Bird Noticing

a virtual reality video game about bird watching

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© Aubrey Simonson
This project is a gift to a 12 year old child in need of a parent.

We will never meet, and you will likely never read this paper, but I hope that Bird Noticing finds you, and I hope that you like it.

This project is dedicated to the great blue heron who frequented my childhood pond, and taught me most of what I know about beauty and respect, and to Sarah Hutchings.
Acknowledgements

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Finally, I am extremely grateful to my partner, Dana Gretton, for both letting me make art about him, and for being a person worth making art about.
This entire project was inspired by this particular medium article:

https://medium.com/@the_jennitaur/how-to-do-nothing-57e100f59bbb

Implementation:

Bird Noticing will be a game developed in Unity for the Oculus.

It will feature a view of a small, open, clearing in some generic New England woods. More distant details of these woods can be made in extremely low-poly ways, but a few nearby trees should be more detailed.

The user should be able to sit, and wait, for birds to show up. These birds will be modeled in Maya, and will hopefully be at least vaguely realistic. These birds will land either on the trees, or perhaps, on the outstretched hand of the player. The addition of some mechanic for measuring general user stillness, and incorporating that into the likelihood of bird approach would be nice, but isn’t essential.

There will be some mechanic for informing the game that you have noticed a bird. This could be as simple as pointing at it. This will log it into a book, accessible via the menu, of the birds which the user has noticed. There will be, of course, mysterious bird-shaped shadows for as of
yet unnoticed birds. I’m basing this portion of the game very heavily on the fishing mechanic of Animal Crossing Wild World:

![Fish Information Screen](image)

(this version is in French, but I think it gets the idea across)

**Why am I doing this?**

This is not a game about birds.

I expect that I will spend a lot of time animating birds, and will begin to feel as though this is a game about birds.
But this game is not about birds.

This is a video game about video games, virtual reality and a medium, and being alone.

There’s this public image of video games which is dominated by the first-person shooter. They are the loud thing your brother does alone in his room all the time. They’re the LAN parties of middle-school boys. They’re a childish and irresponsible waste of time. That image has made it difficult for the medium of video games to be taken seriously in other realms, or for other purposes. Bird noticing is meant to be a sort of anti-FPS. It’s meant to prove that video games can be profoundly peaceful.

The main way in which video games have tried to escape that harsh negative stereotype is by being social. Bird noticing is intentionally not at all social. You cannot share your progress with anyone else. There’s no transmit to social media button. There’s no multiplayer mode. Not everything has to be social. You are in the woods alone.

I chose to use the oculus because I’m excited about it as a medium, and I am in particular excited about virtual reality’s capacity to create a profoundly isolated and peaceful environment. There’s a loading screen while the headset of the HTC Vive tries to connect to the computer it’s attached to, which is just a blank, white dome, with some gray lines to give it some illusion of volume. The first time I found it, I just sort of stayed in that loading screen for a while. It was like holding your breath at the bottom of a pool, but without the urgency of needing to come back up for air. I want to take advantage of virtual reality’s ability to create a place which is so plugged-in and connected that it is unplugged, and utterly free of distraction or the intrusion of
day-to-day life. There are ways in which VR oddly parallels a quiet morning listening to the birds in the actual middle of nowhere, and I’m interested in exploring that.

Finally, a lot of this game, is, of course, exploring what Virtual Reality can’t do. My attachment to the idea of still, early mornings and their interaction with ornithology comes from the fact that bird watching was an important thing that my partner and his father did together while he was growing up. This project is intended to be an approximation of that experience, and an exploration of the ways in which a simulation falls short of it.

--Last edited September 5, 2018
Definition of Terms

HMD

Head-mounted display. I use this term interchangeably with the more colloquial “headset” and “rig”. HMD and headset tend to refer specifically to virtual reality tools related to sound and optics which are attached, either mechanically or by being held with the hands, to the head, while rig tends to refer to the sum total of all of the hardware tools used to experience virtual reality, which can include controllers, base stations, and the associated computer.

Experience

An experience is a unit of content for virtual reality. These can include but are not always games, and can range enormously in length.

Simulator Sickness

I use this term interchangeably with VR sickness and motion sickness, though simulator sickness is the most specific and correct term. Simulator sickness is a feeling of nausea, sometimes accompanied by a headache or dizziness, which can sometimes happen as a result of experiencing VR. Mechanics which cause the player’s perspective in VR to change in a manner which differs from the position of their body in the real world are especially likely to cause simulator sickness.
Technical Overview

Bird noticing is a virtual reality experience developed for the HTC Vive, a commercially available room-scale virtual reality rig. The game features one scene, set in a generic New England woods. The scene was developed in Unity. The major features of the terrain are formed using Unity’s default terrain asset, and the various trees and rocks are all free downloadable assets. The water feature is also made using a standard Unity default asset. Some textures in the scene are default assets, or freely downloaded assets, but the ground under the user is a texture made from a picture of the ground taken using an iPhone SE camera, while standing in a tree in Wellesley’s arboretum.

The objective of the game is to “notice” birds. Birds can be noticed by pointing to them. The noticing mechanic is implemented using a RayCast from the controller. While the user is given a small rod attached to the controller, to indicate the direction of the RayCast, the user cannot see the beam of the laser. This decision is elaborated upon in the Process section. If the RayCast hits a bird, a small chime sound is played, and the text “You noticed: “ appears, followed by the name of the bird.

The game currently features three types of birds: a house sparrow, blue jay, and cardinal. Each bird was modeled, UV mapped, and animated in Maya 2017. UV maps were then exported into Photoshop, where the textures of each bird were hand-drawn using a Wacom Cintiq tablet. These hand-drawn texture files were then brought back into Maya, where all of the ways in which the texture didn’t actually quite fit the bird were noted, and adjusted in Photoshop, in an iterative process.
An example of a texture file, with the guidelines of the UV map overlaid
Birds fly from branch to branch, and slowly approach the user in this manner. Birds can only fly to specific points, which have been marked as landingZones. landingZones are organized into three rings (A, B, and C). Birds first appear in ring C, at a randomly selected landingZone. Each bird has a timer for each ring, which prevents it from moving into the next ring for a fixed amount of time. Thus, after the timer for ring C is up, the bird will fly to a randomly selected landingZone in ring B, and after the timer for ring B is up, the bird will fly to a randomly selected point in ring A. The frequency with which birds are introduced into ring C is controlled by a similar timer.

