

# Prompt Engineering, Tools and Methods for Immersive Experience Development

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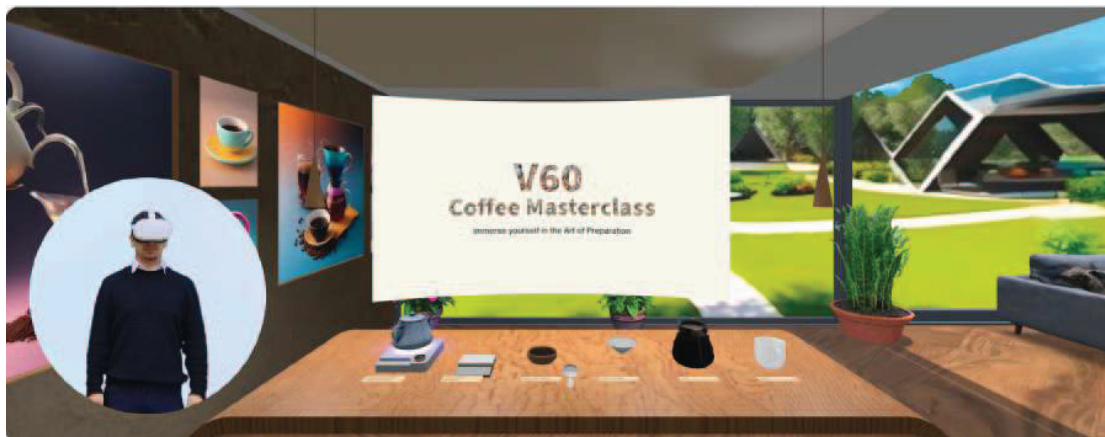


Figure 1: Coffee Masterclass experience immersive. All objects in the scene were generated using Generative Artificial Intelligence (GenAI) tools. Similarly, the conceptualization and development stages also include using GenAI tools.

## ABSTRACT

This paper presents relevant considerations about the challenges of integrating “*prompt engineering*” tools in the design and development of immersive systems. Thus, the contribution of this work is a general framework for the design and development of immersive systems using “*prompt engineering*” tools that use Generative Artificial Intelligence (GenAI). In other words, this proposal provides how to incorporate these tools into a traditional workflow of extreme programming agile methodology, establishing creative collaboration between the user and the GenAI tools. This work includes a concrete example of this dynamic interaction in developing a virtual reality experience for preparing specialty coffee using the V60 method. Thus, the development example shows the use of a set tool of GenAI, “*prompt*” inputs used, their corresponding outputs, and how they are integrated into the final product at each stage of the process. Therefore, the recommendations and challenges presented in this document are based on the knowledge gained from this experience.

**Keywords:** prompt engineering, co-creation, immersive experience development

**Index Terms:** Computing methodologies—Computer graphics—Graphics systems and interfaces—Mixed / augmented reality Human-centered computing—Human computer interaction (HCI)—Interactive systems and tools

The search for suitable methods for designing and developing virtual environments has been a constant concern in academic

and industrial settings. It is understood that the development of virtual environments involves complex challenges in aspects such as aesthetics, narrative, interaction, and immersion. Factors like software robustness, quality, and architecture should be addressed. While it is true that methodological proposals have been diverse, addressing these multifaceted aspects remains a key consideration in the ongoing pursuit of effective approaches for virtual environment design and development. The recent strides in Artificial Intelligence (AI) tools hold the potential to instigate a profound revolution within virtual environment development. Presently, an array of tools is easily accessible to anyone with just a single *prompt*; through natural language queries AI platforms, one can procure images, programming code, 3D models, audio, and more. The term “*prompt engineering*” refers to the skills needed to craft appropriate scripts for use as input in Generative Artificial Intelligence (GenAI) tools [12]. Essentially, these tools leverage Large Language Models (LLMs), pre-trained deep learning models that enable a specific output generation based on a text “*prompt*” [12]. These advancements allow us to see GenAI tools as integral members of the creativity team, fostering a co-creation dynamic between humans and GenAI.

This paper shows an approximation of this direction, proposed a general approach that allows the integration of the “*prompt engineering*” into an extreme programming methodology to build any virtual environment. The proposed approach defines how the GenAI tools must integrated properly into a development loop of extreme programming methodology. This work also presents an example of applying this approach; it shows how a set of GenAI tools is integrated into a development process, the “*prompt*” inputs and outputs. In other words, this paper shows a detailed example of integrating “*prompt engineering*” in a virtual reality application.

The subsequent sections of this paper are structured as follows: Section 1 shows a selected previous work. Section 2 introduces a

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generic framework that incorporates “*prompt engineering*” into an extreme programming methodology workflow to develop a virtual environment. Section 3 presents a practical example, showcasing the development of a virtual reality experience that allows any user to live the art and pleasure of preparing specialty coffees in a V60 method. Finally, Section 4 explores trends and challenges, drawing insights from the experiences detailed in this paper.

