GNG1103

Final Design Report

Aurora

Submitted by

Team E6

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1. Abstract

In partnership with the Ottawa Hospital, our team was challenged to develop a VR (Virtual Reality) application which could be used by cancer patients during their treatments (chemotherapy or radiotherapy treatments) to reduce discomfort.

Over the course for four months, our team developed *Aurora*: a passive VR game where the player rides a spaceship which flies by celestial objects in the Earth's solar system, including Saturn, Pluto, Uranus, other planets, and meteorites.

2. Introduction

VR (Virtual Reality) describes a realistic simulation of a game where the user wears specialized equipment (such as a headset) to enhance immersion and convince the user that the world they are in is "real."

In this project, we wish to reduce discomfort for cancer patients undergoing chemotherapy and radiation therapy treatments. To do this, we leverage the immersive aspect of VR; in layman's terms, we are using VR as a totally-immersive distraction from treatment, thereby making the treatment seem less stressful than it is. To make an analogy, it is less stressful to have a tooth pulled quickly while counting down than to have a tooth pulled slowly.

There were two obvious constraints at the beginning of this project: the limited mobility of the cancer patient, and a phenomenon called "VR" sickness. During treatments, cancer patients only have control of one or fewer arms, and may be prone to nausea with sudden or "out of body" movements such as teleportation, which are both common in most commercial VR games. Because of this, there is a need for VR games which consider these constraints in order to allow cancer patients to use VR during their treatments.

3. Related Work

Previous work has shown VR to be effective for pain management in burn victims. In the game *Snow World,* players are brought through a pre-defined path in frozen tundra setting where they throw snowballs at a variety of targets (e.g. penguins, snowmen, and mammoths) for points.

Previous work has also shown VR to be effective for chemotherapy patients, but information on the games used is more sparse. One study used a VR adaptation of *Chicken Little* for your patients*,* and a *Fast and Furious* for older patients, but either game might be prone to causing nausea.

4. User Requirements

Our team met with one cancer survivor during the empathizing phase of our project, and one during the prototyping stage. During the first meeting, our team asked questions and identified user requirements ("interpreted needs") from our user's answers. This process is recorded in the table below:

Question	Response	Interpreted Need
During chemotherapy treatments, what sorts of activities do patients do now?	Reading, watching movies, music, chatting, eating lunch.	The VR game should require little effort to play.
What is the average age of a patient who might use VR during chemotherapy?	All ages, but usually older.	The VR game must appeal to a variety of ages.
What level of locomotion is appropriate?	Very slow motion might be appropriate, but teleportation would be disorienting.	The VR game must only have slow movement. The VR game must not include jarring teleportation.
What type of interaction, or any, would be ideal for cancer patients?	Controllers should be very straightforward and easy. Additionally, radiation patients must stay very still.	The VR game must have simple controls.
Should a game be more relaxed, or more distracted?	Do both! It depends on what we're seeing, and on the patient. Relaxed things can be interesting.	The VR game must be interesting.
How long are radiation therapy sessions.	It depends; up to half an hour, probably 15-30 minutes.	The VR game must be 15-30 minutes long.

5. Benchmarking

Using our user requirements, we performed benchmarking between three possible solutions: a realistic space journey, a semi-realistic space journey, and an absurdist space journey (see "Appendices"). We concluded that the semi-realistic space journey was the best solution for our problem, because it is primarily serious in nature while allowing for an appropriate level of comedic elements during the game.

6. Problem Statement

A need exists for a VR application which can reduce discomfort during chemotherapy and radiation therapy treatments for cancer patients; the VR game must be interesting to a variety of users, require little to no input from the patient, and must *not* induce nausea.

7. Project Plan & Tracking

In our initial project plan, we assigned tasks using a Gantt Chart (see "Appendices").

As the project progressed, we used the Gantt Chart as a guideline for our "best case scenario" and set achievable goals on a weekly basis concerning time constraints and goals for that week.

8. Bill of Materials

Bill of Materials				
Item #	**Item Description**	**Quantity**	**Unit Price ($)**	**Amount ($)**
1	Planet Creator	1	15.00	15
2	Sun Surface Shader	1	4.99	4.99
3	Sun Shader	1	4.99	4.99
			Total (USD):	24.98

9. Design Features & Game Renders

Upon starting the game, the user sees a start menu. Once the user selects “Start,” the game begins, starting a “blastoff sequence” which fades to black before showing the user a variety of celestial objects.