Birds will only appear if the user holds still and keeps quiet. This was implemented using the ability to track the position of the headset and controllers, and the microphone on the
headset. Each frame, the distance between where the headset is, and where it was during the previous frame, is added to a variable called playerMotion. The same is done for each controller. The process for determining how loud the user is being is more complex, and explored further under Process. Each frame, a master version of playerMotion is incremented by the playerMotion calculated for that turn, as well as the player’s volume. playerMotion is also decremented each turn by an arbitrary number, playerMotionDecayRate, which can be adjusted to change the difficulty of the game. A higher playerMotionDecayRate requires the user to be more still overall, and causes sudden loud noises or jostles to continue to effect the game for a longer period of time.

Some birds can be more easily frightened off by the user than others. This is because each bird has different “bravery” for each ring of the forest. If the playerMotion, at any point in time, exceeds the bravery for any given bird in the ring which it currently occupies, it will fly back to the previous ring. If playerMotion exceeds the bravery of a bird in ring C, the bird is destroyed.

Process

Bird Noticing is a highly personal piece. It’s an attempt at recreating a memory, which, like most memories, is in fact a composite of different, disjoint moments, and come from different people. Bird Noticing is based primarily on the experiences of my partner, Dana, growing up in a family of birders, and my experiences of growing up largely unsupervised in a variety of outdoor settings. I think that some of the things which I respect most about him, like his patience, and his appreciation for and attention to extremely small and commonplace but
good things about the world, like the fact that a tiny and almost perfectly round sphere can not
only be alive, but can also be capable of flight, and commonplace all over the middle of Boston,
were largely instilled by bird watching.

Bird Noticing was inspired largely by a medium article called how to do nothing, which
features the following image.

Dana sent this article to me late at night sometime during my junior year, and I stayed up
later than I should have reading the whole thing, on my phone, in bed. It has a certain
magnetism that makes it hard to put down halfway through. In it, Jenny Odell discusses the
idea that various forms of paying attention to yourself and the world around you, which produce
no tangible benefits or proof that you've learned anything, are among the more important aspects of being a human being, and therefore a valuable thing to be doing with one's time. As a Wellesley student who had, up to that point, been motivated primarily by grades, this article damaged my worldview in important ways. It made me question the guilt that I feel about unproductive time. It made me look for the root of my attachment to productivity, in the abstract, as the true mark of a person's worth.

Bird Noticing was one of those ideas that happen all at once. Near Christmas of 2017, I met some members of my partner’s extended family— the Weigls. Their house was beautiful, their son went to MIT, and they used real napkins, the kind that are folded in fourths, instead of half-sheets of paper towel. Andy Weigl, as well as my partner’s father, were also both birders (though Andy notes that “Geoff would not accept my “birding” status as being on par with him”). Andy asked me about my studies, and I tried to explain that I make virtual reality experiences. The following conversation, if extremely stressful, was one of the most effective brainstorming sessions of my life as I tried to explain, on the fly, how I had a viable career path in a viable medium. All of the ingredients were there: my fascination with virtual reality, my scramble to try to find a purpose for the medium, the ideas about stillness and doing absolutely nothing from the medium article, and the bird feeder outside the bay window, right up near the glass. At some point during the evening, I grabbed a pen, and one of the very nice napkins on the table, and scribbled the word birdnoticing on it. The idea has been largely unchanged from that moment.

Bird Noticing was originally designed to be a primarily visual piece. The inclusion of bird calls was a bit of an afterthought, and something I was considering cutting if I didn’t have enough time. However, from a conversation with Andy Mowbray, I learned that birding is
actually primarily about listening. Conversations with my partner’s father, in addition to my one actual experience confirmed this, as does the article which initially inspired the piece. In it, Jenny Odell notes that, “I had my own introduction to a form of deep listening, but it was through the practice of birdwatching. Actually, I’ve always found it weird that it’s called birdwatching, because half if not more of birdwatching is actually birdlistening. I personally think they should just rename it birdnoticing.” Thus, I increased the sensitivity of the game to the motion of the headset, reducing the ability of the player to look around, and forcing them to listen more.

Bird noticing was originally designed for the Oculus Rift, but, in January, was reconfigured for the HTC Vive. Initially, I planned to use the Rift because it had a much sharper quality of graphics than the original model of the Vive, and was lighter, and therefore more comfortable. However, the release of the HTC Vive Pro during the project, and the acquisition of one of these HMDs by the Knapp Technology Center, eliminated many of the problems associated with the Vive. The Pro has a resolution comparable to that of the Rift, and while it is the heaviest of all three HMDs, its weight in more comfortably balanced, and it features more padding, and an easier size adjustment system.

Finally, the tracking system for the Rift was not ideal for the project. The Oculus Rift is a much lighter headset because all of the location tracking is done by the computer. The headset itself if covered in infrared lights, which the base stations can track. The Vive is a much heavier headset because much of the work of tracking is done by the headset itself. The base stations, also called lighthouses, sweep beams of infrared light across the tracking space, which is then picked up by two cameras on the front of the headset. The Vive’s system is very robust in a room scale setting, but the Oculus can easily lose tracking if the user turns completely around,
and faces away from the base stations. With no visual contact with the real world, that happens very often, especially in an experience which encourages looking around.

The mechanic for noticing birds comes from actual bird watching practices. When birding with other people, the way to show someone a bird is to slowly and silently point at it, with your full arm extended. This allows your companion to follow the longest possible line to see what you’re pointing at. While there simply wasn’t time for me to figure out how to make sure someone uses their full arm, I would still recommend it, as it improves the authenticity of the experience.

The game tracks where the user is pointing, and if that pointing is at a bird, via a RayCast, which is roughly an invisible laser pointer. A large number of people have asked me why they can’t see the laser pointer. This is for two reasons. The first is realism. When birding, one generally does not use a laser pointer.

The second is that I loathe the use of laser pointers in virtual reality. They’re usually used as a way to support interaction with 2D UI elements in a 3D space. Anyone who has ever played a VR game which featured any kind of a menu is likely familiar with the type. They tend to be large, floating panels, positioned somewhere just beyond arm’s length. I discuss this further in the section “What is VR For?”, but here it suffices to say that I consider the practice of porting old, 2D interaction styles directly into 3D space to be a lazy one which sets a precedent which will limit the field as it continues to evolve.