## 1 RELATED WORK

The development of immersive systems has experienced growth, with various software development methodologies being applied. These methodologies have posed unique challenges in immersive systems [9]. As a result, the proposed approaches have been diverse; some have addressed specific challenges in developing immersive systems, while others have targeted application sectors. For instance, methodologies inspired by video game development have been explored for creating VR environments [13]. Additionally, applying agile methodologies, with XP and Scrum as primary references, has been investigated [6, 11, 16]. Meanwhile, other proposals have focused on exploring the application of more robust elements of software engineering, such as complexity and quality in immersive technologies [9], or the implementation of the ADDIE model (analysis, design, development, implementation, and evaluation) in VR development [20].

Understanding that interaction is one of the major challenges in designing and developing an immersive system, its issues have been openly explored. Thus, Wang et al. [18] have formulated an approach to address challenges in human-centered requirements engineering for VR development. Dozio et al. [5] explored the design of elements that evoke emotions in virtual environments. Ashtari et al. [1] focused on the accessible development of AR/VR applications. In contrast, Tanriverdi et al. [15] propose a comprehensive approach to address conceptual and methodological challenges in interface design modeling for VR.

Some reviews on the state of methodologies, approaches, and tools for immersive systems have identified the diversity of development teams, the challenge of high dependence on software development with interaction and visualization hardware, and the need to propose specific methodologies. However, the trend continues to be the adaptation of methodologies, primarily agile methods [4, 8, 7, 10, 3].

The design and development of virtual environments have not been as indifferent to the recent rise of AI, “*prompt engineering*”, and LLMs. Using these tools provides possibilities to reduce the production times of multimedia and 3D material needed to populate environments and explore concepts, narratives, requirements, and other creative elements. [17] provides design guidelines for developing co-creative GenAI systems in virtual environments based on formative studies with generative designers and artists. Bussell et al. [2] propose using GenAI text-to-image tools in co-design workshops in VR, increasing public participation in urban design projects. Ratican et al. [14] propose a new development workflow using GenAI to create 3D content faster, facilitating the potential of the metaverse. Wu et al. [19] analyzed the potential of GenAI and human creativity in a study of 1,600 cases, showing that these tools can act as collaborators in the creative process, complementing human capabilities.

While the development of immersive systems has been explored from various perspectives, it is evident that integration with “*prompt engineering*” is an emerging issue that offers excellent opportunities. This work contributes in this direction by proposing a general approach to integrating GenAI tools into development methodologies that have proven highly suitable for constructing virtual environments, such as XP.

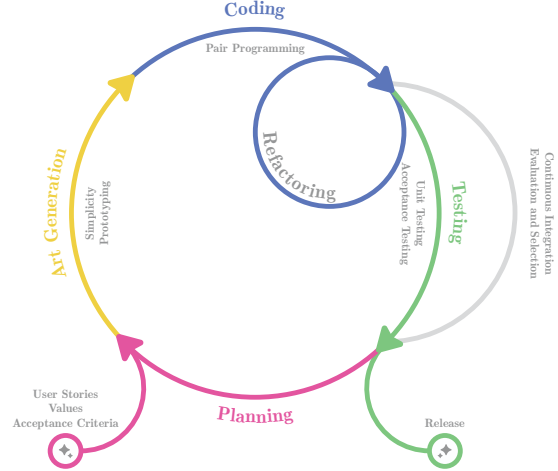


Figure 2: An extended traditional workflow where creative development is optimized in four stages: Planning, Art Generation, Coding and Testing with a scope of proposed tasks with “*prompt engineering*”

## 2 PROPOSED FRAMEWORK WITH “*Prompt Engineering*”

The “*prompt engineering*” in the content generation processes for immersive experiences using LLMs tools involves introducing a workflow that allows their integration efficiently. Figure 2, illustrate a conventional immersive experience development workflow consisting of four stages: Planning, Art Generation, Coding and Testing. Inspired by the principles of XP, focused on simplicity, iteration and adaptability, the proposed workflow seeks to integrate the creative capacity of the GenAI. This boosts development speed by providing a solid foundation for GenAI, automating content generation and accelerating development.

### 2.1 Planning

In the initial stage is Planning, defines the proposal for the immersive experience, design documents, type, idea and main concept, the specific characteristics of the target audience, and other elements. Crucial to this stage is crafting the “*prompts*” that guide GenAI tools throughout development. The defined “*prompts*” will guide the generation of content by the AI, ensuring aesthetics, narrative and experience.

Leveraging GenAI tools, at this stage, generate the narrative elements and interactive features of the immersive experience, including the story, title, narrative progression, character design, costumes, settings, user interface and interactions from “*prompt*” inputs.

### 2.2 Art generation

The Art Generation stage is guided by “*prompt*” needed rate crucial resources, which are iterative evaluated, integrated and developed in the development of the immersive experience. GenAI tools create essential resources, including images, videos, animations, 3D models, and audio, which will subsequently become assets within the final experience.

### 2.3 Coding

The Coding stage is an iterative process dedicated to building the immersive experience upon the designated platform. The integration of generated assets creates the environments, user interfaces and establish the interaction with the graphic resources. The coding and programming implement the functionalities and interactions, while

the errors are corrected with the support of AI-supported coding tools.