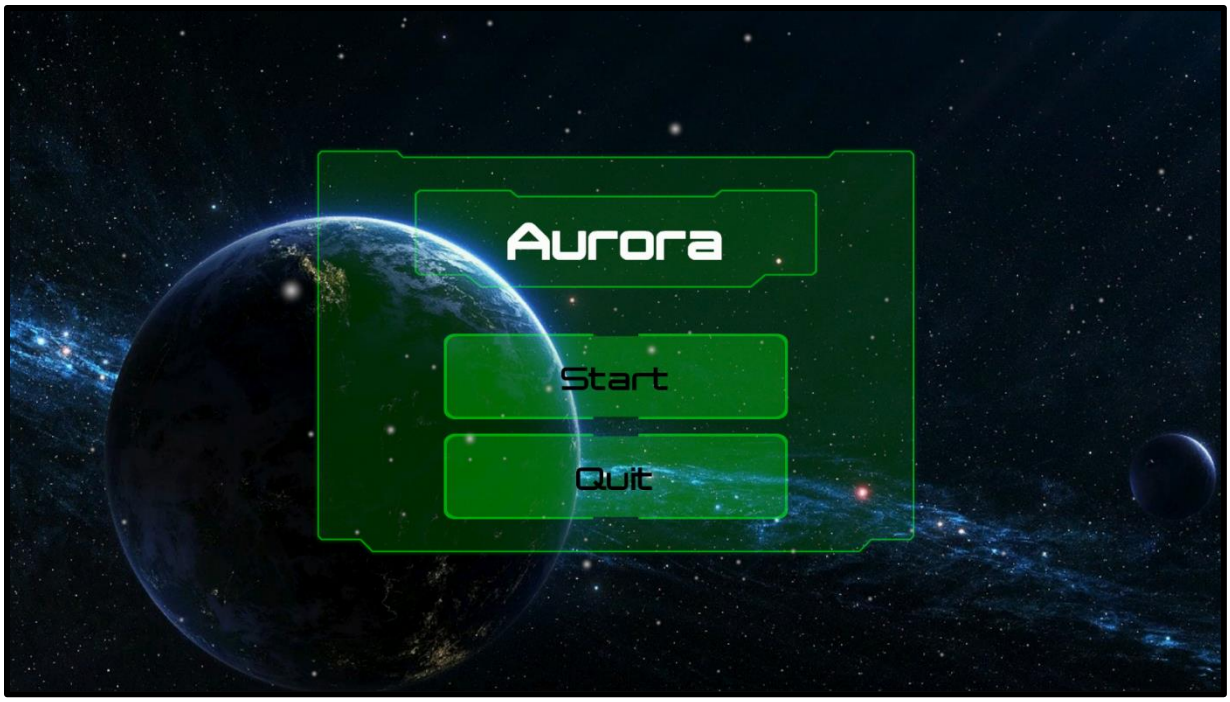

Figure 1: Start screen.

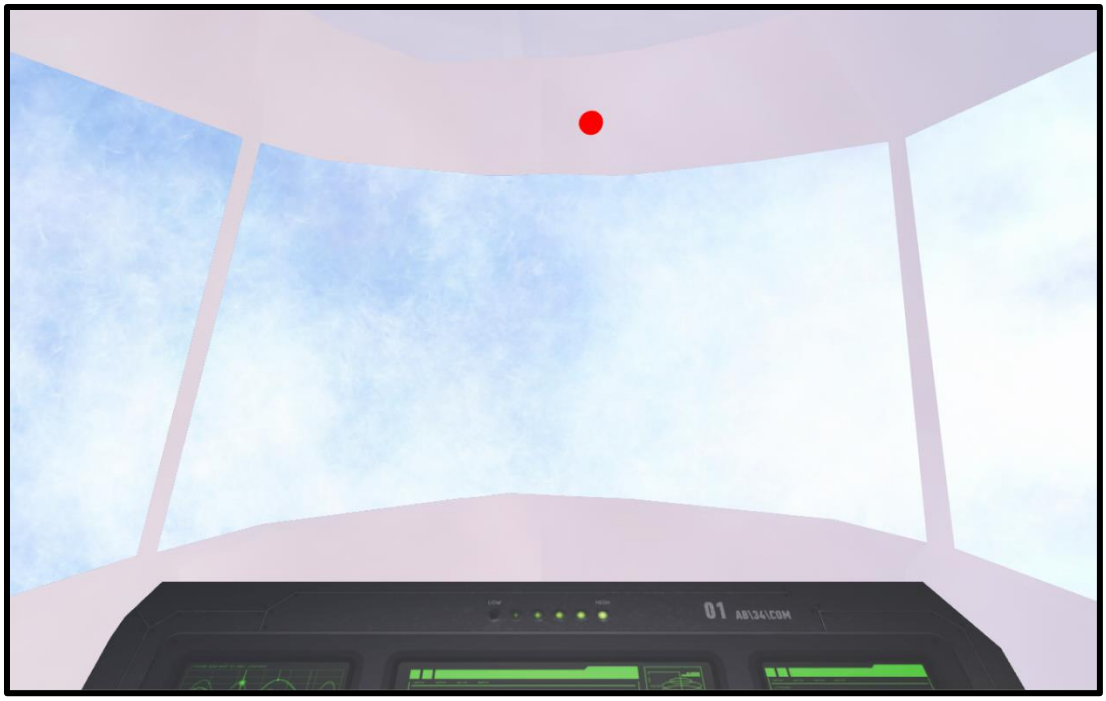

Figure 2: Game render of the "blastoff sequence."

Figure 3: Game render of Mars.

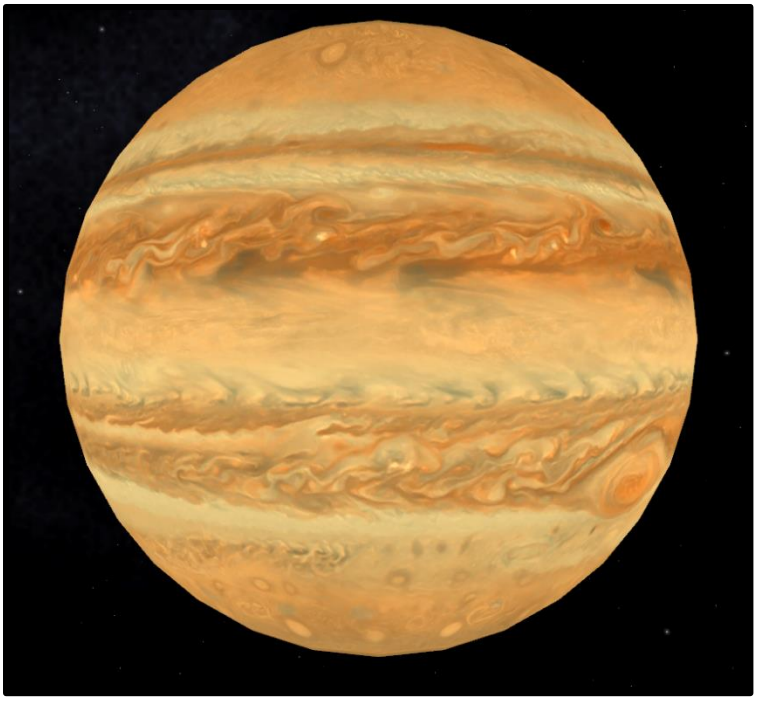

Figure 4: Game render of Jupiter.