Thus, the user is given two short sticks, which roughly approximate pointer fingers, to let them know what direction they are pointing in, and nothing else.

The loud echo that a player can hear of every sound around them came about very accidentally. Unity makes it very challenging to determine the exact volume being picked up by a microphone. However, Unity does have built in functions to record and play audio being
picked up by the microphone, and to get the volume of sound being played in the scene. I am extremely grateful to Youtube user My Little Unity¹, whose code for this workaround I use with minimal modifications. My Little Unity suggests fixing the echo which results from playing the audio picked up by the mic in the scene by assigning this audio a mixer which mutes it. However, after accidentally ending up with an amplified recording of everything around the user playing constantly in the game, I realized that I liked it. It makes the player much more aware of all of the sound around them.

Potential Improvements

In addition to all of the other things that Bird Noticing has been, Bird Noticing has been a test of my skills as a programmer, game designer, and animator. With it, I challenged myself to make an entire, complete video game, alone, in about 8 months, while continuing to be a full-time student with three other classes, a job, and a research position to manage. There are so many things that I would change if I had more time.

I would have loved to include more birds. I am in particular heartbroken that I was not able to include a great blue heron. They are my favorite type of bird. They also would have been much harder to animate than the small blobs which currently populate the game, and would have required an entire separate movement organization system in the code, because they wouldn’t interact with the rest of the scene in the same way that the other birds do. They take slow steps, and prowl primarily at the edges of bodies of water. The water feature in the game was originally included as a place for herons.

A partially finished model of a great blue heron, which was too complex to animate and add to the project.
Other birds which were specifically requested by friends and mentors, but which I just did not have time for are red-winged blackbirds, hummingbirds, mourning doves, chickadees, loons, and swans. Ideally, the game would have at least 25 birds.

The texture file for the chickadee, which was not quite ready in time to be added to the project.
I was also very attached to having a log book mechanic which would tell the player which birds they had seen, and how many birds they had left to find. The log book would be an actual object in the scene with the player. Pages could be flipped back and forth with buttons on either side of it. Each page would include a real picture of the bird which the player had found, its name, a brief text description with facts about it, and a button which could be pressed to play its call. Birds which the player had not yet found would be represented by a page with a gray outline of a mysterious bird reminiscent of “Who’s that Pokemon?”, and a name and text description replaced by question marks.

Bird Noticing will hopefully be released on Steam some time this summer. It will be free to download, and will hopefully feature some number of these improvements.
On Virtual Reality

Immersion

“There is a major qualitative difference between VR and watching video. It feels real. Good VR does that. When done right, VR experiences—intense, beautiful, violent, touching, erotic, educational, or whatever else you choose them to be—will feel so realistic and immersive that they will have the potential, similar to experiences in the real word, to enact profound and lasting changes in us.”

--Jeremy Bailenson

Virtual reality is arguably the most important innovation in media since the internet. Innovations in media, from the novel to the film to the video game, have each afforded the user a higher degree of immersion than anything that came before. Virtual reality is the present edge of what is possible in terms of media immersion.

My first experience with virtual reality was a Samsung Gear in 2017. The Gear is a simple device, consisting of a cell phone and a plastic and nylon rig which holds it to the user’s face. I sat in the office of Brandeis professor Ian Roy, and was told I may want to sit down while using the device. It was good advice. Over the course of the next few minutes, I was

3 Bailenson, 6
approached by both a highly realistically rendered zebra in a highly realistic landscape, which I reached out to try to touch, and a highly realistically rendered dinosaur, which I genuinely flinched from. I then found myself sitting in a small room, which seemed to be the interior of a very traditional tent from a culture I didn’t recognize, listening to the murmuring of the other people nearby in a language which I couldn’t understand. I remember distinctly thinking that film, as a medium, was over. The storytelling potential which I saw a glimpse of in that moment was something that film could never convey. This was the default demo for the device.

The Gear is now a $20 accessory for the Samsung Galaxy smartphone.

I worry a lot about the control that a virtual reality content designer has over their players. This fear breaks down into three primary concerns-- that I, as a content designer, can influence someone’s thoughts and beliefs, that I can emotionally traumatize them, and that I can make them physically ill.

The easiest of these to explain is the capacity to make someone physically ill. It is easy, in VR, to give someone horrible motion sickness. Your eyes tell you that your body is moving, but your body is clearly stationary. In every interaction system that I design for virtual reality, I’m careful with how I move the player through space.

The potential to emotionally traumatize someone in virtual reality in slightly harder to explain. Imagine the scariest horror film that you’ve ever seen-- one where, for weeks after, you had to turn on the little flashlight on your phone in the middle of the night to check that you were the only person in your room. Traditional media have the potential to cause people serious psychological harm. Virtual reality, as an immersive media, has the potential to cause much stronger psychological harm much more easily.
While I was trying out the Gear, a friend near me tried a murder-mystery game on a similar phone-based device. At some point in the game, she had to take the headset off, immediately. There had been a small amount of gore, of the kind that one would expect to be part of a murder-mystery game. It was absolutely within the threshold of what is normal for video games. However, in virtual reality, it felt real and immediate.

The hardest of these to explain are the potential for virtual reality to influence someone’s thoughts and beliefs. In film, a viewer can identify with the protagonist, and thereby feel as though they have performed action which they have not, and thereby come to possess beliefs resulting from those actions without the capacity to evaluate either the actions or the beliefs in the same manner as they would have in real life\(^4\). Virtual reality allows us total control over someone’s entire perceptual input. It allows us a deeper level of immersion than was ever possible with the film. That deeper level of immersion allows for stronger identification with the protagonist, because the user quite literally is the protagonist. Content creators need to be aware, continually, of the fact that people using our content are in an enormously psychologically vulnerable state. If someone wanted to use that power over someone else to make them donate money to a particular organization, or purchase a particular kind of shoe, it’s likely to be much more influential than more traditional forms of media have ever been able to be.

Virtual Reality and Memory

Experiences in virtual reality, for reasons which are discussed further in "On Being Alone", look and feel like memories. They are dream-like. They are fully immersive experiences, being experienced by one person, alone, who is not really there.