## 2.4 Testing

The Testing stage rigorously evaluates the immersive experience against the established requirements. Employing a test plan that encompasses interaction, usability, performance, response, and interaction, you seek to identify and address any potential anomalies that may impact the user experience. Subsequently, the launch is the last process, overseeing the final distribution and deployment of the immersive experience, complemented by AI-powered promotional content generation.

## 3 IMMERSIVE EXPERIENCE DEVELOPMENT EXAMPLE

Immersive systems aim to seamlessly blend VR visualization with the real world, enhancing the naturalness of interaction in the virtual environment by uniting vision, motor skills, and tactile perception. In this work, we explore this potential through an immersive experience to coffee preparation with the V60 drip method. For developers, defining the **Planning** stage comes first, it defines the elements needed for the conceptualization, feasibility, and analysis of requirements.

With this in mind, the process facilitated through constant *prompt* dialogue with ChatGPT<sup>1</sup> found the conceptualization, the main idea, the title, the immersive experience, the aesthetics concept, the basic requirements, and the narrative storytelling, and Bard<sup>2</sup> found step-by-step instructions for the coffee preparation process for the immersive experience. The following dialog is the output generated by *prompts* between the developer, ChatGPT and Bard.

**Developer:** As an expert in virtual, augmented, and mixed reality, I create an immersive mixed reality experience to teach the step-by-step coffee preparation process using the V60 method. Please ask me questions beforehand to better understand the project, and afterward, I will generate the experience.

**ChatGPT:** ...

1. What is the main objective of this mixed reality experience? Is it for education, entertainment, or some other purpose?
  2. Do you have a specific target audience in mind for this experience? For example, is it aimed at novice baristas or coffee enthusiasts in general?
  3. What level of detail and depth do you wish to include in teaching the V60 method process? Should it be a basic introduction or a highly detailed step-by-step guide?
  4. Do you have any graphic or 3D resources available to use in the experience, such as coffee maker models, coffee beans, cups, etc.?
  5. Would you like this experience to be available on specific devices, such as mixed reality headsets, mobile devices, or computers?
  6. Do you have a preference for a particular development platform, such as Unity, Unreal Engine, or something else?
  7. Do you have any ideas on how you would like users to interact with the experience? Would you like them to be able to touch and manipulate virtual objects or simply observe and learn?
  8. Would you like to incorporate gamification or assessment elements into the experience, such as a quiz at the end to assess understanding of the process?
  9. Is there any other specific element you would like to include in the experience, such as background music, narration, or visual effects?
  10. Do you have a specific timeframe in mind for completing this project?
- ...

**Developer:**

<sup>1</sup>ChatGPT, OpenAI, <https://chat.openai.com>

<sup>2</sup>Bard, Google AI, <https://bard.google.com>

1. To empower users to master the coffee preparation process using the V60 method, enabling them to confidently understand and apply key concepts, techniques, and steps necessary to create an exceptional cup of coffee using this methodology.
2. It is aimed at coffee enthusiasts, barista enthusiasts, and anyone interested in learning and perfecting the art of coffee preparation. It caters to both beginners looking to learn from scratch and users with prior experience seeking to refine their coffee preparation skills and techniques.
3. The level of detail and depth of the experience will focus on a basic, quick, and easy introduction to provide users with a solid understanding of the essential elements and key concepts related to coffee preparation using the V60 method.
4. 2D and 3D graphic resources will be used for the virtual objects and environment necessary for V60 coffee preparation.
5. It will be available for the Meta Quest 2 immersive reality glasses.
6. Unity.
7. In this mixed reality experience, users will interact hands-on, immersively, and directly with the virtual objects necessary for coffee preparation, with an approximate duration ranging from 5 to 10 minutes.
8. It will incorporate a final questionnaire to evaluate the user's experience in the coffee preparation process.
9. Visual and auditory instructions will be included to guide the user through the steps.
10. A relatively short, brief timeline for designing, developing, and testing the experience, ensuring that it is ready for implementation and use by users.

**ChatGPT:** ... Here is a summary of how the experience will be developed:

**Experience Objective:** To empower users to master the coffee preparation process using the V60 method, providing them with a solid understanding of key concepts, techniques, and steps necessary to create an exceptional cup of coffee.

**Platform:** Meta Quest 2

**Estimated Duration:** 5 to 10 minutes

**Key Components:**

1. Virtual Environment: Users will be transported to a virtual environment designed to simulate a coffee shop or kitchen. This environment will include all the necessary elements, such as the V60 coffee maker, pitcher, filter, cups, and coffee beans.
2. Visual and Auditory Instructions: Users will receive step-by-step visual and auditory instructions that will guide them through the coffee preparation process. This will include real-time demonstrations using 3D models of virtual objects.
3. Hands-on Interaction: Users will be able to interact directly with virtual objects. For example, they can pour water into the coffee maker, place the filter, add ground coffee, and control the speed and angle of water pouring. The haptic feedback of the Meta Quest 2 will provide a more realistic sense of interaction.
4. Assessment Quiz: At the end of the experience, users will complete a quiz that assesses their understanding of key V60 method concepts and techniques. This will give them an opportunity to gauge their learning and receive feedback.
5. Replayability: Users will be able to repeat the experience as many times as they like to practice and perfect their V60 coffee preparation skills.