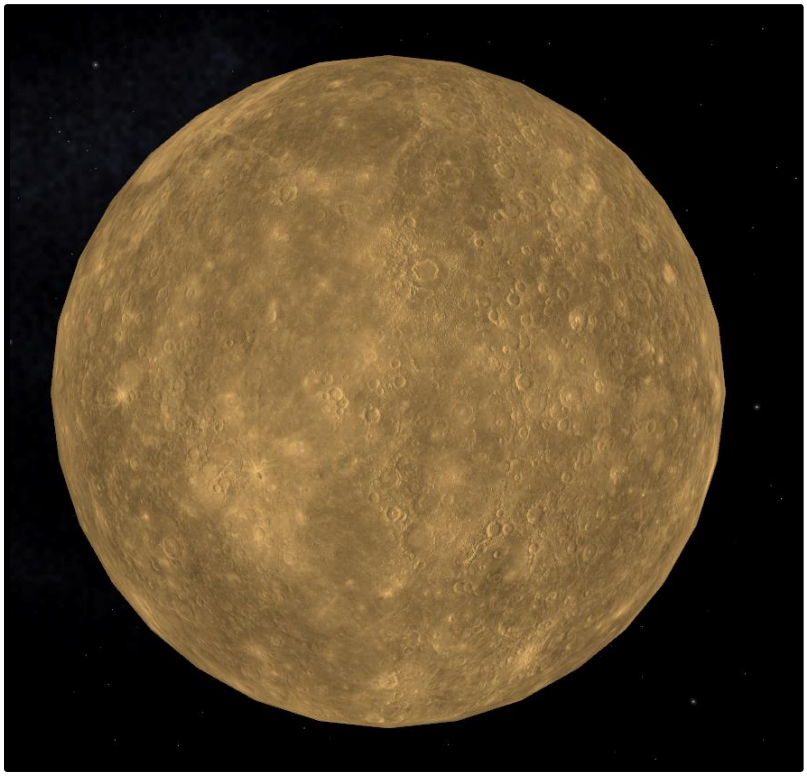

Figure 5: Game render of The Mercury.

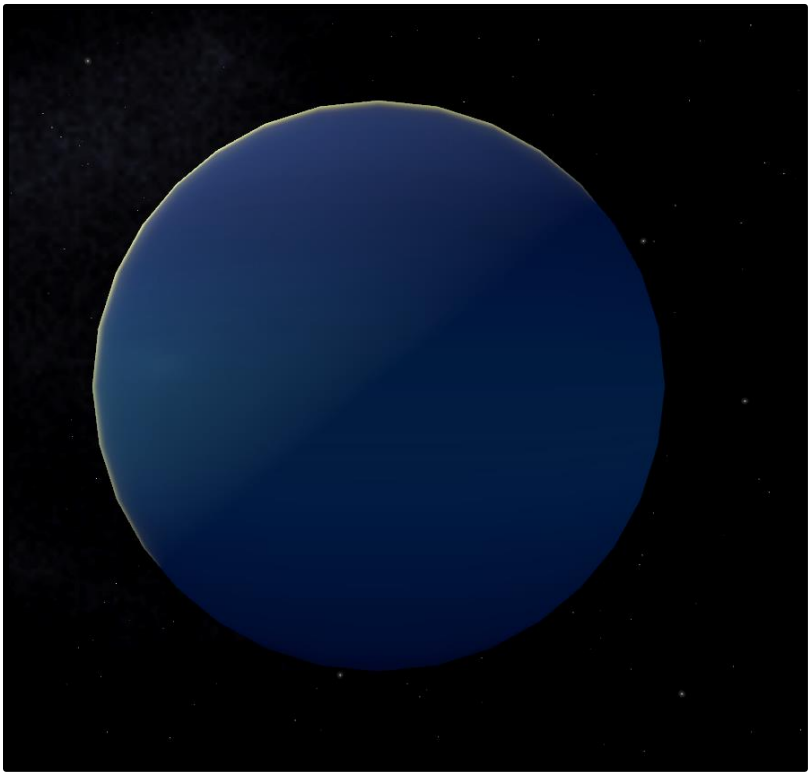

Figure 6: Game render of Neptune.

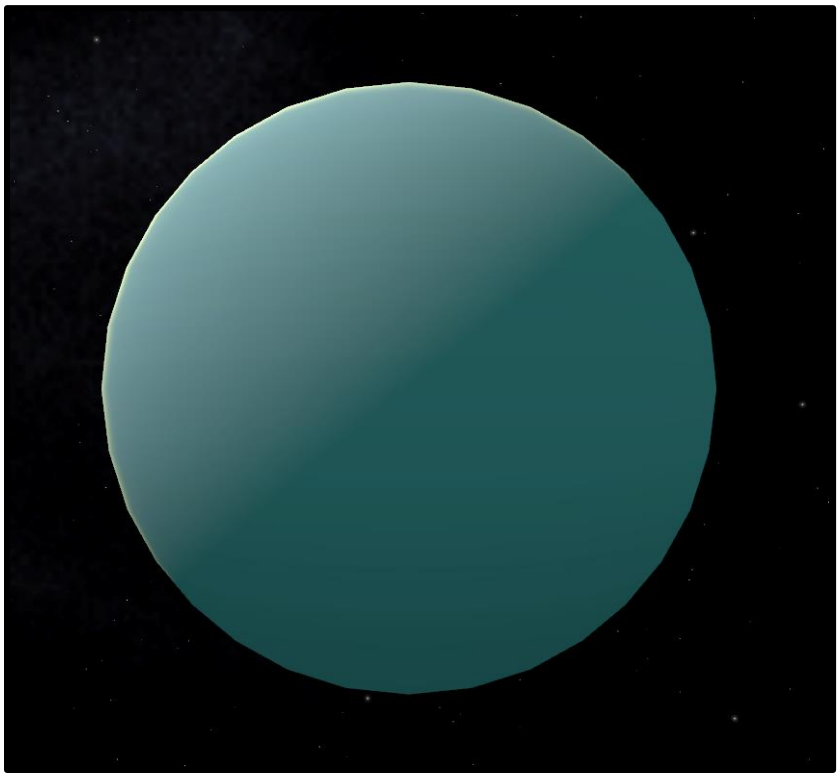

Figure 7: Game render of Uranus.