Bird Noticing is a layered memory. It is the memory left over when you do the same thing, over and over again. The first few times you do something, you remember each time you’ve done it as distinct and separate memories. However, once you’ve done the same thing dozens or hundreds of times, the memory becomes a composite of each of those occasions, which can no longer be separated, and looked at individually. This particular aspect of the experience was inspired by a scene from Einstein’s Dreams, as directed by Nadya Peek. The only character in the scene was Einstein. He sits in a chair and plays his violin. Behind him is a screen, on which a video is projected. The video is exactly what a camera, being held by a woman crouched at the edge of the stage, is seeing. The camera is eventually turned to look at Einstein, and the projection behind him. This, of course, creates the eerie recursive effect described by Douglas R. Hofstadter in Godel, Escher, Bach.

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5 You feel like you should cite this but you do not know how
6 Hofstadter, 485
Recursive televisions screens featured in *Godel, Escher, Bach*

The dialog of the scene is a section of the 1992 novel read aloud. The full text of this section is worth quoting at length, because Alan Lightman is able to describe this idea of composite memories more completely than I ever could:
“Sunday afternoon. People stroll down Aarstrasse, wearing Sunday clothes and full of Sunday dinner, speaking softly beside the murmur of the river. The shops are closed. Three women walk down Marktgasse, stop to read advertisements, stop to peer in windows, walk on quietly. An innkeeper scrubs his steps, sits and reads a paper, leans against the sandstone wall and shuts his eyes. The streets are sleeping. The streets are sleeping, and through the air there floats music from a violin. In the mid and fifth, there is a countless number of young men standing in their rooms and playing violins. There is an infinite number of melodies and thoughts. And this one hour, while the young men play their violins, is not one hour but many hours. For time is like the light between two mirrors. Time bounces back and forth, producing an infinite number of images, of melodies, of thoughts. It is a world of countless copies. As he thinks, the first man feels the others. He feels their music and their thoughts. He feels himself repeated a thousand times, feels this room with books repeated a thousand times. He feels his thoughts repeated. Should he leave his wife? What about that moment in the library of the polytechnic when she looked at him across the desk? What about her thick brown hair? But what comfort has she given him? What solitude, besides this hour to play his violin? He feels the others. He feels himself repeated a thousand times, feels this room repeated a thousand times, feels his thoughts repeated. Which repetition is his own, his true identity, his future self? Should he leave his wife? What about that moment in the library of the polytechnic? What comfort has she given him? What solitude, besides this hour to play his violin? His thoughts bounce back and forth a thousand times between each copy of himself, grow weaker with each bounce. Should he leave his wife? What comfort has she given him? What solitude? His thoughts grow dimmer with each reflection. What comfort has she given him? What solitude? His thoughts grow dimmer until he hardly remembers what the questions were, or why. What
solitude? He looks out to the empty street and plays. His music floats and fills the room, and when the hour passes that was countless hours, he remembers only music.”

Bird Noticing is not based in a single, individual memory. It is based on Dana’s explanation, to me, of his memory of bird watching with his family. This is a memory which has been repeated, with slightly different variations, over and over again over the course of 25 years. The location is sometimes different, and sometimes the same. The weather is sometimes different, and sometimes the same. The people are sometimes different, and sometimes the same. In the end, the memory which he is able to explain to me is the feeling of it being very early in the morning, the cold, and the meditative importance of listening, holding still, and keeping quiet.

Given virtual reality’s capacity to mimic memories, I’m interested in it’s capacity to store and transfer memories, whole and complete. We saw in the section on immersion that VR can simulate remarkably complete experiences. Bird Noticing is one example of preserving a human experience. It has some vague echoes of Lowis Lowry’s *The Giver*.

*The Giver* is a short novel assigned to myself and many other American public school children in elementary school. It tells the story of a perfectly planned society where a set number of children are born each year by designated breeders, and assigned to couples who themselves consist of two people who have been assigned to each other. This society has no contact with the outside world, and its inhabitants live in a state of peaceful ignorance. The exception to this ignorance is an individual, elderly man, and the protagonist, whom the man takes on as an apprentice who will assume his position upon his death. The man’s role in the society is as a keeper of memories. He holds the wisdom of the world before this community was sealed off from society, and is able to transfer those memories, complete and whole, to his
apprentice. While The Giver’s dystopian society explicitly keeps most information from most people, I’m excited about virtual reality’s potential as a future bank of human experiences, which, rather than being held in an individual human being, can be shared.

What is Virtual Reality For?

Virtual reality is unique in that it is, like television and radio, a system, “primarily devised for transmission and reception as abstract processes, with little or no definition of preceding content”. Virtual reality wasn’t developed to make a particular type of content happen. There have been vague dreams of using it to teach surgeons how to conduct certain surgeries, or running military simulations since the 90s. However, when each of the major HMDs, both for AR and VR, have been released, they’ve been released with a distinct lack of content, and content creation has been slow to catch up with the commercial releases of hardware. Right now, this is a major catch in the adoption and evolution of VR. Current content consists primarily of traditional video games with minimal adaptation, a handful of absolutely stellar video games which truly understand and take advantage of the medium, and a selection of educational experiences of a varying qualities. As of yet, no one is really sure exactly what virtual reality is for.

Virtual reality is a fundamentally different medium than anything which has ever existed before it. As discussed in the section on Immersion, virtual reality allows a creator full control over a user’s senses. VR experiences feel like reality. As such, the vast majority of video games cannot simply be ported into VR. Most video games feature at least some degree of violence, and violence in VR should never happen.

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7 Williams, 25
Virtual reality also needs a different kind of interaction design than anything that’s ever come before it. Interacting with virtual reality is different than any previous medium. Things which have worked in other media simply cannot be ported directly into virtual reality. Virtual reality experiences should be designed with the medium in mind, rather than with the medium as a flashy buzzword tied onto an otherwise unrelated idea. Experiences and mechanics ported directly into virtual reality from existing media, and in particular from video games, tend to either not work as well in VR, or are simply constraining our understanding of how to use this medium.

Computers changed our understanding of information. They allowed us to interact with an arbitrarily large amount of information for the first time. We could store things like never before, and we could search the things that we stored. I would argue that VR presents a similar degree of change. Virtual reality allows humans to interact with arbitrarily large amounts of space for the first time. We can create enormous landscapes to put people in, and those landscapes have almost no rules. We can put people in space. We can give them snakes for hands. We can put those hands far away from their bodies. We can give them telekinesis. Virtual reality has opened the door to spatial interaction of a kind which was previously impossible.

