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The Serendipity of Glitches

Haunted by Glitches as a method for providing serendipitous discoveries to scientific research.

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Abstract

Haunted by Glitches is a method being developed that requires the user to act unconventionally, respond to glitches and failures as a positive input, and share discoveries that come up along the way. As part of the development, this essay is made to explore its actual usability to help specifically scientific research through the question: How may the method *Haunted by Glitches*, applied by artists, be of use to scientific research? Through the explanation of *Haunted by Glitches* and its background in the concept of glitch, while also arguing for its usability via the concept of serendipity, this essay explores two case studies. One of Team Rolfes and a dancer accidentally kicking off a motion capture sensor, and one of Edward Belbruno using painting to create a new way for orbital space travel. The results show that all aspects of *Haunted by Glitches* show promise for creating serendipitous discoveries, which is something that has played a role in many significant scientific discoveries.

Key words

Haunted by Glitches, Serendipity, Glitch, Scientific Research,

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Introduction

I would like to expand the discussion of what an artist's role in scientific research might be. As an example, I might, as an artist, develop my own artistic research or perhaps I work together with a scientific research project to create artworks describing their findings. The climate scientist and teacher at the School of the Art Institute of Chicago Mika Tosca discusses the need for more cooperation between artists and scientists in her text *Transcending Science: Can Artists Help Scientists Save the World?* (2019). According to Tosca, she dedicates her career to exploring how artists can help scientists communicate climate science to the public.[1] However, the way she sees the collaboration between artists and scientists is mostly that artists either communicate the scientific findings to the public or help the scientist be more integrated with the public. Likewise, the article *Why—and How to—Engage Artists in Science* (2023) mostly describes a similar view on how art and science can cooperate. However, in the article the sculptor Sara Black is quoted talking about a need for radical co-operations as essential for solving urgent problems in our world, such as climate change.[2] But this does not come with examples of what these co-operations might look like. However there has been many cooperations between artists and scientists. Some examples of this are: The 48 hour creative exchange the MIT media lab and Google Arts & Culture Lab arranged in June 2020. Where many artists, designers and creative technicians gathered into groups to explore projects influenced by the pandemic.[3] The cooperation between Sleep psychologist professor Mary Morell and photographer Catherine Yass trying to capture the existence of a moment between sleep and awakeness.[4] Exploring how artists and scientists can work together isn't something new, but I argue that more exploration is beneficial to encourage more art-science cooperation in the future.

As a fine arts masters student, my goal is to in the future work as an artist collaborating with scientific research projects, but I want to explore further what ways one might do that. Therefore the artistic projects I develop revolves around developing and exploring a method

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[1] Mika Tosca, *Transcending Science: Can Artists Help Scientists Save the World?, EOS*, July 2 2019, https://doi.org/10.1029/2019EO127493.
[2] Kimberly Blaeser et al. "Why—and how to—engage artists in science," *Eos*, August 18 2023,**https://doi.org/10.1029/2023EO230318**.
[3] "Member Collaboration—Open Lab: Home Sprint with Google Arts & Culture," *MIT Media Lab,* Accessed November 14 2023. https://www.media.mit.edu/posts/open-lab-home-sprint-with-google-arts-culture/.
[4] Stuart Jeffries, "When two tribes meet: collaborations between artists and scientists," *The Guardian*, August 21st 2011.

I've titled *Haunted by Glitches*. My goal with the development of this method is to explore an alternative way for artists to collaborate with / be of help to scientists. I believe some artists may have more time and resources than scientists do to explore the failures and unexpected discoveries that come from scientific research. This essay will then be the place where I argue for and explore this through the question: How may the method *Haunted by Glitches*, applied by artists, be of use to scientific research?

The way I intend to answer and explore this question is to first give a background to *Haunted by Glitches* as a method and its roots in glitch as a concept stemming from Glitch Art, theorized by, among others, Rosa Menkman, and glitch feminism by Legacy Russell. Then I will go into the subject of serendipity, the concept of unexpected discoveries that lead to valuable outcomes, and its use in scientific research through a text by Samantha Copeland. With the help of two artistic case studies, Team Rolfes motion sensor hiccup and Edward Belbrunos space orbit painting, I will explore how *Haunted by Glitches* might be able to make place for serendipity in a way that could be beneficial to scientific research.

