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ePoly ECE-GY 5213

Introduction to Systems Engineering

Homework 2

1. Identify a recent development of a complex system of which you have some knowledge. Describe the need it was developed to fill and the principle ways in which it is superior to its predecessors.

Answer 1. One recent development of a complex system I have knowledge of is the development of VR therapy in the field of medicine and telemedicine for the treatment of mental health conditions such as anxiety and PTSD. VR therapy was developed to fill the need for a more accessible, effective, and customizable treatment option for mental health conditions such as anxiety and PTSD. Traditional treatment methods, such as medication and psychotherapy, can be costly, stigmatizing, and have limited effectiveness for some patients.

A study conducted by the University of Southern California Institute for Creative Technologies found that VR exposure therapy was effective in reducing symptoms of PTSD in veterans. The study used a VR environment that simulated a virtual Iraq, where participants could interact with objects and people in a safe environment while receiving exposure therapy. The results showed a significant reduction in PTSD symptoms in the participants who received VR therapy compared to those who received traditional therapy.

Compared to its predecessors, VR therapy offers several key advantages. Firstly, it provides a more immersive and customizable environment for patients to face their fears and anxieties in a safe and controlled setting. This allows for more precise and personalized treatment for patients, as they can repeatedly experience the situations that trigger their symptoms and gradually desensitize themselves to them.

Secondly, VR therapy allows for the collection of objective data on patient behavior and symptoms. This data can be collected through bio-signal

recognition technology, such as heart rate monitors and motion sensors, and analyzed using artificial intelligence algorithms. This allows for a more accurate assessment of patient progress and can help guide treatment decisions.

Thirdly, VR therapy is more accessible and convenient than traditional treatment methods. Patients can receive treatment from the comfort of their own homes, eliminating the need for travel and reducing the time and cost associated with in-person appointments. This can also help to reduce the stigma associated with mental health conditions, as patients can receive treatment in a private and confidential setting.

Overall, VR therapy represents a significant advancement in telemedicine for mental health conditions. It offers a safe, customizable, and accessible treatment option for patients who may have difficulty with traditional treatment methods, and has the potential to become a widely used and effective tool in mental healthcare.

2. The space shuttle is an example of an extremely complicated system using leading edge technology. Give three examples of shuttle components that you think represented unproven technology at the time of its development.

Answer 2. The Space Shuttle was a revolutionary spacecraft that represented a significant technological achievement in space exploration. It was designed to be reusable, allowing NASA to conduct frequent and cost-effective missions to space. The Space Shuttle was an incredibly complex system that used leading-edge technology, with many of its components representing unproven technology at the time of its development. In this response, we will explore three examples of shuttle components that represent unproven technology.

1. **<u>Major engines:</u>**

The Space Shuttle's main engines were a remarkable technological feat. They were designed to be reusable and to withstand the extreme temperatures and pressures of spaceflight. The engines used liquid hydrogen and liquid oxygen as propellants, which was a new technology at the time. The engines were also designed to be throttleable, which meant that they could be adjusted to provide different levels of thrust depending on the needs of the mission.

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The Space Shuttle's main engines used a regenerative cooling system, which allowed them to operate at extremely high temperatures without melting. The engines were lined with channels that circulated liquid hydrogen, which absorbed the heat generated by the combustion process. This technology was unproven at the time, and NASA had to develop new manufacturing processes and materials to create the engine's complex cooling channels.

2. **Thermal protection system:**

The Space Shuttle's thermal protection system was an essential component that protected the spacecraft from the extreme temperatures of reentry. The system consisted of thousands of heat-resistant tiles that were glued to the shuttle's outer skin. The tiles were made of a lightweight material called silica, which had never been used before in such large quantities in a spacecraft.

The thermal protection system was an unproven technology at the time of its development, and NASA had to overcome several engineering challenges to make it work. For example, the tiles had to be extremely lightweight and durable, but also able to withstand the intense heat of reentry. NASA engineers had to develop new materials and manufacturing processes to create tiles that met these requirements. The thermal protection system was critical for the safe return of the shuttle and its crew.

3. **Landing gear:**

The Space Shuttle's landing gear was also an innovative technology at the time. The shuttle had a unique configuration with a nose landing gear and two main landing gears located under the wings. The landing gear was designed to absorb the shock of landing and to provide a stable platform for the shuttle on the runway.

The landing gear was an unproven technology because it had to be retractable to fit inside the shuttle's fuselage during launch and reentry. This required the landing gear to be compact, lightweight, and reliable. NASA engineers had to develop a complex hydraulic system to extend and retract the landing gear, which added to the overall complexity of the spacecraft.