While virtual reality allows for new types of realism and schemorphism in interaction design, it still has certain constraints which do not exist in the real world. Virtual reality is, as of yet, a non-tactile medium. Through tools like hand tracking and controllers, the user can influence the experience using touch, for example, by grabbing or pushing something. However, a virtual reality experience cannot grab or push back. Two of my peers, Emilia Ball and Kealani Finegan, discovered while trying to make a mechanical crank, of the variety that one would expect on a printing press, in virtual reality, that it was almost impossible. The act of
holding onto the crank in the game would mechanically constrain the hand in the game, but it was impossible to similarly constrain the user’s real hand.

The combination of virtual reality’s need for both different content and interaction styles than anything before it have made direct ports of traditional video games into VR generally unsuccessful. A notable example is *The Elder Scrolls V: Skyrim VR*. Skyrim demonstrates one of the trickiest parts of designing realistic VR experiences. In the game, if you try to pet one of the horses (and, of course, everyone tries to pet the horses), your hand will phase through it. It is also possible to walk through the horses, which extremely disorienting. In virtual reality, all objects need to either move when the user touches them, or the user will phase through them. In virtual reality, you’re effectively a ghost. Experience designers need to decide if their players can phase through walls, or if they’ll risk making the player sick by stopping their virtual self while their body continues to move.

With Bird Noticing, I hoped to create an experience which sets a good example for what virtual reality content should be. Bird noticing doesn’t let the user see any kind of violence. It also doesn’t ever put the user in a position where it makes sense to touch anything. It does not lean on any 2D interaction styles. It offers no menus. It takes the fullest possible advantage of the 3D environment, by engaging with all sections of it, rather than having a clear “front”.

It also sets a certain precedent for what virtual reality should be used for. Bird Noticing is not your standard first-person-shooter. It’s a slow, meditative experience. It encourages focus, quiet, and patience. I hope that with it, I am able to influence how future content creators think about what virtual reality is for. I hope that people use it for something more creative than simulations of violence. Virtual reality allows us to create full experiences for other human beings. With enough patience, one person can use it to show someone else the house they grew up in, exactly what their wedding day looked like, or a dream they had once. We can allow
people to live any experience we can imagine and program. I’m excited to see more experimentation in this medium, and I hope that it isn’t constrained by a lack of imagination on behalf of content creators.

On Augmented and Mixed Reality

Augmented reality, mixed reality, and virtual reality are frequently lumped together in conversations about “XR” and “the mixed reality spectrum”. I consider this grouping to be both inaccurate and harmful. Augmented reality and mixed reality are systems which incorporate elements of the real world with elements of the virtual. This can range from headsets such as the Magic Leap One and Hololens, to phone-based experiences such as Pokemon Go. The fundamental difference between augmented reality and virtual reality is that, in virtual reality, one is either interacting with the real world or the virtual world, while augmented reality blends the two.

Virtual reality has the capacity to create experiences which are so plugged in that they are unplugged. You cannot check your phone in VR. Virtual reality also cannot bleed out past the headset and into your real life. You can’t be distracted by it while driving, while having coffee with that friend you haven’t seen in years, or while at your child’s soccer game.

Augmented reality is nothing like virtual reality. If I were to put it on a spectrum with another form of technology, it would be smart phones. Like a smartphone, augmented reality allows an additional data stream into your real life. It is flashing, colorful, additional information introduced into our experience of our day to day lives which snakes out of our pockets, and comes to visit us in the real world. I feel a little luddite-ish when I say this, but I think that critical designer Keiichi Matsuda conveys the absolute cosmic horror I feel about this much better than
I ever could. His video art piece, *Hyper-Reality*, imagines a world with normalized, ubiquitous augmented reality. In it, the real world explodes with cheap color, animation, and sound, like a mid-2000’s web page getting revenge on humanity for abandoning it.

Current applications of augmented reality are generally harmless, due to the fact that AR can currently only be experienced by either looking through a phone, or a headset which is expensive, uncomfortable, and visually obvious. No one wears a Hololens all the time. However, when specifically asked about the increasing accessibility of AR, and the danger that it may cause a descent into a Hyperreality-style future, in an in-person conversation with the author, Varun Mani, former Senior Program Manager for the Microsoft Hololens⁸, said that, while he does see tools like the Hololens, “shrinking down to look like, for example, my glasses,” he

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doesn’t have a clear answer for how to prevent dystopian outcomes related to augmented reality. He trusts that “people are responsible”.

I think that attitude is irresponsible. I don’t think that it’s possible to look at the current commodification of attention and assume that, “people will be responsible” regarding AR. I think that, as accessibility increases, AR will follow a path similar to that of the smartphone. Today, people understand the problems associated with smartphones. We understand that stopping whatever we’re doing every time we hear a notification hurts our ability to focus. We understand that their displays are more visually stimulating than the real world. We understand that the combination of these two aspects of the smartphone give them addictive potential. We find ourselves scrolling through Instagram and we don’t remember opening the app. However, that doesn’t mean that we can stop using them. The ability to respond to a message in a matter of hours, find any information about the world almost instantly, and navigate an unfamiliar city is no longer exceptional. It is expected. And, in a capitalist society, if all of your peers have access to a useful tool, you cannot forgo that tool without losing your ability to compete. It is no longer possible, as a member of the American middle class, to simply not own a smartphone. If we continue to responsibilize consumers regarding regulation of augmented reality, soon, it will no longer be possible to forgo AR.

Bird Noticing is a virtual reality piece. When you are playing it, you are playing it. When you are not, you are not. It has nothing to do with augmented reality.

A Note On Accessibility

In some ways, virtual reality has the capacity to bring experiences to people who would otherwise never be able to have them. We can use it to show low-income kids every sculpture studied in an Art History program at an elite university, or introduce closeted young queer
people stuck in a deeply unfriendly part of the country to landmark moments in the gay liberation movement. In some ways, which will be discussed further in the final section of this paper, Bird Noticing is an attempt to bring some small piece of the experience of being raised by an extremely wise and compassionate family to people who may not have it.