Background

Glitch

Glitch is a relatively new term seemingly having its roots in the german “glitschen”(to glide) and yiddish “glitshn”(to slip) while probably first being used in english for communicating mishaps during live radio recording in the 1940s.[5] After that, according to the Online Etymology Dictionary (2020), “glitch” became more popular via the use from space engineers. The Miriam Webster Dictionary (2023) defines a glitch as “usually minor malfunction” while saying that it can be used for any kind of minor malfunction or snag.[6]

The glitch artist and researcher Rosa Menkman, in an attempt to broaden the understanding and usability of the word “glitch,” describes a glitch as “a (actual and/or simulated) break from an expected or conventional flow of information or meaning within (digital) communication systems that results in a perceived accident or error,”[7] in her book *The Glitch Moment(um)*. She theorized glitch in the context of Glitch Art, the movement of artists searching for, demonstrating and recreating computer and technological glitches to explore processes of non-conforming.[8] This movement became popular in the late 70s in both the art and music scene.[9] Some big artworks in the Glitch Art movement are *TV Magnet* (1965) by Nam June Paik, *Digital TV Dinner* (1978) by Raul Zaritsky, Jamie Fenton, and Dick Ainsworth, and *The Collapse of PAL* (2010) by Rosa Menkman.[10] Menkman also adds that a glitch comes from a missingness of expected functionality, but that this mustn’t strictly be technological. It may as well be a social malfunction.[11]

Even with the idea of social malfunction, Menken seems to throughout her entire text stick with glitch as something happening in relation to technology. The place where she gives room for glitch as something happening outside of technology is in the “Glitch Studio Manifesto” part where she encourages one to not stick to one specific medium and genre, and

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[5] “Glitch,” *Online Etymology Dictionary,* August 18, 2020. https://www.etymonline.com/word/glitch.
[6] “Glitch,” *Miriam Webster Dictionary*, November 16, 2023. https://www.merriam-webster.com/dictionary/glitch.
[7] Rosa Menkman, *The Glitch Moment(um)* (Amsterdam, Network Notebooks 04, Institute of Network Cultures, 2011), 9.
[8] Menkman, *The Glitch Moment(um),* 35.
[9] Ben Barnhart, “Break the Internet: The Rising Popularity of Glitch Art,” Linearity, published October 11 2021, https://www.linearity.io/blog/glitch-art/#the-history-of-the-glitch-art-movement.
[10] Barnhart, *Break the Internet*.
[11] Menkman, *The Glitch Moment(um),* 9.

also to break and bend every medium until it becomes "something new; create *glitch art*."[12] The reason for bringing this up is that in *Haunted by Glitches* I want the notions of glitch to not just be applied to events that are in strict relation to technological devices but also *IRL* (in real life) events. By seeing IRL events as glitches, I open up for the method to be used in more mediums and by more people, and it also leads to more things being able to influence the method users' work which I believe is good for serendipity. So, I argue that it can be experienced outside of computers, phones and other sorts of digital mediums.

In my opinion, Jakko Kemper explains the feeling of experiencing a glitch very well by saying that the glitch has "the capacity to rip the user from immersion."[13] If you're playing a videogame and it freezes while also playing a high pitched noise you'll surely lose your immersion in the game. Glitch is not only about something going wrong technologically but also about the feeling it makes one have when experiencing it. You no longer feel immersed in what you were doing and now have to reconfigure what to do next. This is a feeling one can encounter without being in the presence of technology and I, for my definition, would still call that a glitch.

An example of where glitch has been used as a concept but without being bound to technology is Legacy Russell's *Glitch Feminism: A Manifesto* (2020). In this book, she uses glitch as a way to abstract the body, which she sees as having been defined in a bad and uncomfortable way. She does this by applying the glitch both in and outside of the technological. Seeing things like a car engine not working and a body not conforming to binary norms as glitches.[14] She says: "In glitch feminism, we look at the notion of glitch-as-error with its genesis in the realm of the machinic and the digital and consider how it can be reapplied to inform the way we see the AFK world."[15] AFK meaning *away from keyboard*, referring to the world we live in when we're not by our computer. Glitch can be a concept and event existing outside of technological devices as well as in them.