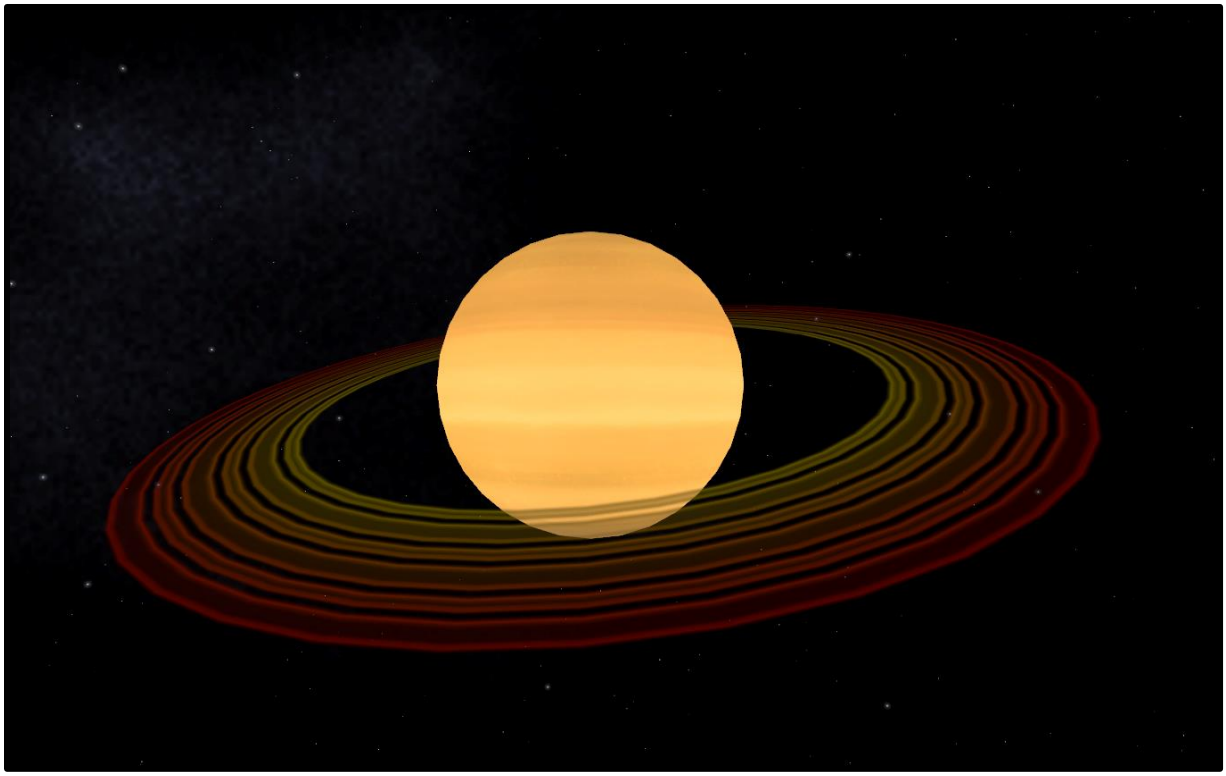

Figure 8: Game render of Saturn.

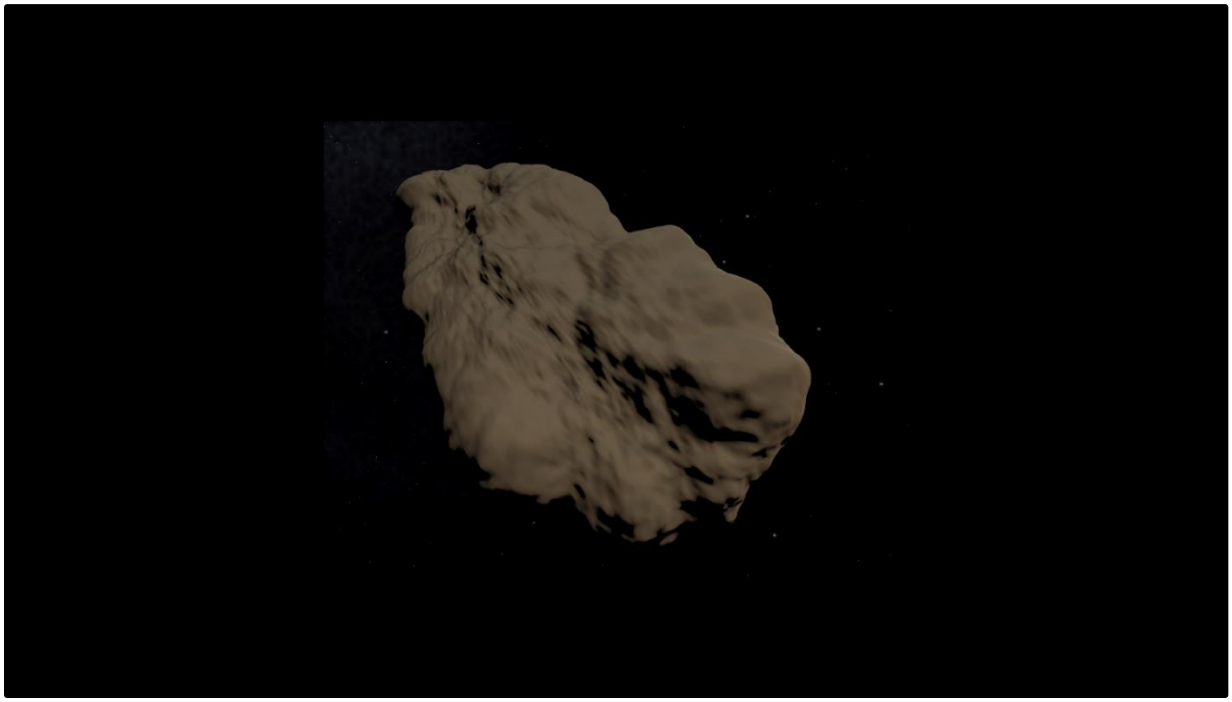

Figure 9: Game render of an asteroid.