**Development Phases:**

1. Virtual Environment Design
2. Visual and Auditory Instruction Development
3. Interaction Programming
4. Integration with Meta Quest 2
5. Quiz Development
6. Testing and Adjustments

**Development Timeline:** Given the short timeframe, efficient work will be required in all development phases. A team of experienced developers in Unity and mixed reality design would be essential to meet the schedule.

With this information, we can begin working on the “V60 Coffee Masterclass” in immersive experience, allowing users to learn and enjoy the V60 coffee preparation process!...

**Developer:** Create a creative and catchy title for the experience.

**ChatGPT:** “V60 Coffee Masterclass: Immersive yourself into the Art of Brewing”.

**Developer:** Design step-by-step instructions for the V60 coffee preparation process for an immersive mixed reality experience. Include the steps, ingredients, and preparation objects.

**Bard:** Step-by-Step Instructions for the V60 Coffee Preparation Process for an Immersive Mixed Reality Experience

Required Objects and Ingredients:

V60 Coffee Preparation Kit: Includes a V60 dripper, paper filter, coffee server, and dripper stand. Ground Coffee: Medium grind coffee is recommended for the V60 method. Hot Water: The ideal water temperature for the V60 method is from 90 to 96 degrees Celsius (from 194 to 205 degrees Fahrenheit).

Instructions:

1. Preparation: The user will find themselves in a virtual kitchen with all the necessary ingredients and objects for preparing coffee using the V60 method. The narrator will explain the necessary steps for coffee preparation, and users will be able to see and hear real-time instructions. Users will be able to interact with virtual objects in an intuitive and realistic manner.
2. Coffee Grinding: The user should measure 20 grams of medium-ground coffee. The narrator will explain how to measure coffee and determine the appropriate grind size. Users will be able to see how coffee is measured and ground.
3. Adding Coffee: The user should pour the ground coffee into the paper filter. The narrator will explain how to evenly distribute the coffee. Users will be able to see how coffee is poured and distributed.
4. Bloom: The user should pour 30 grams of hot water over the ground coffee in a circular motion, from the outside to the inside. The narrator will explain what the bloom is and how it affects the coffee's flavor. Users will be able to see how the ground coffee becomes wet and expands as water is poured.
5. Pouring Water: The user should pour the rest of the hot water over the ground coffee in a circular motion, from the outside to the inside. The narrator will explain how to pour water and control the flow. Users will be able to see how coffee filters through the paper filter and is poured into the coffee server.
6. Cleanup: Once all the water has filtered through, the user should discard the paper filter. The narrator will explain how to clean the utensils. Users will be able to see how the paper filter is disposed of and how the utensils are cleaned.

**Developer:** Acts as a scriptwriter for immersive virtual experiences. Generates a script from the welcome to the interaction of the immersive experience.

**Bard:**

#### 1. Welcome

**Narrator:** Welcome to the immersive coffee brewing experience with the V60 method! The V60 method is a drip coffee brewing method. The ground coffee is placed in a paper filter placed over a jug. Hot water is then poured over the ground coffee in a controlled process. The V60 method is known for producing clean, balanced tasting coffee. It is a versatile method that can be adapted to a variety of coffee beans and flavor preferences. In this experience, you will learn how to prepare a perfect V60 coffee at home.

#### 2. Preparation

**Narrator:** The first step is to prepare the coffee. To do this, you will need the following ingredients and objects necessary to prepare coffee with the V60 method. V60 Coffee Brewing Kit Ground coffee Hot water Next, I will explain the necessary steps of the preparation process.

#### 3. Coffee grounds

**Narrator:** The next step is to measure 20 grams of medium ground coffee. You can use a kitchen scale to measure coffee accurately. Medium ground coffee is the appropriate grind type for the V60 method. To determine the right type of grind, you can use a coffee grinder or a food processor.

#### 4. Adding coffee

**Narrator:** Once you've measured out the coffee, you can pour it into the paper filter. Distribute the coffee evenly throughout the filter, using a spoon or your fingers. Make sure the coffee doesn't touch the bottom of the carafe.

#### 5. Bloom

**Narrator:** The next step is to perform the bloom. Blooming is the process of rinsing coffee with hot water to release trapped gases. To do this, pour 30 grams of hot water over the ground coffee in a circle, from the outside to the inside. Let the water sit for 30 seconds.

#### 6. Pour the water

**Narrator:** Once the bloom has finished, you can pour the rest of the hot water over the ground coffee. Pour the water in a circle, from the outside to the inside. Control the flow of water so that it is constant.

#### 7. Cleaning

**Narrator:** Once all the water has been filtered, you can throw away the paper filter. You can clean utensils with hot water and soap.

#### 8. Enjoy your coffee

**Narrator:** Ready! Your V60 coffee is ready to enjoy. Pour a cup and experience the taste of perfectly brewed coffee.

#### 9. End

**Narrator:** Congratulations! You have prepared a delicious and aromatic coffee. Enjoy your drink.

In the **Art Generation** stage, the co-creation approach used a diverse set of LLMs tools (DALL-E, Midjourney, Stable Diffusion, Leonardo AI, Adobe Firefly, Skybox AI, Krea.AI) for the 3D and multimedia production. However, “prompt” input always included relevant words/sentences related to narrative and aesthetic concepts. Adobe Firefly<sup>3</sup> generated the texture effect for the name of the immersive experience: “V60 Coffee Masterclass”, proposed by ChatGPT, with the “prompt” input: “coffee cup, coffee decoration, barista, minimalist”. Fig. 3 shows the name for the immersive experience.

