

# Postulator: The Design and Evaluation of a Time-Delayed Media Sharing System

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## ABSTRACT

Personal media sharing of photos and video has become a spectacle of the immediate, yet it may come at the cost of meaning and significance. To explore this design space, we created a new tool, Postulator, that supports time-delayed photo and video sharing. Our goal was to understand how media sharing tools should be designed and how they might be used for sending media, if users were able to select delivery time explicitly. We conducted a field evaluation of Postulator over six weeks and found that participants valued sending time-based messages to send reminders, share personal memories and reflections, affect future time periods, and send social greetings. Yet these messaging acts often garnered strong emotions from our participants. The implication is that time-based messaging systems should be designed in a cautionary way that balances the need to send messages ‘into the future’ with complex human emotions that such practices can create.

**Keywords:** H5.3. Information interfaces and presentation: Group and Organization Interfaces – Asynchronous interaction

## 1 INTRODUCTION

Technology has increasingly provided ways for more immediate communication across time and space. This trend is especially prevalent in media sharing applications where we now see photos or videos being shared in-the-moment with applications like Instagram, Twitter, Vine, and SnapChat. Yet research has shown that in contrast to this trend, there is value in slowing down and having time to reflect when it comes to technology usage [19]. For this reason, we were interested in knowing what would happen if we created stronger ties to the notion of time in relation to media sharing by letting users decide *when* their media would arrive for viewing by others.

Although we encounter some aspects of time-delayed communication already, these interactions are still largely immediate. For example, a person could send a friend an email and it would be sent immediately and likely viewed in the next few minutes or later today. Yet in such a scenario there is no means to explicitly say when the message should arrive. Some commercial products support time-delayed asynchronous communication over longer time periods (e.g., whenSend, time-delayed Tweets and emails using Gmail’s Boomerang), but none of these have been studied in terms of their design and usage to explore what makes them work well or how people use them to send time delayed media. Moreover, these systems tend to be focused on text rather than media given their designs. By this we mean that the interfaces feature text input boxes as prominent design components where media can be added, but it is clearly not the focus of the system. For example, FutureMe requires users to

input textual messages and select a recipient, which could include oneself. Users can add pictures, but it is not mandatory. In contrast, we focus on systems that are explicitly meant for media sharing. Other systems such as Timehop retrieve and display media from specific points in the past, but users do not have the ability to control when their media messages are sent or to whom. For these reasons, we decided to implement our own system because we wanted to explore the use of media sharing specifically by making the design focus on sending and sharing photos with others.

To explore this design space, we created a Slow Technology in the form of an online web-based application called Postulator. Postulator users can send media in the form of images or video clips to family or friends where they explicitly set the sending date and time. People could send media-based messages into the near future (e.g., the next few days or weeks), or even into the long-term future (e.g., in a few decades). They may also resort to sending messages immediately akin to present day culture. The goal of our research was to understand how users would use Postulator to send media, and to use this information to inform design choices for future time-delayed messaging systems.

Naturally, studying the use of a time-delayed messaging system in its entirety could be extremely challenging if not impossible. People could conceivably send messages to anybody, anywhere where researchers might then want to see the reaction of the recipients. Yet it could be very difficult to get these recipients to respond with their thoughts about the system. People might also send messages to any point in the future. This might span years or decades. Certainly running a study of such length would be extremely difficult. Given these challenges, we narrowed our evaluation to what we felt was a reasonable scope, and focused mostly on the act of sending messages. Over the course of six weeks, we had nineteen participants use Postulator in an open-ended manner to send messages to any point in the future (days, months, years, etc.). We wanted to learn about who they would send messages to, how long they would send them into the future, what kinds of messages they would send, and what reflections and emotions such decisions much elicit.

Our results address these points and describe the initial appropriations of Postulator by users along with the emotional struggles and benefits that the system brought forward. Overall, we found that some users found it difficult to move out of their current cultural bounds of utilitarianism and rather than using the system for reflection, they used it to send fairly purposeful utilitarian messages to themselves and others. Yet other participants were able to break free from this mould and moved to richer acts of reflection because they could now choose the arrival time of their media-based messages. These acts often created positive feelings with our participants, however, they also created a great deal of angst or feelings of vulnerability not often found with other media-sharing tools. The overarching implication is that there are important human emotions that must be considered and balanced when designing such technologies.

