Motion of the Spheres: Constructing a Compact Mechatronic Orrery
(Technical Paper)

Public perception of entertainment technologies and the scientific effects of those technologies on the brain development of children
(STS Paper)

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction:

Television has long been thought to rot your mind. I believe almost everyone who watches television has heard that adage. This has been something that has been told to children since the early days of television (Fields, 2016). Children today are growing up with newer and fast developing entertainment technologies. Kids must navigate their childhood with a completely different set of ways that they can entertain themselves. Each new technology presents a new set of uses and a new set of ways that it could affect children. With the overflow of new technologies, children will also grow up choosing different technologies as their source of entertainment, so this divide of technologies could cause children to grow up differently. This was evidenced by Bernstein and Crowley in their paper (Bernstein & Crowley, 2008), with the argument that children who live among robots may change the way they think about technology, and the way they differentiate robots from other more commonplace entities. Additionally, each technology produces more fear in the parents of how it could be affecting the development of their children.

This phenomenon of fear of a new entertainment technology is not a new one however. Back in the 1800's, fiction books were the subject of ridicule. They were not seen as educational and because of its fun nature, it was thought to "make your mind flabby" (Bartlett, 2014). Radio also gained popularity rapidly and "From the outset there were those who proclaimed radio's possibilities for either 'good of evil.' ….. that it might possibly serve as a means for the 'salvation of democracy,' a tool to advance education ….. 'Here is a new power inconceivable in magnitude. How is it to be controlled'" (Dennis, 1998, p. 34). Although radio had its proponents, there were still plenty of worries over its effects advocated in the media. A similar sentiment was expressed when television gained popularity in the 1940's and 1950's. Was television and its oftentimes violent media going to negatively affect the development of children? Its popularity

skyrocketed causing an even larger worry that it would become too popular before any real scientific data could be taken.

Now it seems as though virtual reality can be a source of worry as well. It's all-encompassing nature and entertainment value can lead to the same type of worries as with books, radio and television. With all these negative effects in mind, positive attitudes and effects towards entertainment technology have grown, especially with regards to educational benefits. There has been links to development of mathematical abilities, language skills, emotional intelligence, discipline, and talent development (Linnik, 2018). I had always believed VR to be a way to play video games, but using this technology as a way for education has greatly increased the positive benefits of these technologies.

The technical portion of this thesis will talk about a fully manufactured and reliable orrery system, created in the hopes that it will be placed in the Mechanical Engineering building at the School of Engineering at the University of Virginia. as an educational tool with fun aesthetics. The STS portion of this thesis will investigate the media portrayal of television on children brain development, and if studies shown support this portrayal. Then parallels will be discussed that can be drawn between television and virtual reality to see what conclusions should be drawn about the neurological impacts of virtual reality.

Technical Topic:

Background Info

Orreries are mechanical models of the Solar System that represent the positions and motions of the planets and moons. A mechanical arm can be turned so the correct speed and position of the planets can be shown. Traditional orreries are created with complicated gear ratios and lever arms stemming from a concentric shaft (see Figure 1).The complication to this design is that you cannot look into the future very far, unless you plan on spinning the gears hundreds of times, which will be time consuming. Traditional orreries are also inefficient and will lose accuracy as you continue to spin the planet because of imperfections with gears (Cooke, n.d.).

