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Implementation of the Lokananta Records Surakarta Virtual Museum as a Promotional and Educational Media

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Abstarct

A museum is a non-profit institution tin the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits both tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment. A virtual museum is a digital entity that refers to the characteristics of a museum, in order to enhance or add to the experience of a museum through interactivity, richness of content and personalization. The creation of a virtual museum from the Lokananta Records Surakarta museum is needed as an effort to improve and add to the experience of the Lokananta Records Surakarta museum.
This study focuses on developimg a virtual museum to represent the Lokananta Records Surakarta. The application design followed multimedia development lifecycle.
The Lokananta Records Surakarta virtual museum application has been successfully developed as a virtual museum with the feature of being able to explore the virtual museum, interact with 3-dimensional objects in it such as vinyl record, cassette tape, videotape, compact disc and the Lokananta Records Surakarta Production Process Tool Collection.

Abstrak

Museum adalah lembaga nirlaba yang melayani masyarakat dan perkembangannya, terbuka untuk umum, yang memperoleh, melestarikan, meneliti, mengkomunikasikan, dan memamerkan warisan manusia dan lingkungannya baik yang berwujud maupun yang tidak berwujud untuk tujuan pendidikan, studi, pendidikan dan hiburan. Museum virtual adalah entitas digital yang mengacu pada karakteristik museum, untuk meningkatkan atau menambah pengalaman museum melalui interaktivitas, kekayaan konten, dan personalisasi. Pembuatan virtual museum dari museum Lokananta Records Surakarta diperlukan sebagai upaya untuk meningkatkan dan menambah pengalaman museum Lokananta Records Surakarta.
Penelitian ini berfokus pada pengembangan museum virtual untuk merepresentasikan Lokananta Records Surakarta. Desain aplikasi mengikuti siklus hidup pengembangan multimedia.
Aplikasi museum virtual Lokananta Records Surakarta telah berhasil dikembangkan sebagai museum virtual dengan fitur dapat menjelajahi museum virtual, berinteraksi dengan objek 3 dimensi di dalamnya seperti piringan hitam, kaset, kaset video, compact disc dan Lokananta Mencatat Koleksi Alat Proses Produksi Surakarta.

1. INTRODUCTION

By definition, a museum is a building where historical, scientific, or artistic objects are stored [1]. A museum can also mean a permanent non-profit institution that serves society and its development, open to the public, which acquires, preserves, researches, communicates, and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, learning and enjoyment [2]. Virtual Reality (VR) is a simulated experience that can be similar to or completely different from the real world. Virtual reality applications can include entertainment (especially video games), education (such as

medical or military training) and business (such as virtual meetings) [3]. A virtual museum is a digital entity that refers to the characteristics of a museum, in order to enhance or augment the experience of a museum through interactivity, richness of content and personalization. A virtual museum can appear as a digital footprint of a physical museum, or it can act independently, while maintaining the authoritative status that the International Council of Museums (ICOM) grants in its definition of a museum. In line with ICOM's mission of physical museums, virtual museums are also committed to being accessible to the public; both for knowledge systems and for long-term preservation.

Latos et al conducted research on the interaction and communication of information with virtual museums using web-based virtual reality, where the resulting virtual reality can make it easier for users to explore complex museums and capture the information conveyed [4]. Research by Efendi et al, application of the virtual reality of the Sang Nila Utama museum can be used as a promotional medium in the form of creative media that can be accessed by the wider community [5]. In a game evaluation study based on clusters at the Sangiran Museum using a virtual reality application by Purnomo et al, a survey was conducted by museum visitors with the majority of responses are good and users feeling helped and became more interested in the Sangiran Museum [6]. Virtual museum using virtual reality technology can be used as promotional or educational media by providing information that can help and make it easier for users or museum visitors to explore museum. So the development of a virtual museum from the Lokananta Records Surakarta museum is needed as an effort to improve and add to the experience of the Lokananta Records Surakarta museum.