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## 2 RELATED WORK

### 2.1 Slow Technology

The goal of Slow Technology is to support experiences of reflection, mental rest, slowness and solitude [7,20]. While the concept of Slow Technology may sound counterintuitive in the context of developing newer technologies that are faster and more efficient, tools that facilitate slowness can offer stronger notions of time. The idea of Slow Technology is also similar to Reflective Design, which focuses on critical reflection and “bringing unconscious aspects of experience to conscious awareness, thereby making them available for conscious choice” [26]. In Reflective Design, designers seek to support users in reflecting on their own lives, and the practice of reflection is meant to be incorporated into the experience and activity of the user, whereby the technology can be used as a reflective tool or probe [26]. Like our design and study of Postulator, reflective design practices seek to answer questions such as: how can we help users become more reflective about the role of technology in their lives?; and, how can reflection become both a desirable and useful part of technology design?

Similar to our work, researchers have investigated the temporal relationship humans have with computational objects including how people’s perception and association with an object changes over time [14]. For example, the Tejp project [9] explored the use of recording short audio clips in public spaces that could be played back at a later time; essentially creating a digital time capsule for sound. This contrasts our work where we explore sharing media over potentially longer periods of time.

Photobox [20] was a prototype that explored the ways in which people could manage personal digital content as well as their digital legacy. Photobox stored users’ digital photos inside a wooden box and, at random dates in the future, the photos are indiscriminately printed onto film paper to be shared. Study results showed that the Photobox could “support the experiences of anticipation and re-visitation of the past” [21]. Participants also felt it created more meaningful experiences because of the delay.

More recently, Lo [13] designed a number of tangible devices for creating reflection and downtime with respect to digital content in domestic settings. For instance, one prototype, Collective Photo Frame, allowed users to manually adjust a slider to visit digital photos of the past in chronological order. The goal was to encourage shared recollection and reflection.

Most similar to our Postulator system is the location-based game, GEMS, that allows people to capture media-based stories and ‘attach’ them to real world locations [23,24]. These can then be ‘left behind’ for future generations to discover as they travel to the same locations. Study results showed that people valued the experience yet it was often difficult to imagine a future audience without one being explicitly identified. Our system explores time-based media sharing without the tie to geographic locations.

### 2.2 Family Communication Routines

There is a wealth of research on how family members communicate with one another using technology. This provides a basis for understanding how people’s practices might change when using a technology like Postulator.

First, research shows that families use a mixture of synchronous and asynchronous communication tools to connect with another and share information [4,17,29]. Synchronous technologies (e.g., phone, video chat) are typically desired for emotional

conversations [17,22,29] as well as in situations with large time zone differences [4]. Asynchronous technologies, on the other hand, help individuals broadcast information to large groups of family or friends [22] and can also be helpful for the micro-coordination of activities [17,29].

Second, we see a focus on immediacy in communication. This is often because of carefully planned activities amongst immediate family members [17,29]. It can also be a result of the desire to instantaneously let others know what one is up to [17], or be part of an attempt to feel like one is with others ‘in-the-moment’ [8]. Turning to the use of social media sites like Facebook, we see usage focused on maintaining an awareness of friends’ activities [2], coordinating offline socialization [3], and building relationships [10]. Again, these acts are described mostly as being in-the-moment activities.

Third, research has shown that despite the desire for immediacy, people do value deliberate and planned exchanges of information with family members [25]. This suggests that even though present culture focuses on immediate exchanges of information between family and friends, there may be a place for technologies that slow the pace of such exchanges.

### 2.3 Family Media Sharing Practices

We also see a wealth of research on the media sharing practices of family and friends, largely focused on photo sharing and display. First, there is research that explores the act of collocated media sharing where people come together as part of social activities to share photos and reminisce about their experiences [5,6,30]. In many ways, this slow, deliberate sharing of media long after an event is most similar to our design of Postulator.