However, I cannot talk about virtual reality as a tool for making the world more accessible without noting the virtual reality itself is extremely inaccessible. The HTC Vive Pro, which is the optimal system for Bird Noticing, is over $1,000. An Oculus Rift, which offers similar resolution and tracking fidelity, is generally about $400. Each of these are not stand-alone units. They need an extremely high-powered computer in order to run them. Those computers tend to cost at least $800, even when built from disparate parts on sale on various corners of the internet and assembled by savvy gamers, and can be in the $1,000-$2,000 range without the benefit of that expertise. There are certainly more accessible entry points into virtual reality, but they each have serious drawbacks. Certain tools, like Google Cardboard, lose tracking so easily that the illusion of immersion is almost impossible to maintain. The Oculus Go has a strong and overt integration with Facebook in a manner which makes it feel oddly predatory. The Samsung Gear is perhaps the best accessible rig currently on the market, at only $40, but still requires a Samsung phone to power it, which can range from $300-$900 depending on the model. And, of course, older and less expensive models are more likely to lag, and therefore cause simulator sickness.

In addition to being economically inaccessible, virtual reality is inaccessible to people with a variety of different disabilities. I have absolutely no idea how to make virtual reality experiences accessible to anyone who is blind. Most people who are prone to motion sickness of other types, like car sickness, are prone to simulator sickness. I’ve had people with certain
styles of glasses be unable to wear them while in the headset, and I have no idea how wearing
glasses in the headset changes a player’s experience.

Finally, many VR and AR systems tend to be subtly inaccessible in ways related to race
or gender. Most HMDs were designed by people with short hair, and with other people with
short hair in mind. When running user testing for Bird Noticing and other VR experiences I’ve
had people have to dismantle buns and ponytails in order to fit their hair into the headset.
Women of color who have hair which is both long and curly, in particular, have had a hard time
with this.

For most ways in which virtual reality is inaccessible, I have absolutely no idea how to fix
it. As a field, hardware, software, and content designers needs to be worrying about
accessibility issues now, before inaccessible design choices become too baked in to change.
Furthermore, computer science generally, and emerging hardware in particular tend to be fields
where white, able-bodied men are disproportionately represented. Good accessibility solutions
are unlikely to come from people whom the medium is already accessible to. If we want virtual
reality to grow as a field in a manner which includes and is welcoming to everyone, we need to
hire a more diverse field of developers and creators.

On Being Alone

Technology, during the birth and aftermath of the smartphone and social media, has
been demonized as a force of social isolation\(^9\). Virtual reality, in particular, is an easy target


for these attacks. Head mounted displays can only be used by one person at a time, and thus create a experience which is challenging to share equally with a colocated other user. There can be no genuine face to face interaction when your face is covered by a screen. Many of the counterarguments to this narrative have centered around the fact that we can use our technology to connect with other people and cultivate meaningful relationships. I would like to instead argue that technology does not have to be social.

The difference between the social perception of being alone in the absence and presence of technology is enormous. A rainy afternoon with a cup of tea and a good book is a quiet and subtly academic form of solitude, but if I’m reading exactly that same novel, or, worse, something published only online, on my smartphone, it becomes a mindless and antisocial activity. Spending a morning out, alone, in the actual forest, noticing actual birds, is generally seen as something profoundly healthy. Therefore, I don’t think that this negative perception of using technology while being alone comes from the isolation itself, but from being alone with technology.

I think that a great deal of our discomfort with technology-related isolation has to do with the fact that technology allows people to be alone while physically occupying the same space as another person. Someone with their laptop open in front of them is not currently experiencing the same reality as the people around them. They are not expending their attention on the people around them, and those people are not privy to whatever reality they may currently be experiencing. For the people around them, that can be stressful, especially if those people

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consider themselves to be entitled to the attention of the person using the laptop, and entitled to understand what they are doing. As the only person on the subway who is currently not experiencing the personalized reality of a smartphone, as many satirical comics depict, I have no idea what the people around me are paying attention to, beyond the fact that it isn't me. Given that demonization of the socially isolating effects of technology generally comes from this perspective, rather than that of the smartphone user on the subway, it seems likely that the underlying problems which these articles stem from aren't the hypnotized inattentiveness of the user, but the anxieties of the author.

Bird Noticing is intentionally not at all social. You cannot share your progress with anyone else. There is no button to transmit your activity to social media. There is no multiplayer mode. Not everything has to be social. You are in the woods alone.

Virtual Reality is not a social medium. Virtual reality is experienced with a screen connected directly to the body, which precludes any interaction with the real world. Definitionally, virtual reality which includes visuals from or interaction with the real world has moved from being pure virtual reality onto the mixed reality spectrum.

Attempts to impress sociability onto virtual reality thus far have been uncanny, uncomfortable, and unsuccessful. A notable attempt at making VR more social is the Oculus Go. The Go is a more accessible sibling to the Oculus Rift. It’s roughly half the price of the Rift, and doesn’t require any computer to operate it. Thus, it offers the casual user a glimpse into virtual reality with only $200 of up-front cost, compared to the $1,500 required for a Rift and a computer which can run it. Facebook (which owns Oculus) has tried to combat the public relations concerns related to marketing a tool which makes face-to-face interaction with other humans completely impossible while using it, and literally constructs an entirely artificial world for each individual user, by making the Oculus Go more social.
The Go allows users to “hang out” with their friends in virtual reality. The Go cannot be used without being connected to a Facebook account, which provides an existing network of friends to visit in VR. It provides a home screen which looks like the Oculus home of the Oculus Rift, but with a lower polygon count. This “home” can be customized in a variety of small ways. The textures on floors, and patterns on certain furniture items can be selected from a dozen or so options. Once your “home” seems ready for guests, you can invite your Facebook friends over to visit. The home contains a music room, where either you or your guest can change what music is playing in the background of your virtual environment, and a patio with a table at which you can play a variety of simple games.

Facebook was very careful in it’s design of how you and your guest look to one another. There are an enormous number of options for customizing one’s avatar. The user can select from a wide range of skin tones, hair colors, hair styles, clothing items, and masks. Facebook understood that it cannot track the position of any part of the user’s body outside of the head, and the hand which holds the controller, and sensibly therefore only displays a floating bust of the user, cropped and the shoulders and décolletage, like a marble sculpture brought to life. Finally, all clothing choices, and most hair style options are fantastical neon cyberpunk affairs which are deeply reminiscent of David Bowie. Combined with the low-poly style and flat shading, the Go allows users to present themselves as fashionable abstractions of human beings.