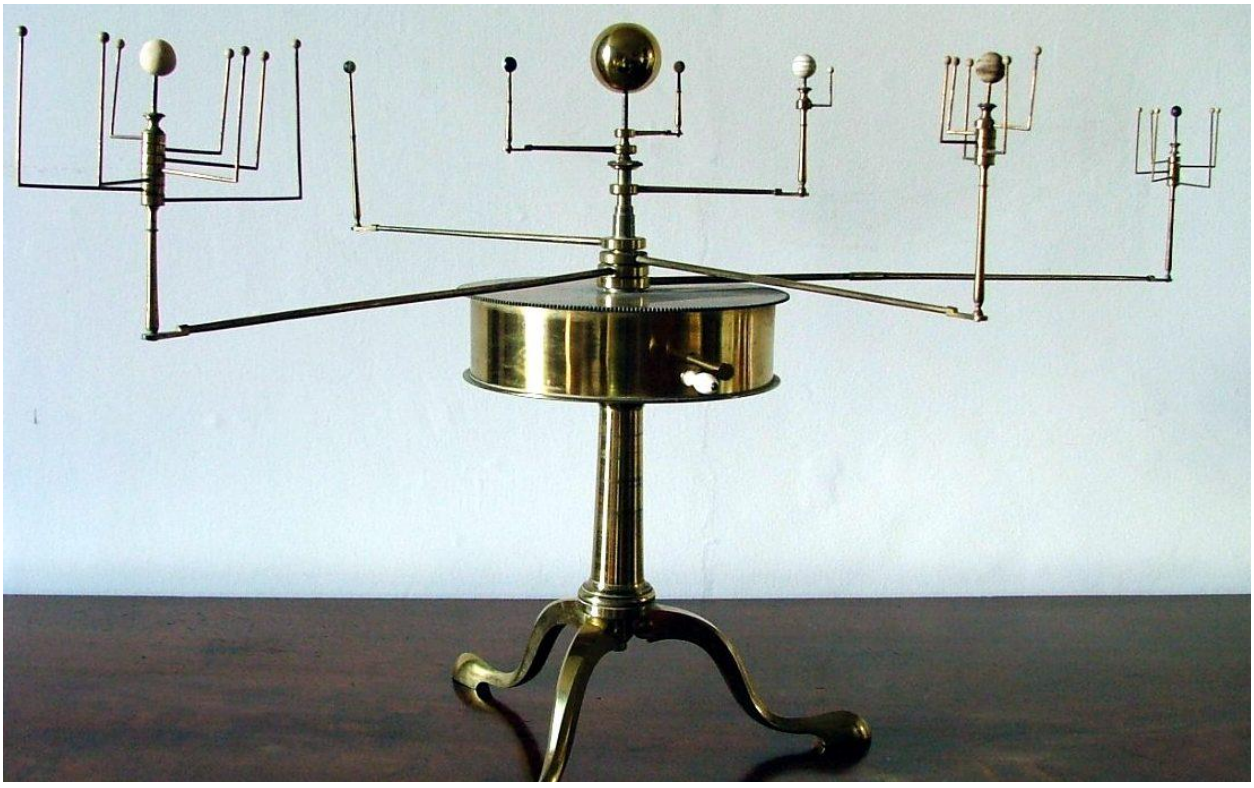

Figure 1: Antique orrery built by Gilkerson & Co in 1810 currently displayed in the Armagh Observatory, From *Universe Today*, Williams, 2016

Purpose

The purpose of creating a mechatronic orrery is to demonstrate in a unique and fun way, the positions of the earth and moon, relative to the sun. This project will create a unique, aesthetically pleasing and accurate model of the Earth, Moon and Sun, while educating people on the seasons, moon phases, eclipses and so on.

Design

The final design will consist of a sun and an earth and moon that will rotate around the sun. The sun itself will not be a traditional sun in that it will be a more artistic than strictly accurate representation. However, the sun will contain a lighting fixture that will shine light on the earth as well as the moon. As the earth rotates, the light will show how the seasons are made relative to the earth's atmosphere. As the light shines on the moon, it will show a rough estimation of how the phases of the moon are created. There will also be an electronic display that will show the phase of the moon as well as the date and the position of the earth. The orrery will have two modes. One mode is where the orrery will rotate on its own at a constant space, showing how the earth and moon are revolving around each other and the sun. The second mode will involve the user input in which a user can put in a date, and the orrery will automatically rotate to show the earth and moon's position at that time. It will also be able to indicate the next eclipse, as well as other events regarding the lunar cycle.