Second, research documents the immediacy that has encompassed much of digital photo sharing. Photos are shared on mobile devices immediately after capture or when one meets up with others [1,11,18,27]. Even in the latter case, this is often close to the time at which a photo was taken and not further into the future as we propose. There is also a culture of digital photo capture that make heavy use of sites like Flickr for immediate sharing with others [15]. The use of social networking sites like Facebook also tends to focus on immediate photo sharing and viewing [10]. Lastly, researchers have even tried to create prototype designs that provide even more immediate sharing of photos through the automated image transfers between capture devices and digital photo frames [18]. This is very much in contrast to our design explorations.

## 3 THE DESIGN OF POSTULATOR

When designing a time-delayed media sharing system, there is a range of design options that one could choose. As said, many commercial tools are focused heavily on sharing text with media being an optional component. On the other hand, designs could also focus on media sharing with text being optional. There is also a range of options available in terms of when messages can be sent and whether there are restrictions on time periods (e.g., short vs. long term, after one’s life). Within this design space, we chose to focus on media sharing as the primary focus because it reflected an avenue that had not been deeply explored with commercial systems. Our research was also highly exploratory, given a lack of studies in this design space, so we chose to pursue design options that did not restrict how long a user could delay sending a message.

Figure 1. The Postulator main page. Users follow three steps to send time-delayed multimedia messages.

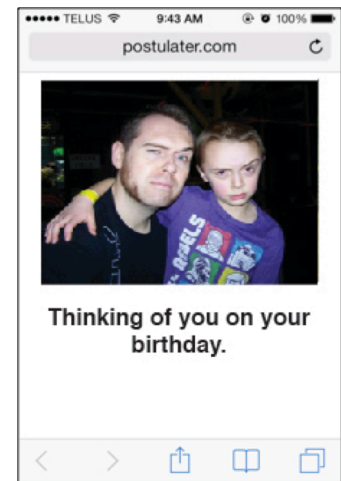


Figure 2. Viewing a Postulator message on a mobile device.

We created an online application called Postulator (Figure 1 and 2) that allows users to send multimedia messages, including images or videos, to a future date and time. Postulator was designed to be as intuitive as possible, using a single webpage. We describe its design through a potential usage scenario:

*Ben captures an image with his son Chris on his 5th birthday on August 15<sup>th</sup>, 2014. He wants to show the image to Chris, but doesn't want it to be shared at that moment. Instead, Ben wants to share the image at a later date, when Chris will be surprised to receive it. Ben opens the Postulator site on his phone (Figure 1) and under "1) Upload Image or Video" he selects the image and includes a caption "Thinking of you on your birthday." Next, under "2) Choose Recipient", Ben enters Chris's name and email address, then (optionally) enters his own so Chris will see who the messages is from. Lastly, under "3) Set Delivery Time and Date", Ben chooses a date of "August 15, 2034" and "9:00am" – this will be Chris's 25<sup>th</sup> birthday and about the time when he is eating breakfast.*

*Twenty years later, Chris and Ben are living in different cities. Chris receives an email from Postulator with a hyperlink to Ben's message. Chris clicks on the URL and views the image for the first time, 20 years later (Figure 2). He then phones Ben (his father) to reflect on the moment.*

The above scenario and usage reflects several design decisions that were a result of months of iterations, self-usage, and design intuition. The addition of text captions is optional as we wanted to explore if users felt a caption was necessary to explain their images or video clips. Overall, we wanted to encourage users to *show* their message, rather than *tell* it.

The use of email addresses reflects the underlying architecture for sending the messages: URLs pointing to the messages are sent through an email server to notify recipients of the arrival of a message. We chose email as a vehicle for notifications because of its relative ubiquity amongst users (compared to various social media tools like Instagram or Twitter). Longer term, email may also be the technology that continues to stay around if messages were sent very far into the future. We created a separate media page, rather than having the media embedded in an email, so we could make the viewing experience more unique. We designed the media page to be very minimal (a blank white webpage, Figure 2); thus, the focus is on the media/message alone.

The freedom to select specific dates and time (e.g., the exact minute) offers users the ability to select very specific moments in the future that may be of personal significance. Whether or not such precision is actually needed is an open question. During our

design iterations, we tested different levels of date/time specificity and felt that it was important to send to specific times in the day, e.g., to time messages for arrival during one's lunch break, at the end of a workday.