2. RESEARCH METHOD

The research was conducted through a system development approach using the Luther version of the Multimedia Development Life Cycle (MDLC) method (See Figure 1). According to Sutopo, in Setiawan, et al, the multimedia development method consists of six stages, namely the stages of concept, design, material collection, assembly, testing, and distribution [7].

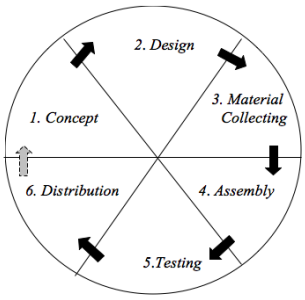

Figure 1. Multimedia development life cycle (MDLC) [7]

The concept stage is the stage of determining the goals and targets of application users (user identification). It also determines the type of application such as interactive, presentation, etc., as well as the purpose of the application such as for entertainment, training, learning, and others. The design stage makes the design of the application and storyboard, including the specification of the application architecture, theme, appearance and material or asset requirements for the application. The material collection stage is carried out by collecting materials that are in accordance with the needs needed in application development and can be done in parallel with the next stage, namely assembly. The assembly stage is the stage where all multimedia objects or materials are developed into applications. Application development is based on the previous design stage. The testing phase is carried out after the assembly phase is complete. Some of the tests that can be done include functional and compatibility testing. Functional testing is carried out to ensure that the functional application can run according to the software requirements specifications. Compatibility testing is a part of non-functional testing conducted on application software to ensure the application's compatibility with different computing environment. The last stage is distribution, where the application is stored in a storage media or services so it can be used by the target user of the application.

3. RESULTS AND DISCUSSION

3.1 Concept

The Lokananta Records Surakarta virtual museum application is a mobile-based (Android) virtual museum application using virtual reality technology as a publication and education medium for users to be able to know the virtual environment of the Lokananta Records Surakarta Museum, such as the main building, showroom and museum room. The application allows users to interact with objects in the museum such as vinyl record, cassette tape, videotape, compact disc and Lokananta

Records Surakarta production process tool collection. The interaction objects are accompanied by information about the objects that are exhibited through audio and visual. The interactions themselves are triggered using pointers and timers.

3.2 Design

The application workflow (see Figure 2) starts from when the user runs the application will be given a choice on the main menu, namely to play virtual reality (Play VR), application usage guides (Help) and information about the application (About). If the user chooses to play virtual reality, the user will be given the choice whether to start from the courtyard outside the main building or directly choose a room inside the museum.

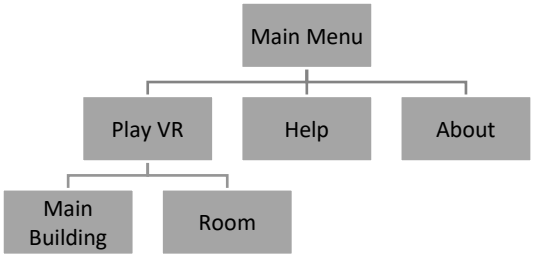

Figure 2. Lokananta Records Surakarta virtual museum application workflow

The theme carried in this application is classic or retro to give the impression of an ancient era. So the background coloring used in the application is dominated by black, gray and white. While the coloring of foreground objects such as buttons uses a reprographic reproduction duotone colors technique of black and white. The interface that will be built in this application is made as easy and comfortable as possible to improve the user experience, especially in the layout of the buttons on each interface. The interfaces designed include the logo page of the Lokananta Records Surakarta museum and Universitas Sebelas Maret as developers, the application logo page, the main menu page, the guide page, and the application information page (see Figure 3).