Methods: 3D Printing and laser cutting (rapid prototyping)

Our project will extensively employ two types of rapid prototyping that are available to mechanical engineering students: 3D printing and laser cutting. 3D printing is an additive

process where an object is created by laying down successive layers of material until the object is created. Extremely complex geometries can be sliced into thin layers and quickly built from the bottom up(Robertson, 2021). Laser cutting is a fabrication process that, “uses a thin, focused, laser beam to cut and etch materials into custom designs, patterns, and shapes as specified by a designer” (Obudho, 2019). Using these methods allows us to quickly build parts with complex geometries and precise features while constantly iterating on our design.

Methods: Microcontrollers vs antique

Mechanical orreries, while breathtaking, reflect traditional mechanical engineering principles, producing precise motion using gears and other mechanical components. With the emergence of cheaper electronic components, most notably microcontrollers, over the past couple of decades, antique mechanisms have been increasingly replaced by mechatronic systems. A mechatronic system is characterized by one or more sensors feeding information to a microcontroller, which is controlling the actuation of a motor. Mechatronic systems improve upon antique mechanisms by simplifying the creation of complex mechanical motions. Our mechatronic orrery will allow us to improve upon antique mechatronic orrery designs by allowing user input. The user will input a date, and the orrery will display the position of the earth and moon in their orbits on that date. This can only be accomplished using servo motors. Servo motors use a closed-loop control system to “allow for precise control in terms of angular position, acceleration, and velocity” (Lavaa, 2021).

STS Topic:

To dive deeper into the problems of entertainment technologies impacts on child brain development and the possibly skewed media portrayal of those impacts, I will draw upon the Social Construction of Technology (SCOT) that was explained well in Pinch and Bijker's "The Social Construction of Facts and Artefacts." (1984). In the paper, Pinch and Bijker go in depth about the concept of a 'relevant social group,' interpretative flexibility and closure/stabilization.

The idea of the relevant social group is by far the simplest concept of the three described above. The basic idea was best explained here when the author stated, "In deciding which social groups are relevant, the first question is whether the artifact has any meaning at all for the members of the social group under investigation" (Pinch & Bijker, 1984, p.414). This seems simple, and the relevant social groups that will be looked upon will first be questioned as to what meaning television and virtual reality poses to them. The relevant social groups that can be explored are obviously the users (children) and the consumers (parents). They obviously have stakes in the technology as it is affecting them the most directly. The less surface level relevant social groups will include the manufacturers of television and virtual reality, software developers for games on virtual reality, and television programmers. These companies will be affected by public perception and demand. If education is demanded more, then they will be forced to create more education-based content. If the media portrays them as villains for creating violent media, it may influence them.

The second idea for SCOT is interpretative flexibility, which is the concept that science and technology are socially constructed and the relevant social groups we discussed earlier, interpret the technology differently. In the case of this paper, television and virtual reality are the technical objects that are being interpreted. The users and consumers are children and their

parents respectively, and the companies that make the technical objects have designed uses for their products. Interpretative flexibility comes into play when users and consumers of television and virtual reality stray from the intended use. Obviously, with technologies such as television and virtual reality there are huge ranges of intended uses, so the interpretation is wide ranging as well and will be explored in this paper.

Finally, closure is described by the author as "the stabilization of an artifact and the 'disappearance' of problems. To close a technological 'controversy' the problems need not to be *solved* in the common sense of that word. The key point is whether the relevant social groups see the problem as being solved" (Pinch & Bijker, 1984, p. 426-427). So, closure in the context of this case is finding a way that relevant social groups can see the problem as being solved. This will involve a goal of informing the relevant social groups of these findings and allowing them to make their own decisions, hopefully providing closure to each group.