Figure 10: Game render of an asteroid.

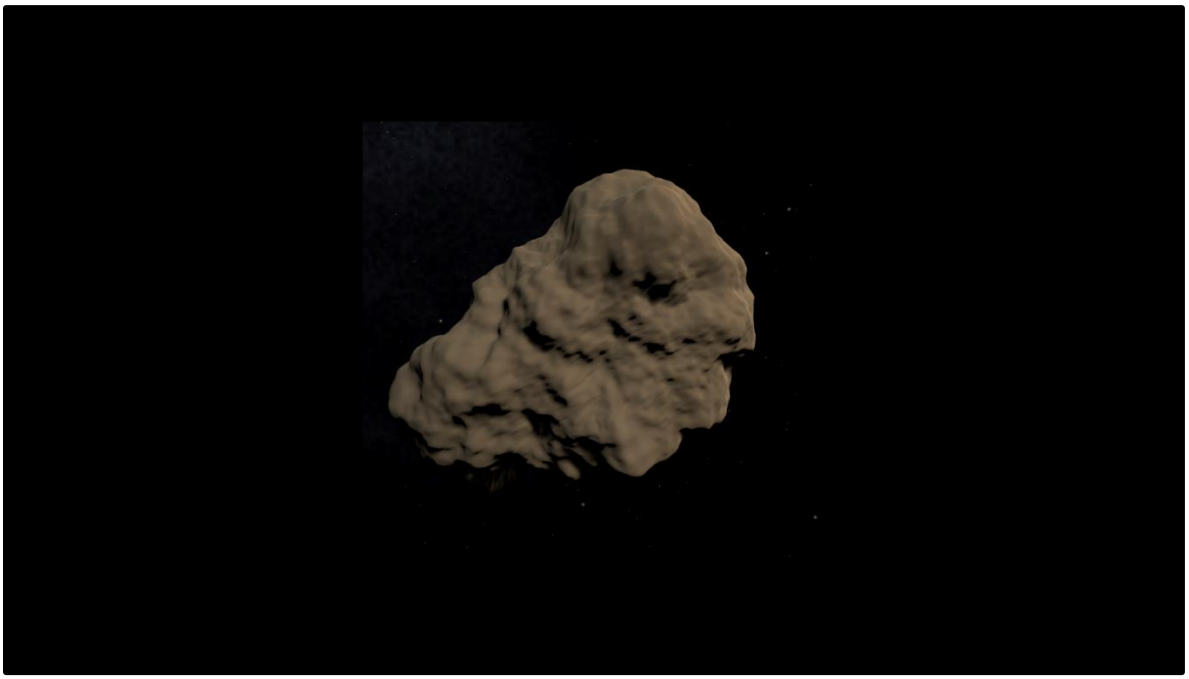

Figure 11: Game render of an asteroid.

Figure 12: Game render of an asteroid.

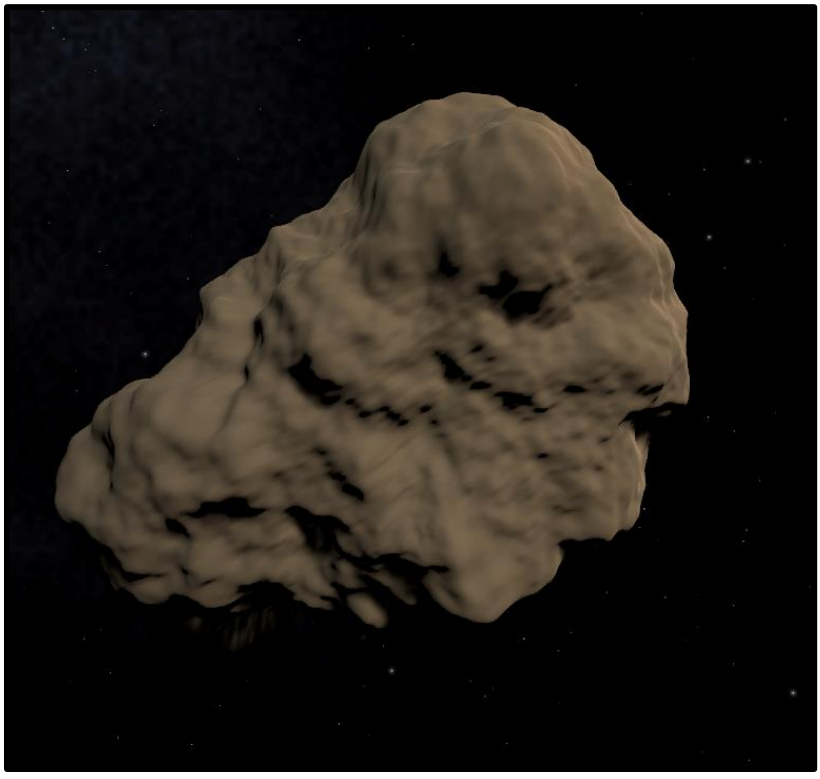

Figure 13: Game render of an asteroid.