Together with glitch there are some concepts, such as mistake, error, failure and randomness, that all speak to similar aspects of uncertainty and unconventionality. Mistake and error together with glitch are both concepts that are sometimes linked to disruption and culture

[12] Menkman, *The Glitch Moment(um),* 11.
[13] Jakko Kemper, "Glitch, the Post-digital Aesthetic of Failure and Twenty-First-Century Media" in *European Journal of Cultural Studies* 26, no 1 (2023): 49.
[14] Legacy Russell, *Glitch Feminism: A Manifesto*, (New York, Verso Books, 2020), 7-8.
[15] Russell, *Glitch Feminism,* 8.

jamming. Culture jamming is a term popularized during the 1990s used for activist and artist performances and events that use media as a way of critiquing and jamming consumerist culture.[16] Failure also speaks to an anti, but of success culture. Jack Halberstam, in *The Queer Art of Failure*, writes of failure as a more creative, cooperative and surprising way of being in the world.[17] Failure can be another way of being, giving other rewards, contrary to success. Randomness is something I've worked with before, but the problem with randomness is that the more you think of it, everything and nothing is random, making it hard to form a method around. For mistake and error it's the connection to jamming culture and its intentionality and activism that doesn't work for the *Haunted by Glitches* method. Same for failure, as a way of intentionally being. The method I want to create is aimed more at the exploration of the unexpected than at the intention of being different, even though it is inspired by it. Especially Jack Halberstam's view on failure.

So with this behind me, I define glitch, in the context of the *Haunted by Glitches* method, as: a (actual and/or simulated) break from an expected or conventional flow of any system (digital or not) that results in a perceived accident or error. And that in this perception rips the viewer from the immersion they were in within that system. What's important is to acknowledge the moment of experiencing a glitch, whether it's visually a glitch or another kind of event.

[16] Marilyn DeLaure and Moritz Fink, *Culture Jamming Activism and the Art of Cultural Resistance*" (New York: New York University Press, 2017), 6.
[17] Judith (Jack) Halberstam, *The Queer Art of Failure,* (Duke University Press, 2011), 2.

Haunted by Glitches

Haunted by Glitches is a method, developed by myself, inspired by the idea, as mentioned above, of glitch, and created with a want for a more explorative working process in artistic work. The basic idea of the method is for the user to go into a project with the mindset to do it in a way that they normally wouldn't, and then to let all glitches, things that go wrong, mishaps, things that rip them from the emersion of working on the project change the direction of the project. And then if they make discoveries along the way that they believe may be of value or useful to someone, they share it with them and others. Others, in case someone else also finds value in it.

The method includes three parts. The first one requires the user to use methods not conventional in their current project / medium / whatever they want to apply this method to. What I want to address here is the complexities of categorizing what can be unconventional. The Cambridge Dictionary defines unconventional as "different from what is usual or from the way most people do things."[18] But to know what is different from the way most people do things isn't always that easy to know. Something that's unconventional in one place or for one person might be conventional in/for another. In this method the user either knows the conventions already (by experience) or takes time to understand them and then figure out what is unconventional. See the conventions in the context they're working in and act differently from them. As an example: if you're cooking dinner, think about the conventions around cooking dinner and do it another way. Fry the un-peeled, un-boiled egg in the pan and boil your rice in hot chocolate.

Secondly comes the glitches. By exploring unconventional ways in their artistic project, the user heightens the chance for glitches. Things break, mistakes happen, they're ripped from the immersion of the project, and that is great! As long as they don't try to fix everything. The main point with *Haunted by Glitches* is to see these glitches as an opportunity to discover something new. Instead of fixing what happened the user can try and see what the glitch might want them to do instead. Like a co-worker giving an idea. If their pen breaks, maybe that glitch wants them to start working in another medium. If their computer runs out of

[18] "Unconventional," *Cambridge Dictionary,* accessed October 28 2023, https://dictionary.cambridge.org/dictionary/english/unconventional.

storage, maybe that glitch is telling them to work with very low resolution video instead of with full HD resolution.

Lastly, there is an importance in documenting the process and being able and willing to share it. This is something that many online communities already do on places like YouTube, Reddit and Discord. Helping each other out by sharing what they themselves have learned. When the user of *Haunted by Glitches* is making something, they might end up with an end product, however it might be very different from their original idea. By sharing the documentation people get a chance to see all the twists and turns the project has taken and understand the work that has gone into the project.