## 4 FIELD DEPLOYMENT

We conducted a field deployment over a six-week period to understand how people would send messages using Postulator. Our evaluation focused on the behaviors of the *sender* (as opposed to the recipient) to understand what types of messages they would send, when they would set them to arrive, and how the act of time-delayed message sending might prompt reflective acts in the moment of composing and sending messages.

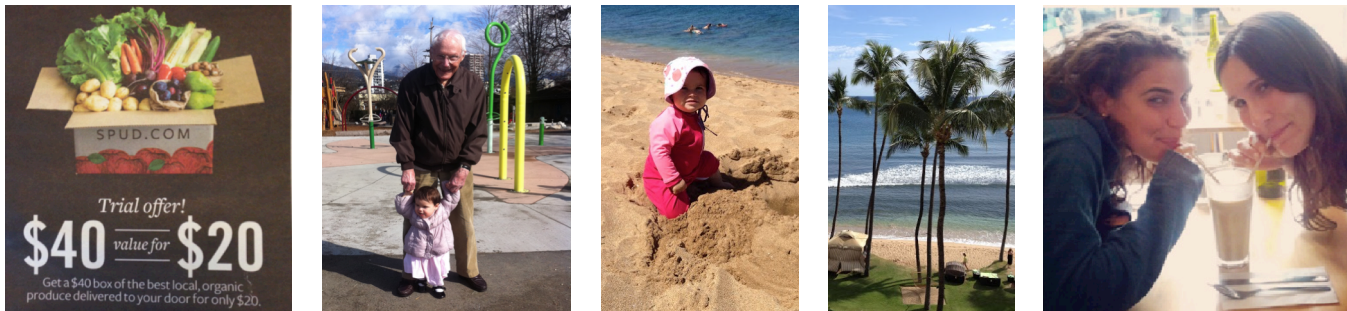
### 4.1 Participants

We recruited nineteen participants (10 male) via Facebook and email advertisements, and snowball sampling through family and friends. Ten participants were between the age of 20 and 29, three were between 30 and 38, five were between 55 and 67, and one was of age 94. Participants' occupations included students, architects, teachers and retired professions. All had experience with using email, but their use of social media and habits with sharing photos and videos varied heavily: some had never used social media while others used it daily. We deliberately selected a broad sample to understand various perspectives. We also purposely chose to recruit individuals rather than an existing social group because we wanted participants to be able to send media to anybody of their choosing, rather than just recruited participants. That said, as a result of our snowball sampling, there were eight participants who knew each other at some level (e.g., acquaintance, friend) but all participated independently.

### 4.2 Method

**1. Pre-Study Survey:** First, participants completed a pre-study survey about their multimedia capturing and sharing routines, and their communication habits with friends and family.

**2. Deployment:** Participants then used Postulator for a period of six weeks. Participants were told to use Postulator as much as they liked over the six-week period, but were encouraged to use it a few times a week. Participants used their own devices, typically either a smartphone (e.g., iPhone) or their desktop computer, and sometimes a combination of both. As said, most participants did not know each other in the study. Consequently, participants mostly sent messages to other people not involved in the study,



a) Visual reminder from P5. b) P14 to grandchild. c) P5 to herself. d) P5 to herself. e) P9 to a friend in 2019.  
Figure 3. Messages sent from participants.

though there was small number of messages sent between participants. Throughout the six weeks, participants were reminded periodically to use Postulator via email. We also monitored usage by reviewing logged server data.

For the first three weeks of the study, participants used Postulator freely without any prompts or suggestions. After this point, we sent participants a list of suggested uses for Postulator because we felt overall usage was relatively low (e.g., only 2-3 messages each). Suggested usage included sending time-delayed greetings (e.g., birthdays), preserving memories by sending to children once they would be older, and making predictions about the future. These were all types of messages that we had seen by particular participants during the first three weeks of the study. We hoped that the suggested scenarios would increase participant usage as well as inspire or spark novel uses of Postulator in the case that participants were not able to think beyond the media sharing practices of present day (focused on immediacy). However, as it would turn out, the frequency and types of messages did not change for participants during the second three weeks of the study. Each participant continued to send the same types of messages that they did in the first half of the study.

