creation step, we added prompt areas to guide ideation and visualisation (see F and G in Figure 2). Sound designers, less familiar with user experience methods, may be assisted by guidance on designing specific phases, as illustrated by the scenario of Nia. In contrast, UX designers, who are likely to be familiar with storyboarding, sometimes asked for clarification, based on the scenario of Yuna. To assist, we introduced a feature that initiates conversations with generative AI (see E in Figure 2). Users select the storyboard theme (see A in Figure 2) and number of phases, and the tool automatically generates prompts like, "Provide a storyboard about [theme] consisting of [number of phases] phases, carefully aligned with task analysis and considering the user's cognitive flow." This helps draw out perspectives based on target users and following tasks, structuring the cognitive assignment of chords in the next step. Users can then ask further questions to the AI as needed. Additionally, we created a space for visualising each phase by inputting short descriptions into the AI. Users can refine their ideas and generate visualisations based on the content of each phase, meeting the needs of both sound and UX designers in the scenarios.

In the chord assignment step, we added two generative AI features that automatically create chord progression and note arrangement options (see K and N in Figure 2). As discussed in the previous step, users can initiate conversations with the AI for chord progression options by selecting the number of phases, tonal key (with an "any" option), and tonal functions in plain-language (start, rising, peak, semi-end, end) in the order of assigning storyboard phases. The tool translates these into musical terms, generating LLM prompts like, "Provide 5 chord progression options in [tonal key] for [number of phases] measures, following the tonal functions in the order specified by: [tonal functions in the order]." The corresponding musical terms for tonal functions are tonic (start), subdominant (rising), dominant (peak), submediant (semi-end), and tonic (end). For note arrangements, users can input a chord name