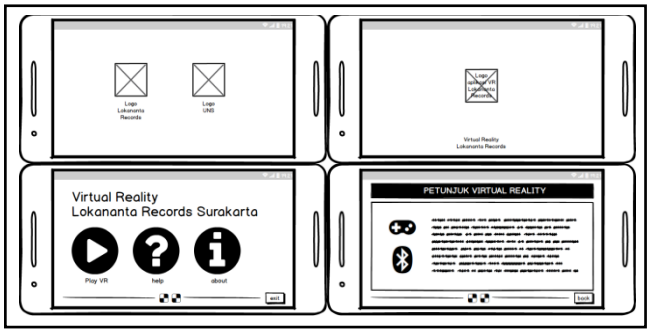

Figure 3. Lokananta Records Surakarta virtual museum application interface design

3.3 Material Collecting

The materials needed in the Lokananta Records Surakarta virtual museum application include the main building object (see Figure 4), showroom, museum room, vinyl records, cassette tapes, video cassettes, compact discs (see Figure 5) and Lokananta Records Surakarta production process tool collection. The main building of Lokananta Records Surakarta has various rooms that are used for various purposes and has several assets.

Figure 4. Lokananta Records Surakarta main building

The showroom is a space used to showcase products ever produced by Lokananta Records Surakarta. In the showroom, there are 4 types of objects on display, namely vinyl record, cassette tape, videotape and compact disc.

Figure 5. Vinyl record, cassette tape, videotape and compact disc

The Museum Room (see Figure 6) is a space used to exhibit a collection of equipment that was used for the production process at Lokananta Records Surakarta in ancient times. Among them are Ampex Streo 2 pack Master Recorder 351-2P 1964, TRIO CD-1040 40 MHz Oscilloscope, High Band U Matic VTR HB 1985, Phantom Power Supply 1985, TRIO PAL Color Pattern CG-912, TRIO AG-203 CR Oscillator 1985, Oscillograph 292-6A91 1960, AMPEX Master Recorder 1980, STUDER Master Record AB0 1985, Electro Sound Quality Control 1980, Player Vinyl Garard model 301 1960, Leitch Audio and Video Distributor Amplifier and BINSON Echorec model PE603T.

Figure 6. Lokananta Records Surakarta production process tool collection

This application also requires images as textures of 3-dimensional objects, including photos of the President and Vice President of the Republic of Indonesia, Lokananta Records Surakarta logo, compact disc covers, cassette tape covers, video cassette covers, vinyl record covers, museum equipment indicators, posters in showrooms, museum halls and hallways, pictures of grass, floors, rough walls, poles, roof tiles, wood and iron. The application background audio uses musical instruments and the object explanation information is carried out by the voice actor.

3.4 Assembly

Two dimensional application interface drawing using CorelDraw software. The application interface includes the logo page of the Lokananta Records Museum and Universitas Sebelas Maret as a developer, the application logo page, the main menu page, the guide page, and the application information page (see Figure 7).

Figure 7. Lokananta Records Surakarta virtual museum application interface

Three dimensional objects (see Figure 8) creation in the Lokananta Records Surakarta virtual museum application using the Blender software. The steps taken are modeling followed by coloring and giving textures according to real objects. The production of 3-dimensional objects is broadly divided into 3 groups, the first is 3-dimensional objects of the main building, showrooms and museum rooms.

Figure 8. Three dimensional objects of the main building, showroom and museum room

The second group is objects in the showroom, including vinyl record, cassette tape, videotape and compact disc (See Figure 9).

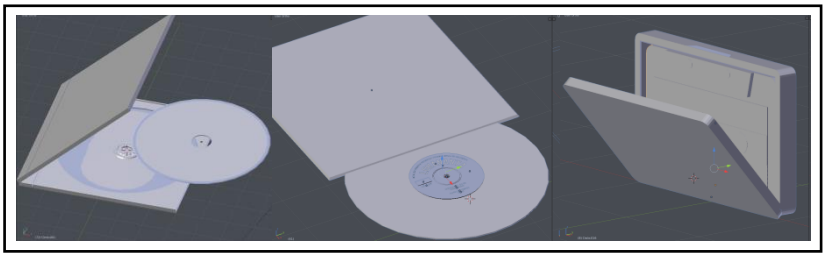

Figure 9. Three dimensional objects of vinyl record, cassette tape, videotape and compact disc

The last group is the objects that are in the museum room which contains a collection of audio devices that have been used for the production process at Lokananta Records Surakarta in the past (see Figure 10).