The masks are necessary as a tool for preventing the immediate descent deep into the uncanny valley. The Go has no way of knowing how the user is holding their face, or where they are directing their eyes. Thus, the masks are a way of hiding stiff, artificial faces out of view. Human beings are very good at knowing what a face ought to look like, and Facebook seems to have understood that the Go does not have the ability to replicate facial expression.
However, there is one aspect of facial expression which Facebook could predict. It is possible to speak to your guest in virtual reality using the Go, and the Go can use that audio to understand when your mouth must be moving. It thus puppets the mouth of the floating, cyberpunk bust along with whatever the user says. The effect is absolutely horrifying.

Virtual reality experiences, in many ways, resemble dreams. They are imperfect recreations of reality, even when they try to be faithful. The resolution of the head mounted display is still impractical for the display of text which isn’t comically large. The user's entire world lags slightly with every movement of the head. The user experiences severe tunnel vision, due to the fact that there is simply no room in the display to broadcast anything to the user's peripheral vision. Perhaps most importantly, the depth of field in a head mounted display is perfect. The user's focus does not change when they focus on objects which are closer or farther away. Instead, everything is in focus, all the time. For these reasons, virtual reality experiences visually closely resemble dreams.

Like dreams, virtual reality experiences are highly personal. I played through all of Super Hot in a single sitting a few weeks ago, and ever since, I have wanted to convey what the ending of that game felt like for me, personally, because I feel fundamentally changed by it. However, there is absolutely no way to effectively describe that experience to another person. Explaining virtual reality experiences to another person is extremely challenging. It is so easy to do such complex and subtle world building in such an immersive medium that there simply is not the bandwidth in spoken conversation to really convey what you experienced. The only way to convey that experience is to allow the other person to experience it. Even then, they'll experience it differently than you did.
Much of the vulnerability involved in making virtual reality experiences so powerful comes from their being alone. I think that one of the reasons why *Super Hot* affected me so strongly is the fact that no one else was there experiencing it with me. When visually disconnected from any other person, there is no other human brain to check in with, to confirm that what you’re seeing is real, or that you’re interpreting it correctly.

Virtual reality creates a space for a profound sort of solitude. It creates an entire world in which no other person exists. In doing so, it creates an opportunity both for self-exploration and tranquility. I think that this is an aspect of the medium which we should fully embrace and explore, rather than a design flaw to be mitigated.

Virtual Reality and The Body

A famous New Yorker coming from 2005, about anonymity on the internet.
The internet was revolutionary for a variety of reasons, but the one which I’d like to focus on is the ability it gave people to communicate without their bodies. The early internet was anonymous. It was a way to reach out into an underground parallel universe. In that universe, no one knew who you were, and no one knew who you were. This created an absolute haven for people with bodies which normally hold them back or bar them from spaces in the real world-- people who are overweight, who are transgender, who are disabled, or who are people of color.

As the internet has grown and progressed, virtual identities have reconverged with real-world identities. Sites like Facebook will ban accounts for not using an ordinary name, and profile pictures on social media are generally of oneself. People curate their brand, be it a social media presence or a personal website, and that brand is generally attached to one’s own, real identity.

Virtual reality has unique potential, especially in these early days of its existence, to recreate the anonymity of dinosaur chatrooms. VRChat, and comparable networked multiplayer games share many characteristics of early internet chatrooms. They allow strangers from all over the world to communicate, in a remarkably intimate, real-time sort of way. As a confused stranger who is new to one of these experiences, other users who are real human beings will generally help you get your bearings. The first time I used VRChat, I met another player early on who showed me rooms which were worth seeing, taught me the basic conventions of interacting with other people, and generally made me feel welcome. While we could hear each other’s real voices, we never exchanged real names, and each of us had no idea what the other looked like. VRChat allows players to decide what they look like. This is a major feature of the game. Over the course of the evening I was a variety of anime girls, an anthropomorphic pastel rabbit, and a character from Overwatch.
Virtual reality, in this manner, manages to create an experience which is liberated from the body, in that no one can know what your body looks like. However, it is still an experience which is deeply bodily. Falling from buildings will still make your real stomach drop. When you point to something, you do it with your real hands. When you look at something, you really turn your head to look at it. In this manner, you fully embody the character which you’re currently virtually embodying. Their hands are your hands.

Virtual Reality and StoryTelling

In “What is Virtual Reality For?” we discussed the unique challenges and opportunities virtual reality poses in terms of interaction design and content creation. Now that we’ve had time to more fully explore my philosophy on virtual reality generally, I’d like to focus in particular on the conventions of storytelling in virtual reality.

Virtual reality is a young medium. The conventions for storytelling in it aren’t established yet. Viewers of film understand that cuts back and forth between two people who are talking which do not break the 180 degree rule mean that those two characters are talking to each other. They understand that if a film uses a wide, establishing shot, and then a close up of a particular person, that person is in that place. Those rules aren’t obvious. It took half a century for them to really be ironed out, and for audiences to understand them. Virtual reality hasn’t had that half a century yet. No one knows what the jump cut is for VR yet. Right now, it is the job of content creators to experiment as widely as is possible, in order to find and establish those rules.
I think that virtual reality, to some extent, grew out of video games. However, I think that both conventional video games and VR grew out of film.

One of the main challenges facing virtual reality content creators who are from a film background, rather than a video game background is directing the gaze of the viewer. Virtual reality environments, by virtue of being 3-dimensional spaces, simply cover more area than a viewer can look at at any given moment. Several solutions for viewer gaze directions have been tried, and all suffer from different faults.

One strategy for gaze-direction is what I like to call the “stage method”. The stage method creates a stage. This stage is in 3D, but does not occupy the full space available to the content designer. Instead, all content occurs in front of the user, on what effectively amounts to a stage. The user is not able to move within or around the stage, and can only see it from a constrained variety of angles.

A notable example of the stage method is Allumette, a virtual reality retelling of The Little Match Girl. This experience is fully non-interactive. All action takes place on a miniature stage in front of the user. This stage, which consists of a few highly stylized blocks of a town, is scaled such that characters are roughly four inches tall. If the user tries to walk around or into the stage, the stage will move away from them, constraining them into a set number of views.
The stage method effectively uses virtual reality as a 2D medium, with extra pizazz. It underutilizes the potential of the medium. While it isn’t disorienting to the viewer, I worry when I see content created using the stage method, that it’s setting a limiting precedent.