[1] https://github.com/Yorkcla/AI-powered-CST-for-sound-design

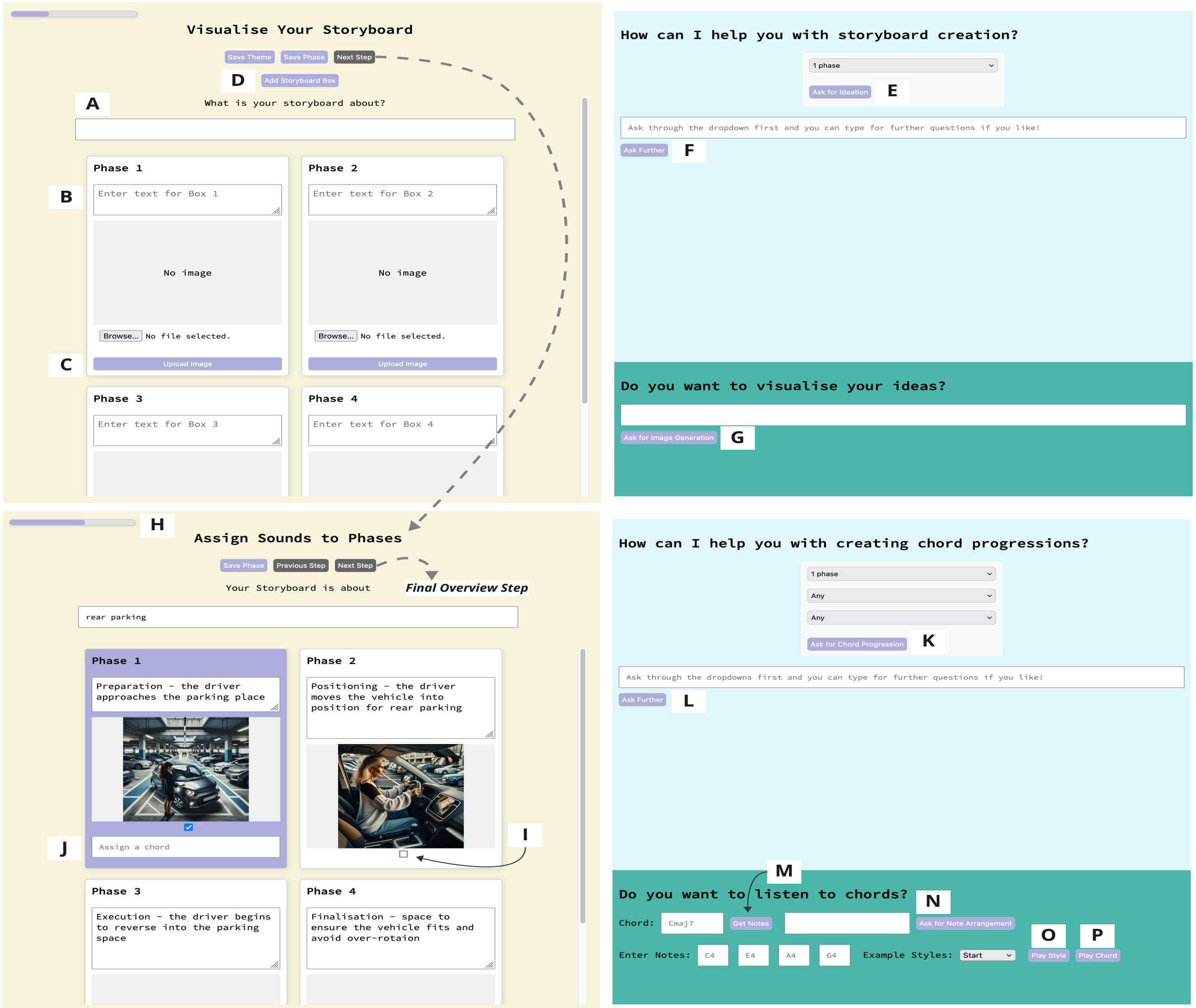

Figure 2: Interfaces for storyboard creation and chord assignment: A) Storyboard theme input; B) Storyboard phase theme input; C) Image upload for phase description; D) Add phases button; E) Initiate storyboard ideation (phase count option); F) Further inquiry button; G) Image generation button; H) Progress bar; I) Checkbox for chord assignment; J) Chord input; K) Initiate chord generation (phase count, function, tonal key options); L) Further inquiry button; M) Note components button; N) Initiate note arrangement; O) Play rhythmic style button; P) Play chord button.

in the selected chord progression, and get the note components of the chord from the tonal.js library (see M in Figure 2). The AI can then generate options for note arrangements, automatically asking, "Provide 5 harmonic note arrangement options, including inversions for 4 voices, based on [note components] with suitable octave numbers." Users can then ask further questions to the AI for both chord progression and note arrangement as needed (see L in Figure 2). These features cater to UX designers with limited tonal music knowledge and sound designers with some, but not extensive, experience described in the scenarios.

5.2 Supporting Features

In this section, we highlight additional features and concepts, followed by the AI applications. First, we considered advanced options for practitioners with a deeper understanding of tonal music. For instance, in the sound designer scenario, Joon was a team colleague with a background in classical music composition, and it is likely that may be varying levels of music theoretical knowledge among the members of a design team. To accommodate users with more music knowledge, we added advanced options for selecting specific tonal keys, including options for tonic and major or minor systems

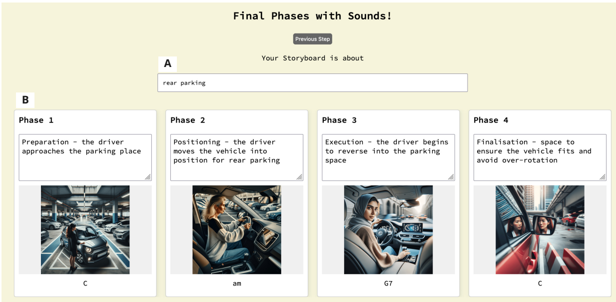

Figure 3: Interface for final overview: A) Storyboard theme; B) Phase details including themes, images, and assigned chords.