Figure 10. Three dimensional object of Lokananta Records Surakarta production process tool collection

The audio implementation in the Lokananta Records Surakarta virtual museum application is divided into 2 main parts, namely background audio and object information audio. The audio used in the application uses the MP3 digital audio encoding format. The audio editing process uses the Adobe Audition software, where the editing process is carried out such as cutting, adjusting the sound amplitude and reducing noise mainly on the recorded audio. Implementation of the Lokananta Records Surakarta virtual museum application (see Figure 11) was developed using the Unity game engine and game editor.

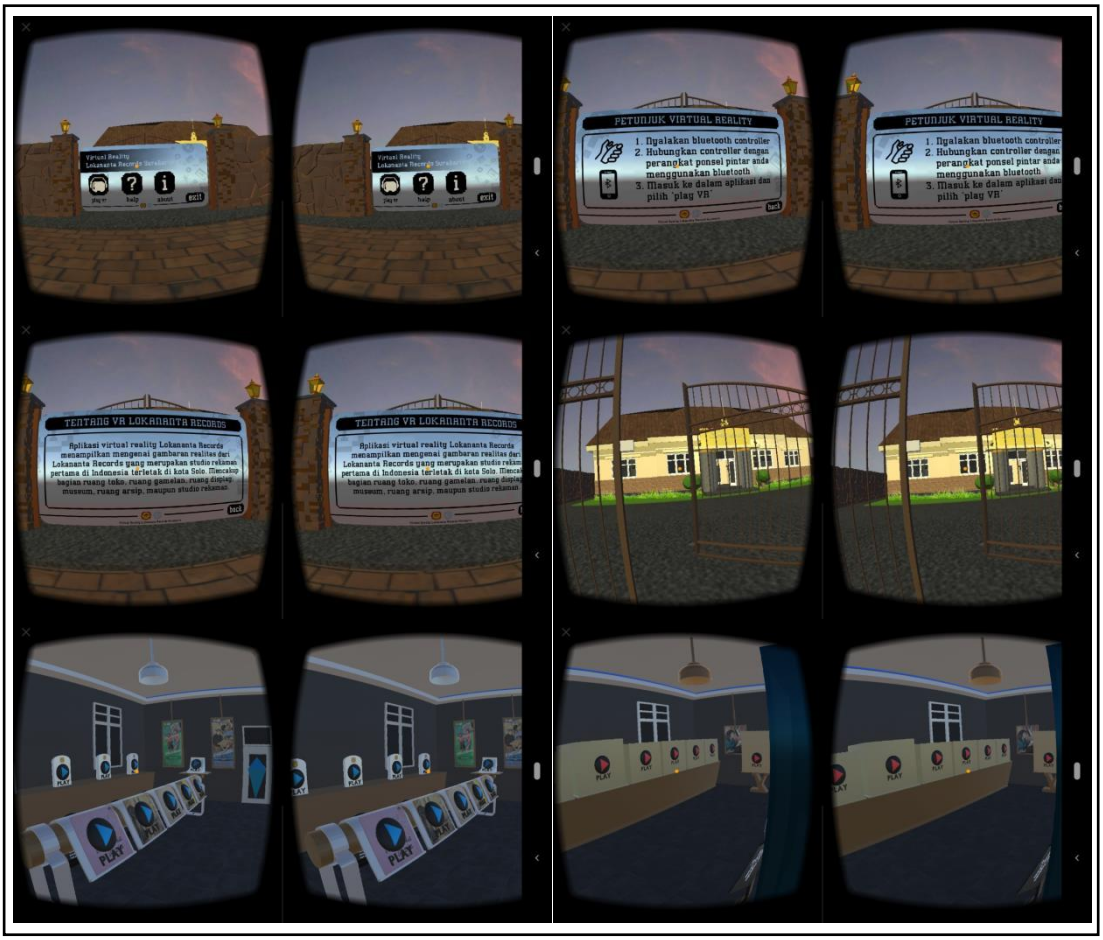

Figure 11. Implementation of Lokananta Records Surakarta virtual museum application

3.5 Testing

3.5.1 Functionality Testing

Functional testing is a test carried out to find out and check the running of various functions contained in the application being tested (see Table 1). The test is divided into two groups, the first is the interaction testing and application animation such as the interaction of the Play VR button, About button, Help button, Back button, Exit button and scene switching. In addition, testing is also carried out on loading scenes and 3-dimensional objects of buildings or spaces, such as logo scenes, the main building scenes and 3-dimensional objects of the main building, showrooms scenes and 3-dimensional objects in the showrooms and museum room scenes and 3-dimensional objects in the museum space.