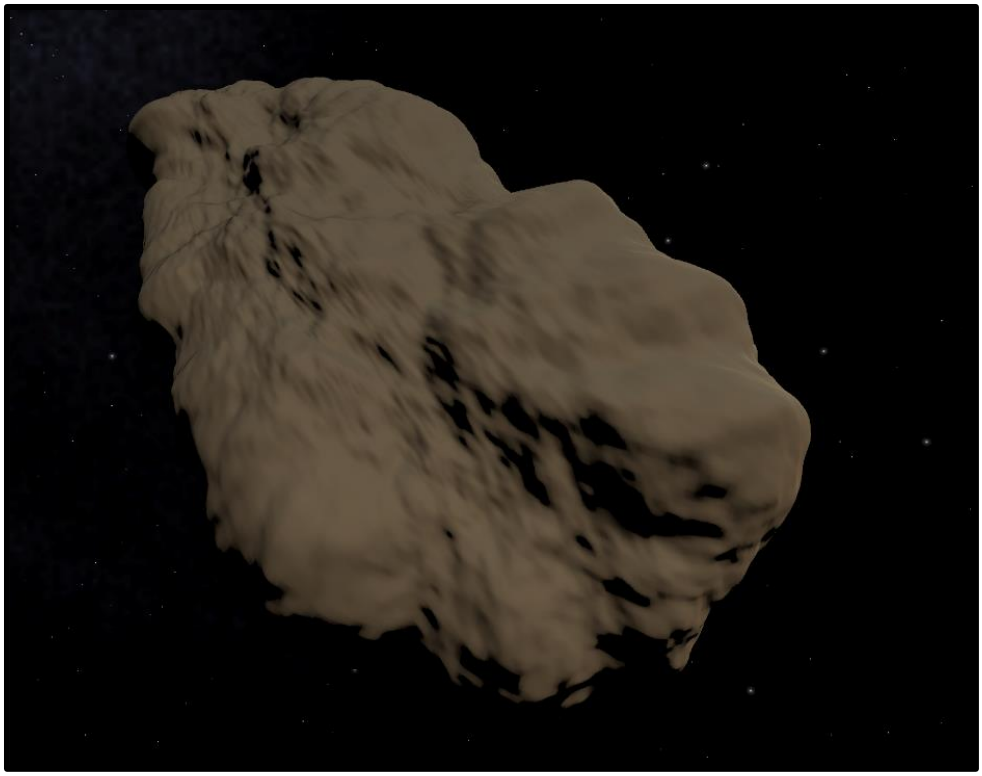

Figure 14: Game render of an asteroid.

10. Prototyping Strategy

Prototype	Goals	Success criteria
1	- Implement skybox changes and the spaceship window (proof of concept).	- Transitions must feel natural. - Transitions should not be prone to causing nausea.
2	- Finalize the skybox and cockpit layout. - Add planets to the scene. - Add movement through space.	- The cockpit should be “believable.” - Movement should appear natural. - Second client meeting will be used to assess how game elements look and feel to an “outsider.”
3	- Add meteors to the design. - Fix filesharing problem. - Finalize placement of objects and spaceflight.	- The meteors should be “believable.” - Filesharing should be successful (binary state of success). - Spaceflight should be “believable” and aesthetically pleasing.

11. User Manual

To begin the game, press the “Start” button on the title screen. From there, simply sit back and relax – no user input is required for the rest of the game, except to look around as desired at planets and other celestial objects which enter the field of vision of the player.

12. Conclusions & Recommendations for Future Work

Our team successfully constructed a VR application which suited our clients' needs. The space journey did not induce nausea during testing, was highly visually appealing, and would be an appropriate game for patients seeking a laid-back experience. Additionally, because our game only requires one button press to begin, it could be appropriate for both chemotherapy and radiotherapy patients.

If our team was to continue developing this game, there are a variety of features that could be added to make the game even more appealing to patients. For examples, in early stages of design we wanted to incorporate a "pilot" avatar that could sit with the player during their journey. Due to time constraints this could not be added.

Going a step further, some patients might like if that pilot could be played by a third party (such as a family member outside of the room during radiotherapy treatments) to give the illusion that he player has a person nearby during their treatments. This could even allow for family to "visit" the patient from afar, perhaps even from across the world; this would mean that wherever the patient's loved ones are, they could always visit during treatment.

Regarding aesthetics, some improvements could be made to the meteors in the game. Our final meteor design did not meet our standards, but we did not have time to implement the newer, more realistic meteor model one of our members constructed after finalizing the design (which was only used for our banner on Design Day, and not the game itself (see "Appendices").

13. Works Consulted

Hoffman, H. G., Patterson, D. R., Seibel, E., Soltani, M., Jewett-Leahy, L., & Sharar, S. (2008). Virtual Reality Pain Control During Burn Wound Debridement in the Hydrotank. The Clinical Journal of Pain, 24(4), 299-304.

Morris, Louw, & Crous. (2010). Feasibility and potential effect of a low-cost virtual reality system on reducing pain and anxiety in adult burn injury patients during physiotherapy in a developing country. Burns, 36(5), 659-664.

Patterson, D., Jensen, M., Wiechman, S., & Sharar, S. (2010). Virtual Reality Hypnosis for Pain Associated With Recovery From Physical Trauma. International Journal of Clinical and Experimental Hypnosis, 58(3), 288-300.

Schmitt, Hoffman, Blough, Patterson, Jensen, Soltani, . . . Sharar. (2011). A randomized, controlled trial of immersive virtual reality analgesia, during physical therapy for pediatric burns. Burns, 37(1), 61-68.

Schneider, S., & Workman, M. (2000). Virtual reality as a distraction intervention for older children receiving chemotherapy. Pediatric Nursing, 26(6), 593-597.

14. Appendices

Design Criteria	Weight	Solution #1 (w/ Muri) (w/ Ryan)	Solution #2 (w/ Muri) (w/ Ryan)	Solution #3 (w/ Muri) (w/ Ryan)
Presence of artificial motion	4	3	3	3
Appropriate content	2	3	3	3
Simple setup (time it takes to set up the game)	3	3	3	3
Setup can be fulfilled by an attending nurse.	4	3	3	3
Calming, soothing, peaceful content.	4	3	3	3
Meets dexterity requirements.	5	3	3	3
Simple controls.	5	3	3	3
Variable length of experience.	1	3	3	3
Appropriate duration depending on treatment.	4	3	3	3
Presence of NPCs in the virtual experience.	3	3	3	3
Calming audio.	4	3	3	2
Entertainment value.	5	1	3	2
Total:		122	132	119

Figure 15: Benchmarking.