(see K in Figure 2). Secondly, we introduced an automatic note interpretation feature within the note arrangement process, which allows users to access specific components of individual chords (see M in Figure 2). This feature, supported by the tonal.js library, does not rely on AI. Thirdly, we developed a chord listening feature to aid in chord progression and note arrangement decisions with the tone.js library (see O and P in Figure 2). Users can input four notes with octaves and listen to the chord in different arrangements. The feature offers two modes: play style or just chord, with example styles based on tonal functions in plain language, detailed with rhythmic variations in Table 1. Finally, we added an onboarding section (see Figure 4) and a progress bar (see H in Figure 2) to guide users through the tool's steps and features, drawing from a recent user study [11]. This addition enhances their experience with the AI features and overall usability.

Table 1: Rhythmic styles for tonal function: tonal functions listed vertically in plain language, with four-note sequences and individual durations shown horizontally in seconds.

	1st	2nd	3rd	4th
Sequence	0.0	0.2	0.4	0.6
Start	0.5	0.1	0.1	0.1
Rising	0.1	0.2	0.3	0.7
Peak	0.7	0.7	0.7	0.7
Semi-End	0.1	0.1	0.1	0.3
End	0.1	0.1	0.1	0.5

6 DISCUSSION

Our study established two domain challenges in sonic interaction design—the need for recommended samples and translated musical knowledge—through case studies, identifying AI-based design opportunities. Based on these contexts, we developed two practitioner scenarios that detail the user journeys of sound and UX designers. Further, we created a prototype as a CST for sonic interaction design with tonal cognition, incorporating four generative AI applications and four supporting features, primarily focusing on intuitively initiating conversations with the AI system for recommendations, as

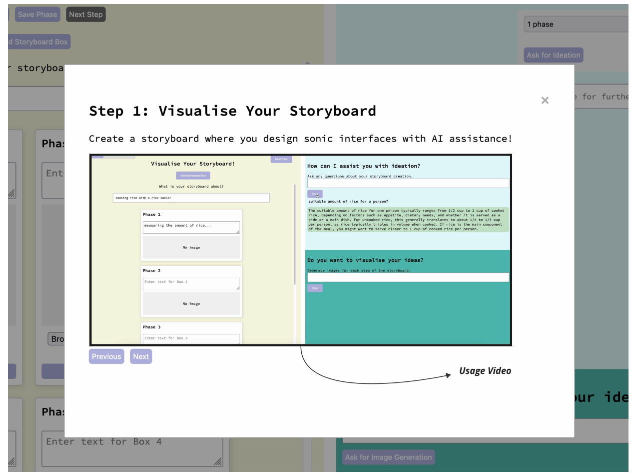

Figure 4: Modal window for onboarding section: overall instructions for each step with usage videos

reflected in the scenarios. By employing a scenario-based design approach, we defined user contexts and detailed practitioner journeys, extending beyond recent research findings to materialise design possibilities into a tangible interface with AI applications.

Our findings lead to several reflections for the future development of the CST for sonic interaction design. First, the initiating conversation feature could be expanded to support image generation. Users would select options in plain language, with the tool converting these into key factors for appropriate AI-generated storyboard images. Second, the tool could benefit from enhanced automation, such as aligning chord listening more closely with AI-generated options, allowing users to listen to selected chords without intermediate steps, and offering more intuitive controls for octaves and inversions rather than requiring manual input of specifics. Additionally, incorporating other sound design libraries or more fully utilising the existing frameworks could improve the detailed tuning of musical factors, such as rhythm and timbre, which were excluded from this study, after the logic decision phase. Finally, the storyboard creation process could be refined by adding sub-phases, as mentioned in the UX designer scenario, rather than simply adding basic phases. Displaying these phases in a horizontal order rather than vertically would also enhance the intuitive user experience, aligning more effectively with the tonal cognition flow.

Future work could focus on exploring the complete design steps of sonic interaction design with tonal cognition and developing a corresponding CST that incorporates the design reflections above. From storyboard ideation and sound tuning to audio file extraction, additional generative AI features or supporting frameworks could be integrated into the tool development. Following this, a usability evaluation of the CST will be conducted to test its effectiveness, understand the barriers of the design method with tonal cognition, and guide subsequent interface refinements. This research and the resulting CST will empower practitioners to create sound intuitively yet logically with AI assistance, opening up vast design possibilities in sonic interaction design through generative AI.

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