Leonardo AI<sup>4</sup> was employed to generate images in different visual styles that satisfy the narrative and aesthetic requirements. Fig. 4 shows the chosen outputs of the generated images.

<sup>3</sup>Adobe Firefly, Adobe Inc., <https://www.adobe.com/products/firefly.html>

<sup>4</sup>Leonardo AI, Leonardo.AI Inc., <https://leonardo.ai/>



## V60 Coffee Masterclass

Figure 3: “V60 Coffee Masterclass” Adobe Firefly text effect “prompt” output.



Figure 4: Leonardo “prompt” outputs.

The generation of the physical environment where the user will interact used a skybox, an essential texturing technique to create immersive and realistic virtual environments. Skybox AI<sup>5</sup>, facilitated the creation of images with an equirectangular projection from “prompt” inputs. The images generated with Skybox AI were retouched in Photoshop powered by Adobe Firefly. Additionally, combining multiple outputs generates depth and visual atmosphere. Fig. 5 shows the chosen and corrected outputs of the equirectangular images for the skybox.



Figure 5: Skybox generated by “prompt” input, and retouched by Photoshop powered Adobe Firefly. a: “Imagine a sky and clouds”, b: “Imagine an outdoor environment in nature. minimalist, vibrant”, c: Parallax effect created with the generated skyboxes

Furthermore, to produce aesthetic patterns, offering unique and harmonious color palette according to the graphic concept and aesthetic design, ColorMagic<sup>6</sup> was used with the “prompt” input: “UI Coffee”. Fig. 6 show the output generate.

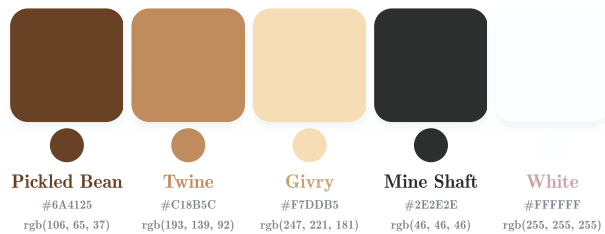


Figure 6: Color palette generated by MagicColor

<sup>5</sup>Skybox AI, Blockade Labs, <https://skybox.blockadelabs.com>

<sup>6</sup>ColorMagic, Nucumo, <https://colormagic.app/>

The generating 3D models from a “prompt” input is possible with emerging LLMs (Kaedim 3D, DreamFusion, 3DFY, Shap-E, Genie), optimizing the process of 3D modeling through increased speed. In this case, Genie<sup>7</sup> and Shap-E<sup>8</sup> allowed the creation of various high-quality furniture, nature, objects and other 3D assets for the virtual world, generating meshes and textures from simple inputs. Fig. 7 and Fig. 8 shows the respective outputs of the Genie and Shap-E generation.



Figure 7: Genie 3D models “prompt” outputs

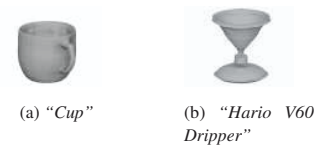


Figure 8: Shap-E 3D models “prompt” outputs

The creation of realistic textures necessary to provide an attractive feeling in the virtual environment, was empowered by WithPoly<sup>9</sup> from a different “prompts” inputs for each material. These textures, skillfully applied to the materials of 3D objects, infuse them with

<sup>7</sup>Genie, Luma AI, Inc., <https://lunalabs.ai/genie>

<sup>8</sup>Shap-E, OpenAI, <https://github.com/openai/shap-e>

<sup>9</sup>WithPoly, WithPoly, <https://withpoly.com>

intricate details, and an unparalleled sense of realism within the virtual world. Fig. 9 show the material outputs.

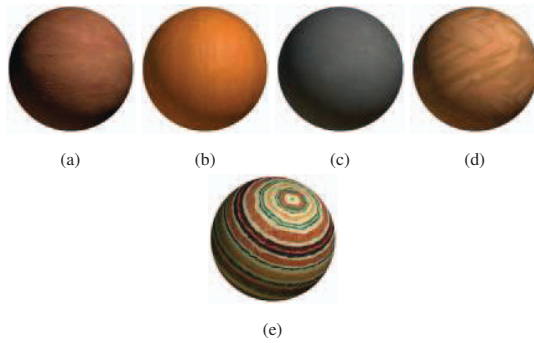


Figure 9: Textures “prompt” outputs. a: “Ground coffee”, b: “White oak wood fine, extreme fine details, vertical grains”, c: “Stucco, interior, wall”, d: “Herringbone, wood flooring, extreme fine details, polished, realistic, interior-design, luxury parquet”, e: “Realistic rug with warm colors and very fluffy with circular patterns”

The creation of videos from a simple prompts is possible from a “prompt” input with creative GenAI tools (Runway, Pika.art, Leonardo AI), synthesizing realistic and consistent videos, aligning with the composition and overall design aesthetic of the production. Runway<sup>10</sup> allowed the production of videos that adapt to the visual concept of the experience. Fig. 10 show the respective results of video generation.