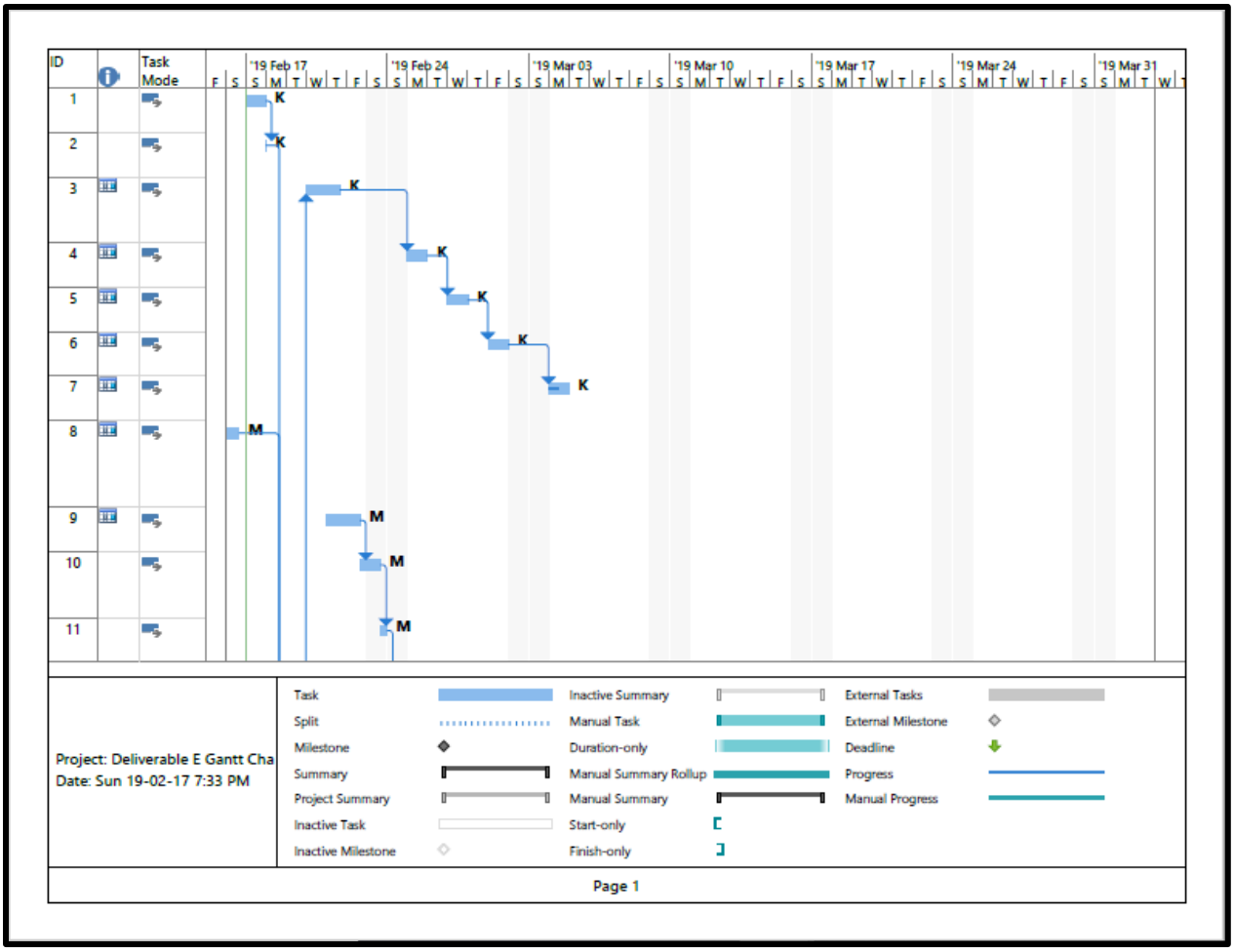

Figure 16: Gantt chart part 1.