Also, and in my opinion, more importantly, by documenting and being willing to share, in the case that the user comes across something that they think other people might find useful, there should be no reason to hide it from them. By sharing things like that the user and the recipients of their sharing help each other explore and grow. This essay is looking at a general use of *Haunted by Glitches*, but as an example: in my own application of the method the people I would share with are people working with, researching and developing virtual reality (VR) technology. I explore VR using this method to be able to hopefully make some sort of findings that can be of value, of use, helpful to researchers and users of that field. I do, however, share it in a way that is available for anyone with an internet connection just in case someone outside of this community finds it useful. And if I come across something that I believe is of use to other specific researchers I would share it with them as well.

Serendipity

Here I explain the concept of serendipity as I believe it is the main argument for why *Haunted by Glitches* can be of use to scientific research.

Serendipity as a concept was first coined by Horace Walpole in a letter to his friend Horace Mann in 1741.[19] He describes serendipity as accidental discoveries and the ability to make good judgment of things we originally weren't in search for. Horace wrote: "now do you understand *Serendipity*? . . . *accidental Sagacity* (for you must observe that *no* discovery of a thing you *are* looking for comes under this description."[20] The word "serendipity" was inspired by the Persian fairy tale called *The Three Princes of Serendip,* first written by Amir Kuhsrau in 1302.[21] The story tells of the wise princes that use their intelligence to help people in different kingdoms. The part of the story that seemingly inspired the word is when the three princes use seemingly useless clues they found along their travels to give an amazingly good description of a lost camel (or mule, different iterations has a different animal here) that they've never seen.[22] By remembering seemingly useless discoveries they made along the way they were able to use those discoveries to later find much use in them and help someone.

One of the most common usages for serendipity is in the scientific community when describing a discovery that came from unexpected events or methods. Or as assistant professor at Delft University of technology, Samantha Copeland put it: "discoveries that occur in the intersection of chance and wisdom."[23] Chance being the unexpected event that leads to some sort of discovery and wisdom pointing to the importance of the individual to understand that the unexpected event might be of value, and for them to take the chance to explore it further. Copeland later expands on the definition of serendipity by clarifying that a discovery is not serendipitous unless it has an unexpected moment and also leads to a

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[19] Robert K. Merton and Elinor Barber, *The Travels and Adventures of Serendipity: A Study in Sociological Semantics and the Sociology of Science*, (Princeton, Princeton University Press, 2004), 2.
[20] Horace Walpole (1741) quoted in Merton (2004).
[21] Anonymouse, "The Three Princes of Serendip" Fairy Tale: The Origins of Serendipity," The Technologist, published January 12 2017, https://theteknologist.wordpress.com/2017/01/12/the-three-princes-of-serendip-fairy-tale/.
[22] "The Three Princes of Serendip," New Acropolis, Accessed October 29 2023. https://library.acropolis.org/the-three-princes-of-serendip/.
[23]Samantha Copeland, "On serendipity in science: discovery at the intersection of chance and wisdom," *Synthese* 196 (2019): 2386.

valuable outcome. An unexpected insight marked with an element of surprise and wisdom but that doesn't lead to a valuable outcome she calls "serendipity lost"[24]

The aspect of serendipity that is mostly discussed in scientific research is a cognitive one. The importance of the one experiencing the potentially serendipitous moment is to make the connection that it could be a valuable discovery and to then act upon that. This might require the person to make assumptions that their preconceived knowledges might be wrong or incomplete.[25] The professor of sociology, Gary Alan Fine, and the head of department at IMC Graduate School, James G. Deegan name this category of serendipity "Analytical serendipity" and describe it as being able of "permitting numerous conclusions from the same data".[26] By seeing that an unexpected discovery can be more than just an accident or mistake one cognitively makes a connection that is needed to be able to explore the values of this discovery.

Fine and Deegan also describe two other categories of serendipity: Temporal serendipity and serendipity relations. Temporal serendipity is basically being at the right place at the right time. Written in relation to ethnographers they write.

> Being exposed to a particularly dramatic event can, at times, transform a mundane ethnography into a classic. Missing the same event, without depicting equivalently dramatic occurrences, can make an ethnography seem pedestrian. . . serendipity presumes not only that one will observe memorable events, but that they will be recognized as significant.[27]

The event of being in the right place at the right time might lead to a valuable discovery just as well as being able to cognitively see how something unexpected is worth exploring further.