Figure 10: Runway “prompt” outputs

While achieving co-creation through LLMs-generated content is the overarching objective, continuous evaluation and selection of generated content remain crucial for successful integration into the workflow. Subsequently, the team decides on the acceptance content considering factors such as color, style, context, format, type, and the other elements that contribute to the final quality.

In the **Coding** stage, the device used to deploy the immersive experience was Meta Quest 2, the most known runtime embedded system integrated into a Head Mounted Display. Unity3D was the integrated development tool. The chosen IDE, because it is a pioneer in integrating into its curated ecosystem AI-powered solutions, including GenAI tools. It is also recognized for its high-quality graphics, C# programming language support, and compatibility with Meta development SDK and OpenXR standard.

In order to accelerate and facilitate the coding stage, this build process integrated BlackBox AI<sup>11</sup> to automate the generation of some C# language scripts in Unity. The specific coding of the scripts were generated from a “prompt” input: “Create a script to enable

particles when rotated to 90 degrees in Unity” and “Create a script to rotate a GameObject a number of degrees continuously in Unity”. Code 1 presents the code for particle control, while Code 2 handles object rotation.

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class RotationParticle : MonoBehaviour
{
    public GameObject particleSystem;
    private ParticleSystem particles;
    private bool isPlaying = false;

    void Start()
    {
        particles = particleSystem.GetComponent<ParticleSystem>();
    }

    void Update()
    {
        float angle = Vector3.Angle(transform.forward, Vector3.down);
        if (angle <= 90 && !isPlaying)
        {
            particles.Play();
            isPlaying = true;
        }
        else if (angle > 90 && isPlaying)
        {
            particles.Stop();
            isPlaying = false;
        }
    }
}
```

Code 1: Particle control generated by BlackBox AI

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class RotateObject : MonoBehaviour
{
    public float speed = 50.0f;
    void Update()
    {
        transform.Rotate(Vector3.up * speed * Time.deltaTime);
    }
}
```

Code 2: Object rotation generated by BlackBox AI



Figure 11: Overview of the integration of content generated by “prompt” engineering with GenAI tools in Unity3D

<sup>10</sup>Runway, Runway AI, Inc., <https://runwayml.com>

<sup>11</sup>Blackbox AI, Blackbox AI, <https://www.blackbox.ai>

Finally, the **Testing** stage, evaluation with users and experts, and launch plan may be prepared by a conversational collaboration with Bard, allowing the generation of dynamic and adaptive strategies providing valuable information to evaluate usability, immersion, and user experience (UX).

**Developer:** Act as an expert by trying an immersive virtual reality experience of coffee preparation with the V60 method, where the user can interact and go step by step in preparing coffee like a professional or beginner bartender. Propose a test plan involving both experts and end users. Define the recommended number of end users and experts, along with a testing schedule. In addition, it includes a proposal for the use of state-of-the-art validated instruments to evaluate usability, UX and interaction.

**Bard:**

**Objective:** Evaluate the usability, UX, and interaction of an immersive VR experience for coffee preparation using the V60 method, targeting both professional and beginner coffee enthusiasts.

**Target Participants:** Virtual Environment, Visual and Auditory Instructions, Hands-on Interaction, Assessment Quiz and Replayability

**Estimated Duration:** 5 to 10 minutes

**Key Components:**

1. Experts: 5 coffee professionals with extensive experience in V60 brewing technique.
2. End Users: 15 participants with varying coffee brewing experience levels (beginners, intermediate, and advanced).

**Testing Schedule:**

1. Pilot Testing: Conduct a pilot test with 2 or 3 participants (1 expert, 1 or 2 end users) to refine the testing procedures and identify any major flaws.
2. Expert Testing: Two sessions with 5 experts each, focused on task completion time, technique accuracy, feedback on realism and ease of use of the VR tools.
3. End User Testing: Three sessions with 5 participants each, testing across experience levels. Observe task completion, learning progress, engagement, and emotional response.

**Assessment Tools:**

1. Qualitative: Conduct semi-structured interviews with all participants after each session, focusing on UX, satisfaction, suggestions for improvement, and level of immersion
2. Quantitative: Utilize validated instruments for specific aspects: System Usability Scale (SUS), Flow State Scale (FSS), Cognitive Effort Rating (CER), Eye-tracking, Biometric measurements (optional)
3. End User Testing: Three sessions with 5 participants each, testing across experience levels. Observe task completion, learning progress, engagement, and emotional response.

**State-of-the-Art Validated Instruments:** Mobile Eye-tracking glasses, Physiological monitoring devices and VR Analytics platforms.

**Data Analysis:**

1. Analyze qualitative data from interviews using thematic analysis to identify common themes and insights.
2. Analyze quantitative data from validated instruments using statistical methods to compare findings across different user groups and identify areas for improvement.
3. Combine qualitative and quantitative data to generate a comprehensive understanding of UX and potential areas for optimization.