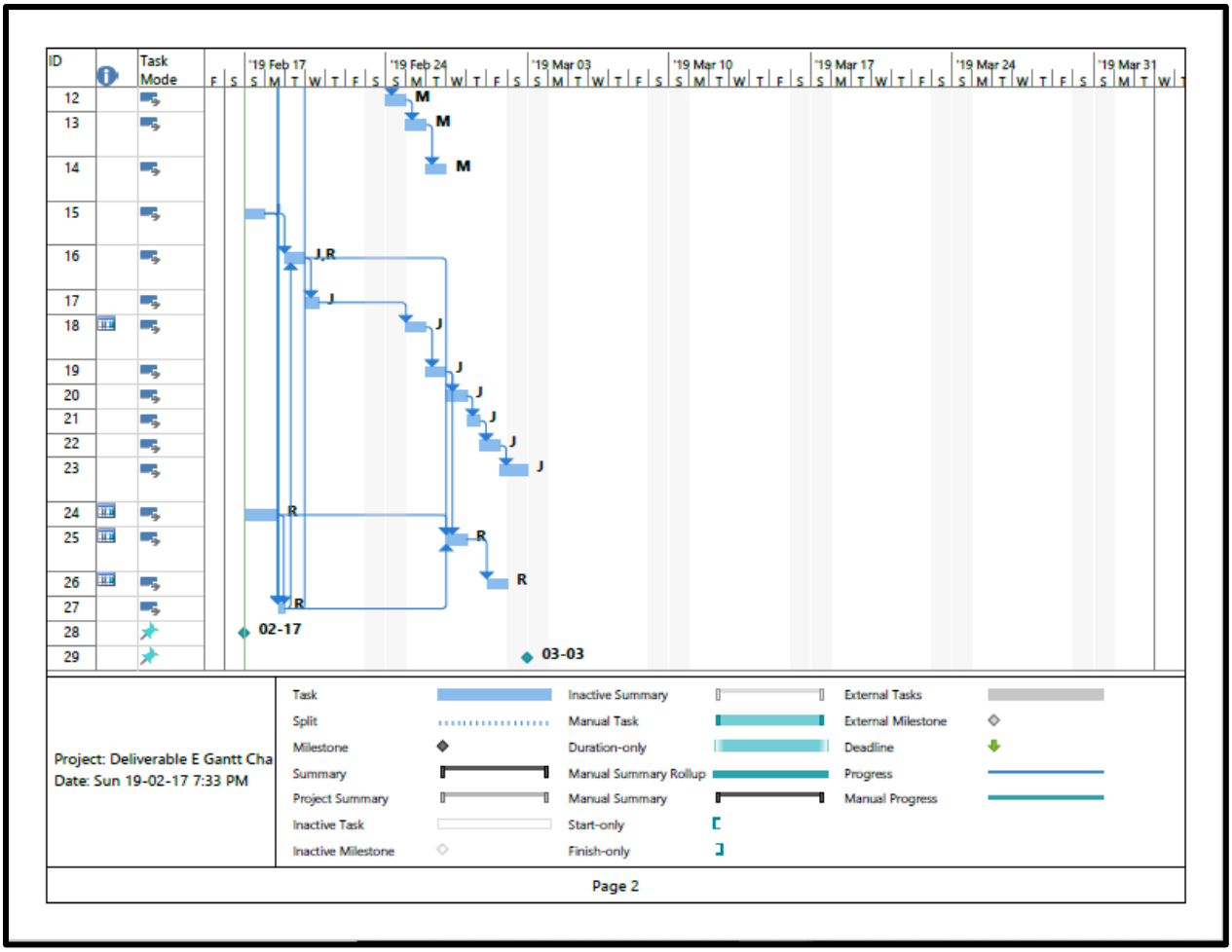

Figure 17: Gantt chart part 2.

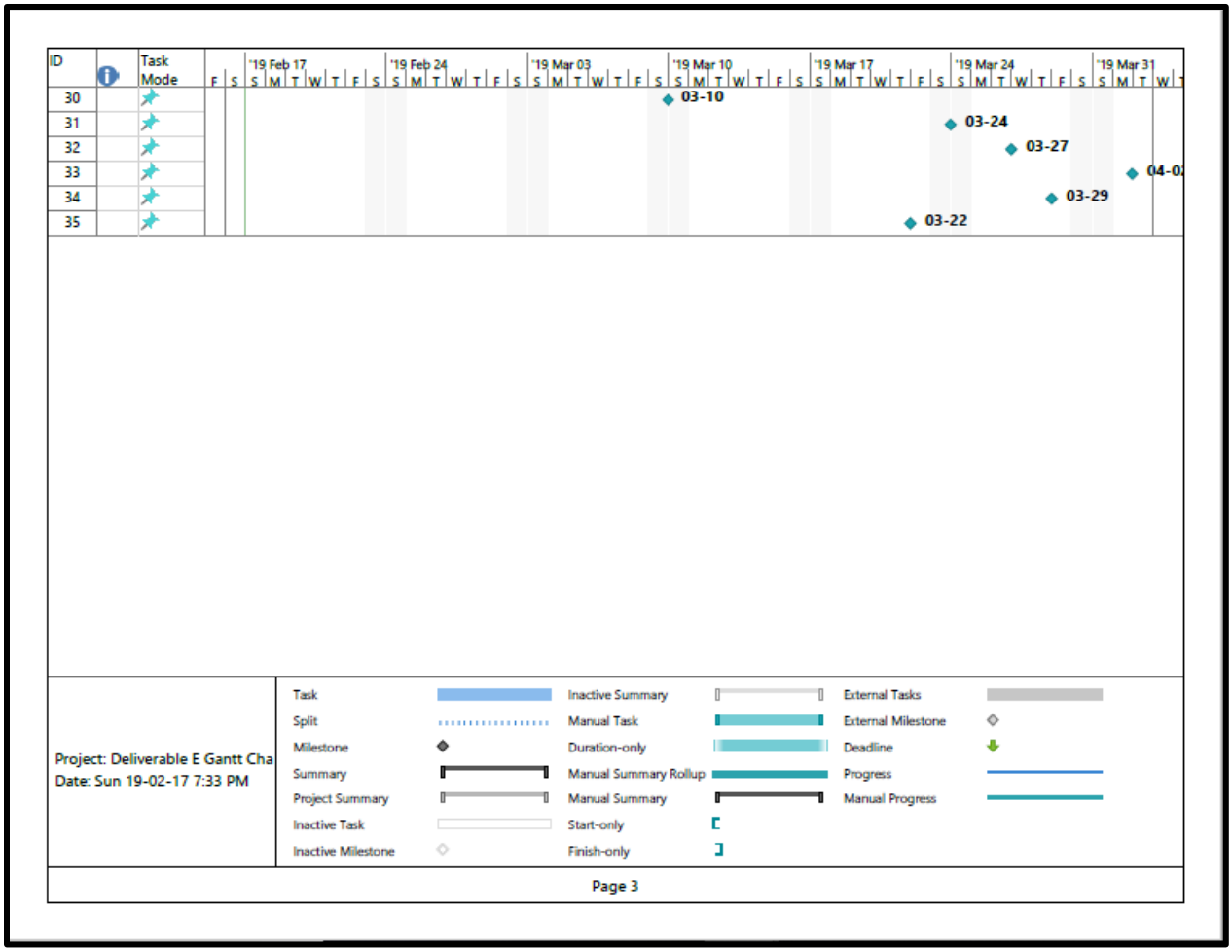

Figure 18: Gantt chart part 3.

Figure 19: Design Day banner, including updated asteroid models.