Another common method, seen most often in 360-video adaptations of real movies, is the “continual redirection” method. The continual redirection method keeps the user looking in the correct direction by cutting every few seconds. After the cut, the user is looking in the correct direction, and there simply isn’t time for them to drift far enough to be confused before the next cut.

This method can be seen in the widely promoted 360-adaptation of the stage show of The Lion King. The Lion King was shot using a variety of 360 cameras, located on the stage, in the wings, and in the audience. The user is snapped from camera to camera in a manner which feels exhilarating, but is also extremely disorienting. As a frequent VR user who rarely experiences motion sickness, and can generally handle even the most confusing mechanics, I was only able to watch the first 20 minutes of the show.

Colosse, the experience which won Oculus’ Mobile VR Jam 2015, employs a less common variety of truly 3-dimensional virtual reality storytelling which I call the “wait for the user” method. Colosse allows the user to look around the scene, taking everything in, and only progresses the story when the user looks in the right direction. While this method is innovative, and, as I’ll discuss in a moment, a beautiful example of space-based rather than time-based storytelling, the exact manner in which it was executed can leave the user looking around at the start of a scene, unable to figure out where to look in order to make the story progress. Furthermore, there is no explanation of this mechanic for the user. Thus, when nothing is happening, the user looks around faster and faster, to try to figure out where the action is, and therefore becomes less and less likely to settle their gaze on the correct part of the scene.
Cycles, Disney’s first VR experience, directs user gaze using color. The short film tells the story of a family, over the course of 50 years, from the perspective of their home. The experience involves a number of vignettes, bridged with time-lapses. When the user looks away from where they’re meant to, the scene darkens. This subtly cues the user on where they should be looking. The team calls it “The Gomez Effect”\(^\text{13}\). This fading out of color fits perfectly with the experience’s content. It’s about memory and nostalgia, and only stays in color when the user focuses on the memory in question. The only thing that I dislike about this technique is that it minimizes the user’s ability to explore. If they stop to pay attention to a details of the house, they’ll be missing the action. It therefore limits user agency.

The best example of storytelling, using space, and gaze direction I’ve seen thus far is Crow: The Legend. This experience retells the Native American legend from the Lenape tribe\(^\text{14}\) of how Crow burned his colorful feathers while bringing fire to the world. This experience, partially because it seems to be aimed at a young audience, keeps the stage very sparse. It includes exactly the environmental details that it needs to, and nothing more. Characters can be introduced from any side of the player, and direct their attention by speaking. Lines are delivered slowly, and with enough pause for the user to look around during the scene, and there are frequent breaks at which the narrative stops until the user waggles the controllers, which allows additional exploration time if so desired. The fact that the player is not visible to any of the characters is smoothed over by the narrative by making the player a spirit. It seems to come less from the tradition of film, video games, or even stage-based theater, than it does from the sort of informal, audience-integrating, semi-improvisational theatrical practice of street performers and theme parks.


In general, I think that VR storytelling works better when it is treated as less of a time-based medium, and more as a space-based medium. If time continues in a linear manner, the viewer has to work to never miss anything. It reduces their agency by continually giving them specific action to focus on, rather than allowing them to explore a scene until they’re ready to move on. In this manner, I think that VR can learn a great deal from narrative-based video games. Video games frequently only progress the story when the user has taken an action to progress the story. Things which happen in the next room will only happen once the user enters the next room. The user will only find out what is in the box when they open the box. The user has to talk to an NPC- the NPC will not approach them. I’ve used the terms user, player, and viewer interchangeably throughout this piece, but this form of spatial storytelling treats the player as a player. They are fulfilling an active, rather than passive role in their experience of the narrative.

Spatial storytelling in which the player sets the pace via actions is more effective when coupled with spatial storytelling in the sense that the space itself tells a non-linear narrative through its features. A creator can tell the player about a character through a room in which that character spends time. Is it clean or messy? Do they keep pictures of family members or jars with pickled animals in them on their desk? Do they leave the chair pushed in? Does the mug left on the desk contain coffee or tea, is it sleek and minimalist or does it say “World’s Best Dad”, and is it empty, cold, or still steaming? A creator can tell the player about an event by using its aftermath. Think of the classic example from film of a house that has been broken into by someone who is clearly looking for something. All of the drawers from the bureau are on the floor. In this aspect of storytelling, creators can learn a great deal from museum curation. We imply meaning when we place things near each other, and we create a narrative out of the path that a player will walk through our environment.
Finally, space-based narratives work better than time-based narratives in VR because they reduce the rate of cuts. In film, cuts generally happen every few seconds. Viewers are very adept at understanding them, and not being disoriented by them. However, cuts in VR are, as of yet, almost always disorienting. The player can struggle to orient themselves in a new environment, and therefore miss a few moments of the narrative while they do so. Furthermore, that spatial disorientation can add to the motion sickness which still plagues users of VR.

With Bird Noticing, I tried to create an example of spatial storytelling. The experience has no linear narrative. The story should occur to the user slowly, over time, as they explore the experience. Bird Noticing is a space, and event, a memory, and a feeling.

This is not a Game About Birds

I have spent a great deal of the last few months animating, programming, and learning about birds. I, myself, am not a birder. I cannot emphasize enough the extent to which Bird Noticing is not a game about birds.

Bird Noticing is first and foremost an attempt to use virtual reality to convey real world experiences. It is an attempt to look at my partner, pinpoint an experience that taught him patience and a certain wonder for the world around him, and preserve it in a game like a pressed flower under glass.

With Bird Noticing, I’ve tried to make a game that teaches young men patience. Bird watching in particular seemed like exactly the right kind of experience to capture because it is hard to do it without learning something more fundamental than what calls match what birds.
Jenny Odell notes that, “What amazed me about birdwatching was the way it changed the granularity of my perception, which was pretty “low res” to begin with. At first, I just noticed birdsong more. Of course it had been there all along, but now that I was paying attention to it, I realized that it was almost everywhere, all day, all the time.” It is hard to bird watch in a manner that does not cause a certain kind of meditation.

I know that I cannot give every young person the kind of gentle, wise, and supportive family that Dana has. However, I can try to capture some small piece of that experience, and release it into the world.
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