**Reporting:**

1. Prepare a comprehensive report summarizing the findings from all testing phases, including key metrics, user feedback, and recommendations for improvement.

2. Provide actionable insights for developers and designers to enhance the VR coffee experience based on user needs and preferences.

**Additional Considerations:**

1. Ensure diverse recruitment of participants for representative testing results.
2. Conduct testing in a controlled environment with calibrated VR equipment.
3. Consider offering incentives to participants for their time and effort.
4. Adapt the testing schedule and instruments based on pilot testing results.

The Fig. 11 provides a graphical representation of the content generated by GenAI. On the other hand, the immersive experience is visually presented in the Fig. 12 developed from the application of the workflow with “prompt engineering” in “Coffee Masterclass”. Furthermore, demonstrating the “prompt engineering” integration that defines the proposed framework for the development of immersive systems, offers a comprehensive understanding of the collaboration with GenAI, being a reference for future implementations.



Figure 12: “Coffee Masterclass,” an immersive VR experience for Meta Quest 2.

## 4 FINAL REMARKS AND FUTURE WORK

This paper presents the first version of a framework for integrating the use of GenAI tools, commonly referred to as “prompt engineering”, into the development workflow of a virtual environment. The proposed framework extends the traditional loop of the extreme programming methodology, outlining specific tasks achievable through “prompt engineering”. A practical example of a virtual reality experience developed using tools like ChatGPT, Bard, Leonardo AI, Adobe Firefly, Skybox AI, WithPoly, ColorMagic, BlackBox AI, Genie, Shap-E, and Runway, is provided.

The experiences gained from developing the virtual reality example and preliminary tests highlight the potential of GenAI text-to-image, text-to-3D model tools in reducing the production workload for assets and audiovisual material crucial in virtual environment development. However, maintaining consistency with the established graphic concept is a central challenge, because executing similar “prompt” inputs at different times can yield results deviating from the intended visual concept. To address this, outputs from these tools can be employed as inputs for graphic artists, enabling them to harmonize the visual concept. Overcoming barriers in adopting these technologies by audiovisual



professionals, who should perceive them as complementary rather than threatening to their work, remains a primary challenge. In text-to-text GenAI tools, a key challenge is enhancing the robustness of certain outputs. Despite this, they serve as a promising starting point for a multidisciplinary team.

In the planning and testing stages, integrating GenAI tools allows for exploring additional ideas and concepts, enriching the overall experience. During the art and coding stages, the quality of graphics, aesthetics, and narrative storytelling aligns with traditional processes, yet the efficiency surpasses that of conventional methods. This experience underscores the importance of having a creative team proficient in “prompt engineering” and interaction with Large Language Models. Consequently, these skills will become desirable capabilities for individuals creating immersive experiences. An essential recommendation is to retain GenAI outputs, as any image, model, or sound has the potential to enhance the virtual environment. However, caution is advised when incorporating emerging tools of GenAI; their outputs should be evaluated for relevance and quality before integration into the environment. Nevertheless, the swift evolution of AI introduces concerns regarding the intellectual property and copyrights of generated content. Determining authorship becomes complex in machine-involved scenarios, necessitating exploration of ways to protect copyright and intellectual property rights among developers, designers, creators, and LLMs.

On the other hand, it is necessary to evaluate the potential to improve the user experience by solving problems related to immersion, interaction, satisfaction, and user engagement. Including the evaluation through specific metrics, implementing methods to improve user interfaces and visual guidelines, minimizing the generation of unwanted outputs, and powerful the creative process. Additionally, optimize the integration of “prompt engineering” tools into the workflow, promoting efficient and collaborative design between developers and GenAI. Finally, explore best practices to facilitate the development of immersive experiences in diverse areas.