Table 1. First group functional testing

No	*Testing*	*Test result*
1	*Functional and animated VR Play Button*	*Interactions and animations work well*
2	*Functional and animated About Button*	*Interactions and animations work well*
3	*Functional and animated Help Button*	*Interactions and animations work well*
4	*Functional and animated Back Button*	*Interactions and animations work well*
5	*Functional and animated Exit Button*	*Interactions and animations work well*
6	*Functional and animated Scene Switch*	*Interactions and animations work well*
7	*Logo scene and Logo design*	*Scenes and logo designs are successfully loaded when the application is run*
8	*Main Building Scene and Main Building 3-dimensional objects*	*Scenes and 3-dimensional objects are successfully loaded and displayed properly*
9	*Display Room Scene and 3-dimensional objects in the Display Room*	*Scenes and 3-dimensional objects are successfully loaded and displayed properly*
10	*Museum Room Scenes and 3-dimensional objects in the Museum Room*	*Scenes and 3-dimensional objects are successfully loaded and displayed properly*

The second group of tests (see Table 2) is testing the loading, interaction and animation of 3-dimensional objects in the main building, showrooms and museum room such as trees, gates, fountains, vinyl record, cassette tape, videotape, compact disc, collections of audio devices that have been used for the production process and along with information from objects that can interact with users.

Table 2. Second group functional testing

No	*Testing*	*Test result*
1	*Tree*	*3D object loaded successfully and can be animated well*
2	*Gate*	*3D object loaded successfully and can be animated well*
3	*Water fountain*	*3D object loaded successfully and can be animated well*
4	*Vinyl record*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
5	*Casette tape*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*

6	*Videotape*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
7	*Compact Disk*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
8	*Ampex Streo 2 pack Master Recorder 351-2P 1964*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
9	*TRIO CD-1040 40 MHz Oscilloscope*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
10	*High Band U Matic VTR HB 1985*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
11	*Phantom Power Supply 1985*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
12	*TRIO PAL Color Pattern CG-912*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
13	*TRIO AG-203 CR Oscillator 1985*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
14	*Oscillograph 292-6A91 1960*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
15	*AMPEX Master Recorder 1980*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
16	*STUDER Master Record AB0 1985*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
17	*Electro Sound Quality Control 1980*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
18	*Player Vinyl model Garard 301 1960*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
19	*Leitch Audio dan Video Distributor Amplifier*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*
20	*BINSON Echorec model PE603T*	*All parts of a 3-dimensional object can be loaded. Interaction and animations work fine*

3.5.2 Compatibility Testing

In this stage, application testing is carried out on several smartphone devices with different specifications, including the Xiaomi Redmi 4X, ASUS Zenfone 4 Max ZC554KL, Google Pixel and Samsung Galaxy S9+. The tests carried out included application installation, application loading, virtual reality loading, 3-dimensional objects handling, audio handling and rendering capabilities.