Serendipity relations refer to the possibility that the relations we make with people we meet might lead to some form of valuable outcome. The authors explain how the connection and cooperation between two specific researchers will lead to other outcomes than if it was two other researchers exploring the same question.[28] They also, again, remind us that it is not until

[24] Copeland, *On serendipity in science,* 2391.
[25] Copeland, *On serendipity in science,* 2387.
[26] Gary Alan Fine, James G. Deegan "Three principles of Serendip: insight, chance, and discovery in qualitative research," *International Journal of Qualitative Studies in Education* 9 no.4 (1996): 441.
[27] Fine, *Three principles of Serendip,* 438-439.
[28] Fine, *Three principles of Serendip,* 440.

we are able to capitalize on these relations that they can be called serendipitous. Fine and Deegan argue that every person one knows depends completely on chance. Hence, all relations check the box of being unexpected and the only part left for it to be serendipitous is for it to create value.

One final part to the concept of serendipity that I want to add is the importance of sharing discoveries with others. Copeland writes: "A contribution she makes to science by publishing her intermediate results, for instance, may unexpectedly result in her involvement in another discovery process."[29] By sharing one's information created in one discovery process, serendipitous or not, it might lead to someone else being able to make another discovery in a way one might not expect, serendipitously. In her text, Copeland also discusses the normalization of early publishing, that it can lead to creator sharing of information that can lead to serendipitous discoveries. However, this would require an acknowledging of these early publications as essential for serendipity and a greater citational practice when it comes to giving credit to these unexpected sources of valuable knowledge.[30]

So, serendipity describes an unexpected discovery that when acknowledged and researched further leads to a valuable outcome. It can be applied to any kind of discovery but is perhaps mainly used when describing unexpected and valuable scientific and ethnographic discoveries. A discovery does not gain the serendipity stamp until it has shown value and is therefore always applied retrospectively. However, researchers see value in creating the opportunity for serendipity to occur. Lastly, serendipity has a bigger chance of occurring if information and discoveries are shared, even if a valuable outcome hasn't been found yet.

[29] Copeland, *On serendipity in science,* 2400.
[30] Copeland, *On serendipity in science,* 2400.

Case study 1: Serendipitous dance

Recently I had the honor of interviewing Sam Rolfes of the artist/production studio Team Rolfes. Rolfes works mainly with digital performances where he uses VR-technology and motion trackers to create live visuals, music videos and imagery for artists and shows. Although not working out right with *Haunted by Glitches* as a method, he has a similar way of working. For example, early on, he would encounter glitches and system crashes while performing. Instead of hurrying to try to fix it, he would react to it with slapstick humor, and when realizing it added a lot of humor and appreciation from the audience, he started intentionally implementing it in future performances.[31]

The main focus of this case is around a project he made together with Marshstepper (a noise music and performance trio) and the dancer Raymond Pinto for Berlin Atonal 2019. While rehearsing for the show, Pinto had on a wireless motion capture suit where the sensors were only attached by straps around his arms and legs. “Basically, as he was moving he accidentally kicked of one of his- one of his… his foot fell off. Like scattered across the floor.” Here Rolfes is referring to Pintos foot mounted motion capture sensor falling off, not his real foot. The first reaction was to go and grab it and just attach it again but when Pinto picked up the sensor he could at the same time see his digital character live on a screen. He holds up the sensor and “realizes that as he’s moving his hand - now that he’s holding his foot sensor in his hand - he’s like: Oh fuck, this is my foot. I am… I’m mixing inputs here. And that was really transformative for him cause, you know, as a dancer with a human body you typically only have… you have the inputs you have. Your hand is your hand, your foot is your foot.”[32]

This discovery led Team Rolfes to start using this dislodging and misplacement of motion capture sensors as a performative aspect of their live shows, leading to more humorous and chaotic content. Although not having scientific value, as of yet, this discovery is serendipitous in its unexpectedness and value for Team Rolfes. They did not intentionally use *Haunted by Glitches* as a method and did not intentionally attach the motion capture sensors too loosely to be unconventional as the method might have called for, but by reacting with

[31] Sam Rolfes (Artist) in video call conversation with the author, October 19 2023.
[32] Rolfes, 2023.

excitement and curiosity to this glitch, using it instead of trying to fix it, they followed the second part of the method, granting them a valuable outcome.