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## REFERENCES

- [1] N. Ashtari, A. Bunt, J. McGrenere, M. Nebeling, and P. K. Chilana. Creating augmented and virtual reality applications: Current practices, challenges, and opportunities. In *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems*, CHI '20, p. 1–13. Association for Computing Machinery, 2020. doi: 10.1145/3313831.3376722 2
- [2] C. Bussell, A. Ehab, D. Hartle-Ryan, and T. Kapsalis. Generative ai for immersive experiences: Integrating text-to-image models in vr-mediated co-design workflows. In C. Stephanidis, M. Antona, S. Ntoa, and G. Salvendy, eds., *HCI International 2023 Posters*, pp. 380–388. Springer Nature Switzerland, Cham, 2023. doi: 10.1007/978-3-030-78462-1\_13 2
- [3] G. V. de Andrade, A. L. C. Gomes, F. R. Hoinoski, M. G. Ferreira, P. Schoeffel, and A. Vahldick. Virtual reality applications in software engineering education: A systematic review. *arXiv preprint*, 2022. doi: 10.48550/arXiv.2204.12008 2
- [4] A. C. C. dos Santos, M. E. Delamaro, and F. L. S. Nunes. The relationship between requirements engineering and virtual reality systems: A systematic literature review. In *Proceedings of the 2013 XV Symposium on Virtual and Augmented Reality*, SVR '13, p. 53–62. IEEE Computer Society, 2013. doi: 10.1109/SVR.2013.52 2
- [5] N. Dozio, F. Marcolin, G. W. Scurati, L. Ulrich, F. Nonis, E. Vezzetti, G. Marsocci, A. La Rosa, and F. Ferrise. A design methodology for affective virtual reality. *International Journal of Human Computer Studies*, 162(C), 2022. doi: 10.1016/j.ijhcs.2022.102791 2
- [6] M. Freitag, P. Westner, C. Schiller, M.-J. Nunez, F. Gigante, and S. Berbegal. Agile product-service design with vr-technology: A use case in the furniture industry. In *Procedia CIRP*, vol. 73, pp. 114–119. Elsevier B.V., 2018. doi: 10.1016/j.procir.2018.03.305 2
- [7] N. Ghrairi, S. Kpodjedo, A. Barrak, F. Petrillo, and F. Khomh. The state of practice on virtual reality (vr) applications: An exploratory study on github and stack overflow. In *2018 IEEE International Conference on Software Quality, Reliability and Security (QRS)*, pp. 356–366, 2018. doi: 10.1109/QRS.2018.00048 2
- [8] U. Gulec, M. Yilmaz, and V. Isler. A literature survey: Is it necessary to develop a new software development methodology for virtual reality projects?, 2017. doi: 10.3217/jucs-023-08-0725 2
- [9] G. J. Kim, K. C. Kang, H. Kim, and J. Lee. Software engineering of virtual worlds. In *Proceedings of the ACM Symposium on Virtual Reality Software and Technology*, VRST '98, p. 131–138. Association for Computing Machinery, 1998. doi: 10.1145/293701.293718 2
- [10] N. Li, J. Du, V. A. González, and J. Chen. Methodology for extended reality-enabled experimental research in construction engineering and management. *Journal of Construction Engineering and Management*, 148(10):04022106, 2022. doi: 10.1061/(ASCE)CO.1943-7862.0002367 2
- [11] E. Lozada-Martinez, J. E. Naranjo, C. A. Garcia, D. M. Soria, O. R. Toscano, and M. V. Garcia. Scrum and extreme programming agile model approach for virtual training environment design. In *2019 IEEE Fourth Ecuador Technical Chapters Meeting (ETCM)*, pp. 1–5, 2019. doi: 10.1109/ETCM48019.2019.9014882 2
- [12] J. Oppenlaender, R. Linder, and J. M. Silvennoinen. Prompting ai art: An investigation into the creative skill of prompt engineering, 2023. doi: 10.48550/arXiv.2303.13534 1
- [13] J. Polcar, M. Gregor, P. Horejsi, and P. Kopecek. Methodology for designing virtual reality applications. In *Annals of DAAAM and Proceedings of the International DAAAM Symposium*, pp. 768–774. Danube Adria Association for Automation and Manufacturing, DAAAM, 2015. doi: 10.2507/26th.daaam.proceedings.107 2
- [14] J. Ratican, J. Hutson, and A. Wright. A proposed meta-reality immersive development pipeline: Generative ai models and extended reality (xr) content for the metaverse. *Journal of Intelligent Learning Systems and Applications*, 15:24–35, 2023. doi: 10.4236/jilsa.2023.151002 2
- [15] V. Tanriverdi and R. J. Jacob. Vrid: a design model and methodology for developing virtual reality interfaces, 2001. doi: 10.1145/505008.505042 2
- [16] B. Tischbein, C. Bull, C. Wiegand, D. Gradianu, E. Qamar, F. Isho, and M. Mahmoud. Software development methodologies for virtual reality. In *2021 International Conference on Computational Science and Computational Intelligence (CSCI)*, pp. 1951–1957, 2021. doi: 10.1109/CSCI54926.2021.00362 2
- [17] J. Urban Davis, F. Anderson, M. Stroetzel, T. Grossman, and G. Fitzmaurice. Designing co-creative ai for virtual environments. In *Proceedings of the 13th Conference on Creativity and Cognition*, C&C '21. Association for Computing Machinery, 2021. doi: 10.1145/3450741.3465260 2
- [18] Y. Wang, B. Cheng, T. Hoang, C. Arora, and X. Liu. Virtual reality enabled human-centric requirements engineering. In *2021 36th IEEE/ACM International Conference on Automated Software Engineering Workshops (ASEW)*, pp. 159–164. IEEE Computer Society, 2021. doi: 10.1109/ASEW52652.2021.00041 2
- [19] Z. Wu, D. Ji, K. Yu, X. Zeng, D. Wu, and M. Shidujaman. Ai creativity and the human-ai co-creation model. In M. Kurosu, ed., *Human-Computer Interaction. Theory, Methods and Tools*, pp. 171–190. Springer International Publishing, Cham, 2021. doi: 10.1007/978-3-030-78462-1\_13 2
- [20] S.-J. Yu, Y.-L. Hsueh, J. C.-Y. Sun, and H.-Z. Liu. Developing an intelligent virtual reality interactive system based on the addie model for learning pour-over coffee brewing. *Computers and Education: Artificial Intelligence*, 2:100030, 2021. doi: 10.1016/j.caeai.2021.100030 2