Table 3. Compatibility testing

No	*Device*	*Testing*	*Test Result*
1	*Xiaomi Redmi 4X, with specifications are Android 6.0.1 (Marshmallow) MIUI 11 operating system, Qualcomm MSM8940 Snapdragon 435 (28 nm) chipset, Octa-core 1.4 GHz Cortex-A53 CPU, Adreno 505 GPU, 16GB internal memory and 2GB RAM, 5.0-inch, 68.9 cm2 (~70.7% screen-to-body ratio) screen size with 720 x 1280 pixels resolution, 16:9 ratio (~294 ppi density).*	*Application installation*	*The installation process takes 39 seconds*
		Application Loading	*The loading process into the application takes 8 seconds*
		Virtual reality loading	*The virtual reality scene loading process takes 22 seconds*
		3D object handling	*All 3D objects can be displayed*
		Audio handling	*All audio can be heard well*
		Rendering ability	*Rendering is not good, FPS drops very often when running the application*
2	*ASUS Zenfone 4 Max ZC554KL, with specifications are Android 7 (Nougat)*	*Application installation*	*The installation process takes 49 seconds*

	ZenUI 4 operating system, Qualcomm MSM8937 Snapdragon 430 (28 nm) chipset, Octa-core 1.4 GHz Cortex-A53 CPU, Adreno 505 GPU, 32GB internal memory and 3GB RAM, 5.5 inches, 83.4 cm2 (~70.4% screen-to-body ratio) screen size with a resolution of 720 x 1280 pixels, 16:9 ratio (~267 ppi density)	*Application Loading*	*The loading process into the application takes 7 seconds*
		Virtual reality loading	*The virtual reality scene loading process takes 22 seconds*
		3D object handling	*All 3D objects can be displayed*
		Audio handling	*All audio can be heard well*
		Rendering ability	*Rendering is not good, FPS often drops when running the application*
3	*Google Pixel, with specifications are Android 7.1 (Nougat) operating system, Qualcomm MSM8996 Snapdragon 821 chipset (14 nm), Quad-core CPU (2x2.15 GHz Kryo & 2x1.6 GHz Kryo), Adreno 530 GPU, 32GB internal memory and 4GB RAM, and a screen size of 5.0 inches, 68.9 cm2 (~69.0% screen-to-body ratio) with a resolution of 1080 x 1920 pixels, 16:9 ratio (~441 ppi density)*	*Application installation*	*The installation process takes 31 seconds*
		Application Loading	*The loading process into the application takes 7 seconds*
		Virtual reality loading	*The virtual reality scene loading process takes 12 seconds*
		3D object handling	*All 3D objects can be displayed*
		Audio handling	*All audio can be heard well*
		Rendering ability	*Rendering is quite good, FPS is quite stable although sometimes drops occur in certain parts*
4	*Samsung Galaxy S9+, with specifications are Android 8.0 (Oreo) One UI 2.5 operating system, Exynos 9810 chipset (10 nm), Octa-core CPU (4x2.7 GHz Mongoose M3 & 4x1.8 GHz Cortex-A55), Mali- G72 MP18 GPU, 64GB internal memory and 4GB RAM, 6.2-inch screen size, 98.3 cm2 (~84.2% screen-to-body ratio) with 1440 x 2960 pixels resolution, 18.5:9 ratio (~529 ppi density)*	*Application installation*	*The installation process takes 27 seconds*
		Application Loading	*The loading process into the application takes 7 seconds*
		Virtual reality loading	*The virtual reality scene loading process takes 10 seconds*
		3D object handling	*All 3D objects can be displayed*
		Audio handling	*All audio can be heard well*
		Rendering ability	*Rendering goes well, FPS is very stable and doesn't drop*

3.6 Distribution

Applications that have been successfully tested are distributed in several ways, such as providing applications to partners, namely Lokananta Records Surakarta, the public or mobile application online stores.

4. CONCLUSION

The conclusions that can be drawn from this research, the implementation of the Lokananta Records Surakarta virtual museum application using virtual reality technology are as follows:

1. A Lokananta Records Surakarta virtual museum application has been built which shows the main building, showroom and museum room in the form of 3 Dimensional objects based on the shape of buildings, spaces and objects from Lokananta Records Surakarta. Applications can be run using a virtual reality headset and bluetooth remote controller for museum virtual exploration and objects interaction.
2. The Lokananta Records Surakarta virtual museum application that was built can run on android-based smartphone devices with minimal specifications, having an Application Programming Interface (API) version 4.4 (KitKat), having a Gyroscope sensor and 300MB of free storage.

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