Sam Rolfes is also very open with sharing this discovery with others. In this discussion I had with him he was willing to share it but also in other places to more people. One time when he shared this story was in Montreal at the Mutek Forum 2023. In a masterclass he held together with artist Kevin Peter He called *Between the Keyframes: Humanity in Virtual Production* he shared this same story to a room of around 60 people.[33] By doing this he follows the third part of *Haunted by Glitches* in a way that this glitch might catch the interest of someone that can create scientific value in this discovery.

Case study 2: Serendipity Space Travel

In the 1980s NASA had a problem. Shooting a rocket into space required a lot of fuel, this wasn't unexpected, however the problem was that in order for the spacecraft to enter the moon's orbit it had to use massive amounts of fuel to break the speed that it had on the way there. This was done with what is called the Hohmann's transfer trajectory.[34] However, the artist, scientist and mathematician Edward Belbruno started questioning if there wasn't another way that would require less or no fuel.

In the 2015 documentary *Painting the Way to the Moon* directed by Jacob Akira Okada, Edward Belbruno tells the story of how he came to discover a way less fuel consuming method for a spacecraft to enter the moon's orbit.[35] When Belbruno suggested looking into a possible way to enter orbit without using huge amounts of fuel he eventually had his funding taken away. In his saying being unofficially fired. He explains how this started a downward spiral for him. His partner left him, he accidentally ran over a dog that then bit him leading to him falling ill. As a way out of this spiral he started painting, as a way to calm him down. Inspired by the way Vincent Van Gogh was able to capture a moment really fast he decided to try to paint the earth-moon system in the same style to see if it would help him figure out a solution to the orbit problem.

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[33] "MASTERCLASS | Between the Keyframes: Humanity in Virtual Production," MUTEK Forum, accessed November 30 2023, https://forum.mutek.org/en/shows/2023/workshop-between-the-keyframes-humanity-in-virtual-production.
[34] "Trajectories," NASA, accessed November 30 2023, https://science.nasa.gov/learn/basics-of-space-flight/chapter4-1/.
[35] Edward Belbruno, *Painting the Way to the Moon*, directed by Jacob Akira Okada (2015; United States: First Encounter Productions and Eyespot Pictures), Documentary film.

By painting this he found a pattern in his painting, a line that led from earth to the moon in a way that made him understand that it was interesting in some way. He translated the line into data that he could add into a simulation in his computer and when he did it showed that he had found a way to enter orbit using much less fuel. He had found the first ballistic capture orbit to the moon.[36]

Let's start with discussing the serendipitous nature of this discovery. When it comes to the painting it can't properly be seen as a serendipitous discovery since in the documentary Belbruno explains that the idea with the painting was to be a way to test his hypothesis, making that discovery not unexpected in the true serendipitous way. However his story contains aspects of temporal serendipity and serendipity relations. Temporal serendipity in the way that he was in the right time and place for gaining an interest in the orbital science at NASA, being fired and hitting the dog that bit him. The last two don't seem like "the right time and place" at least not in a good way, but it seems like those two events led to him exploring the earth-moon system with painting. Also, serendipity relations in the way that if he had had another boss at NASA he might not have been fired and the discovery may or may not have happened. He also had a special relationship to Van Gogh's paintings that made him believe that his painting could be worth a try.

Now to the similarities with *Haunted by Glitches*. In the method's meaning of it, Belbruno encountered some really big glitches: being semi-fired, having his girlfriend leave him, hitting that dog and becoming ill from the dog bite. All of these together seems to have led to him painting this discoverous painting. Instead of going further down that negative spiral he took to painting to relax. The glitch that he also wasn't formally fired, leading him to still be a part of NASA might have been what kept his interest in this orbital question alive. Speaking to the first part of *Haunted by Glitches* is the unconventionality of trying to solve an astral engineering question using expressive painting. It is probably not something they are taught or expected to do at NASA. Thirdly, he chose to share the discovery with NASA, the place that cut his funding for having this very idea. And later, also sharing his idea that expressive painting could solve such a complex question to the audience of this documentary.

[36] Belbruno, *Painting the Way to the Moon*, 2015.

Discussion

The problem with speculating on the valuableness of a method in development is the fact that there aren't any cases already that have had time to intentionally use the method. With that said, I believe that these two cases show good arguments for the potential of *Haunted by Glitches* to be of use to scientific research. In different ways they show how aspects that *Haunted by Glitches* is built on led to different kinds of serendipitous discoveries. One of which has proven big scientific value.