SCOT will also be appropriate to virtual reality specifically because of its young nature. Virtual reality becoming more easily accessible to the public is a new development, and as was argued by Chant, SCOT is a good way to look at young technological systems (Chant, 1996). Within SCOT, I will also look at the technological objects themselves. Winner described this best in his paper "Do Artifacts Have Politics?" when he emphasized the importance of studying specific technical systems because the technical aspect is something that is sometimes overlooked (Winner, 1980). So, when considering screens such as television and VR, we have to understand what technical aspects of these technologies will affect the user. One example for this is the blue light that televisions emit. It is known to negatively affect sleep, learning, mental health and weight (BlockBlueLight, n.d.). Blue light is an ingrained part of the technology itself

and it has a direct impact on the user, that is sometimes overlooked when studying effects of these technologies.

One of the main challenges facing this research will be giving attention to all relevant social groups. With a business–like television, there are so many groups involved, that the goal could get lost in all of the people that have to be taken into account. In addition, the interpretations of these technologies are wide ranging, and it will be difficult to fully account for all interpretations. Therefore, violence and education will be the main focuses of interpretations. Another challenge that is being faced in my research is a lack of perfect data. Countries will take surveys about the public's perception of science and technology, how often they use technologies and their general attitudes towards these technologies. The problem with these surveys is it can be hard to properly gauge technological knowledge of the those being surveyed, they are known to overstate their interest in a technology and data on these topics is released irregularly (Besley, 2013). This paper will focus only on the attitudes within the United States. Lastly, I am drawing upon parallels between television and virtual reality, as research on virtual reality is limited. They aren't perfect comparisons, but it is a reasonable jump to make as virtual reality may become a more normalized way of watching television in the future (Dredge, 2017).

Research question & methods:

The research question for the STS topic is as follows: how has the past technology of television been accused of causing neurological damage to children under 10, and what connections can be made to virtual reality?

One of the main sources of information to answer this question will be studies of the effect that television has had on children and their neurological development. This will consist of

finding both positive and negative effects and reporting both in this paper. These findings will come from a variety of sources, but will all come from credible medical sources. The best example of this will be the use of a study from the National Institute of Health (NIH), in which it gives an overview of both positive and negative side effects related to watching television. For the positive, it is able to show that children can learn from television, but that time spent watching television and the content of the programs can be dangerous (Dietz & Strasburger, 1991).

The second source of information to answer this question will be taken from papers and news articles that have been printed that talk about television's impact on toddlers. This source of information will be largely biased and will illuminate the media's portrayal of television and virtual reality. The portrayal from the media will largely influence the public perception of these technologies.

The combination of these two modes of research will help to show whether the media's portrayal and public perception of television matches with the scientific findings from medical journals.

Conclusion:

I anticipate to find that the problem at hand is not binary at all. I believe that there will be many positives and negatives that television and virtual reality can pose. There are some sources even trying to only make the argument that television does not affect children as much as what was thought (Kuhhirt & Klein, 2020). This being said, I do believe that the media will focus on the negative effects of these technologies and will largely ignore the beneficial impacts they could have. The research I conduct will likely show that technology does have a large impact on

the brain development of children, but it is up to interpretative flexibility on whether this is a good or bad impact. Content is going to be a major player in this problem. The technology itself can be dangerous in of itself, but the content is going to play a much larger role (Kirkorian et al, 2008).

I instead will hypothesize that emerging entertainment technologies have a beneficial educational effect on the development of children. This paper shows that educational benefits of virtual reality and how good of a tool it can be when used properly (Helsel, 1992).

If these deliverables are successful, then they might contribute to future public perception of technology. New technologies may garner less skepticism and instead will be welcomed with open arms and can be implemented in day-to-day life more quickly. I hope that this paper proves that these technologies can be beneficial enough for child development that they will be implemented in the school system! What are seen as entertainment technologies initially, have multitudes of uses and education is a large one that I believe could be useful. The goal of this paper is to not force anyone to use technology, but to weed out all the unnecessary information and give the relevant social groups the most useful data so that they can make an informed decision on how they want to use the technology if at all.

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