The two cases followed different aspects of *Haunted by Glitches*. In the Rolfes case they did not act unconventionally but when a glitch occurred they chose to use it instead of trying to fix it. For Belbruno there were a lot of glitches, but it's arguable if he used saw them as an opportunity to paint. However, he did act unconventionally by using painting as a way to figure out the ballistic capture orbit instead of starting with numbers and simulations. Then both of them shared their discoveries. Rolfes started sharing with anyone that was interested and Belbruno shared with NASA and then later with the documentary film team.

Both cases also show different aspects of serendipity. For Rolfes it's very much a case of analytical serendipity, as discussed by Fine and Deegan.[37] Something unexpected happened and they had the cognitive capacity to understand that it could be valuable for them. Although not leading to a scientific value yet, it is still a clear case of a serendipitous discovery. For Belbruno it was very much a case of scientific discovery but it plays on other aspects of serendipity. Here it's more about serendipity relations and arguably temporal serendipity.[38] It is worth arguing if being fired, hitting the dog and all of that is really what led him to create this painting. Belbruno himself in the documentary seems to describe this as a series of events leading him to making the painting and in that case it could be a case of temporal serendipity. But it is also temporal serendipity thinking that he was the right person at NASA to gain the interest in orbital problems with his interest in Van Gogh's paintings. And for serendipity relations it is mostly about his relation to Van Gogh and his painting. Had he not had that, he wouldn't have made that kind of painting thinking it could help him solve the orbital problem.

[37] Fine, *Three principles of Serendip,* 441.
[38] Fine, *Three principles of Serendip,* 438-439.

Although my own experiments with this method aren't complete I can see similarities to these two cases. By using *Haunted by Glitches* I've come across similar experiences as Rolfes where I find fun nuanced ways of using virtual reality devices, for example inverting the way you move in the digital world to create a new way of confusing your own body. With Belbruno I see a similarity in being able to track the events that led up to the discovery. Had Belbruno not remembered and shared all these events I wouldn't have been able to argue for the serendipitous nature in that story. As I'm working I document the unexpected events I come across, but from this story I have a new respect for why it can be useful for myself and others.

Conclusion

By exploring the different aspects of *Haunted by Glitches*, an expanded understanding of the concept glitch and the concept of serendipity, I was able to see how they played different roles in both Team Rolfes discovery of humor in the dislodging of motion capture sensors, and in Edward Belbrunos painting that led to the discovery of the first ballistic capture orbit. Through this I've found an answer to the question: How may the method Haunted by Glitches, applied by artists, be of use to scientific research? By looking at these cases, it shows that the aspects that *Haunted by Glitches* rely on have a tendency to lead to serendipitous discoveries, both outside of and within scientific research. This method shows promise of creating opportunity for serendipitous discovery, which many times in history has been the grounds for important scientific discoveries such as the discoveries of Pluto, radioactivity and gravity.[39] This does not prove that *Haunted by Glitches* always will lead to serendipitous discoveries that are of use for scientific research, but it does show evidence of its potential to do so.

Before starting this essay, *Haunted by Glitches* had not been influenced or supported by the concept of serendipity. It was very speculative if it was a method worth developing. But now, there is evidence that it may be helpful for creating more serendipitous discoveries. Although I see this essay as a success, managing to show evidence that *Haunted by Glitches* can be of use to help scientific research, I also see how this is not true proof. The case studies each show different serendipitous aspects and similarities to *Haunted by Glitches* but I have so far not managed to find an example of someone using all parts of my method, knowingly or not,

[39] Fine, *Three principles of Serendip,* 435.

while also showing aspects of serendipity. There might also be a bit of a research ethical question of my objectivity in this research. I have tried to view everything objectively, but it still is an essay by me about a method I've made for my own artistic practice. To add to a less one sided discussion of *Haunted by Glitches'* use in scientific research it would be helpful in the future for others to also study its connection to serendipity and at that point me or others might have actually used the method to make useful discoveries in different scientific fields. I also believe that there should be more research done into the point Samantha Copeland is making about how making it easier to publish intermediate research results can be seen as more valid to create an environment more nurturing of serendipitous discoveries. [40]

By finding proof for its potential usefulness to scientific research, this essay has helped motivate the further development of *Haunted by Glitches* in my artistic practice.

[40] Copeland, *On serendipity in science,* 2398-2400.

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