**3. Post-Deployment Interview:** After the deployment period, we conducted semi-structured interviews over Skype and in-person. Interviews began with a review of the messages that participant sent to ensure we understood when and why they sent them. Then we focused on the positive, negative, unique, and memorable moments using Postulator. These questions allowed us to classify the types of messages people were sending along with the desired recipient time periods. Interviews lasted between 30 and 60 minutes.

**4. Follow-Up Survey:** Three months after the study concluded, we followed up with our participants and asked them to complete a short survey over email. This survey examined their reflections on their original messages and also asked them about any reactions that they might have received from others to the messages they sent via Postulator (if any were received in this time period). 10 people replied to the survey and we include these reactions throughout our results.

All participants were entered into a draw for a gift card (\$200). Participant's names were entered into the draw based on the number of times they sent messages with a maximum of ten entries (i.e., ten messages). Thus, the extrinsic motivation to participate was small. We hoped that this would be enough to trigger a basic level of participation and then intrinsic motivation might prompt additional message sending.

### 4.3 Method Limitations

One obvious caveat of our method is the limited deployment period of six weeks. Clearly we were not able to capture the long-

term effects that such a system might raise; however, in order to properly do this, a person would need to conduct a study lasting years if not decades, and potentially reach out to a vast array of message recipients who could be located anywhere in the world. Our research is therefore centered primarily on the sending of messages and the emotional responses of people to the act of sending. Given this focus, our data analysis revealed that our study period was long enough that we gathered initial uses of the technology during its 'novelty' phase, as well as the sending of messages once the novelty had worn off and people began to think more deeply about how they would want to send messages into the future given the tool. This latter usage was what drew out deep emotional responses from participants.

In addition, our study period spanned April and May, which means we could have missed time periods where unique life experiences, such as special occasions, birthdays, or holidays occurred for participants. This should be taken into account when considering our results.

### 4.4 Data Collection and Analysis

Interviews were audio recorded and transcribed by the researchers. We used open, axial, and selective coding [28] to analyze our data for each participant. This revealed several recurring patterns of usage under two main themes: reflective acts, and utilitarian purposes. Each theme was comprised of several more specific usage behaviors. We compared these themes across participants and age levels. We did not find any obvious differences amongst age groups or technology experience.

Next we present our results. First, we provide a breakdown of the number of messages that our participants created and sent and how these related to time. Second, we describe the main ways in which participants used Postulator.

## 5 MESSAGE SENDING PATTERNS

Across all nineteen participants, 177 Postulator messages were sent during the study period. A sample is shown in Figure 3. There were a median of 9 messages per participant with a range of 4 to 21 (mean  $9.3 \pm 4.0$ ). The median number of days that messages were sent to in the future was 32 days, with a minimum of 1 day and a maximum of 60 years (mean  $3.8 \pm 8.4$  years). 142 of the 177 messages (80%) contained a caption. 173 (98%) of the messages contained an image and only 4 contained a video. The number of messages sent during the first three weeks of the study was 81. We noticed a slight increase during the last three weeks as the number of sent messages rose to 96. Thus, while we thought sending was low in the first half, it actually reflected typical usage. As mentioned, the types of messages being sent did not change after the first three weeks of the study, despite our additional prodding and suggestions. Instead, our suggestions

already reflected what participants were doing, or they were uses that particular participants were not interested in engaging in.

Participants used desktop and laptop computers, tablets, and mobile phones to send Postulator messages. Device preference was mainly based on convenience of functionality and schedule of participant (e.g., if traveling via train to work, etc.), as well as the availability of photos (e.g., photos stored on mobile or desktop). The majority of messages contained pre-existing photos taken within the last year, while some photos (and all videos) were taken specifically for sending with Postulator. Participants generally decided who they wanted to send a message to first and then found a relevant photo. It was also common for participants to discover old photos that they wanted to share first, and thus the recipient was a secondary thought.

Postulator messages were sent to a variety of people, including oneself, partners, close friends and family. In general, older participants tended to send more messages to their partners and family, whereas younger participants were more likely to message close friends. Overall, participants reacted positively to Postulator and liked the idea of slowing down the act of sending messages.

### 5.1 Utilitarian vs. Reflective Uses

Within the above sending patterns, our analysis revealed that participants were sending messages for a mixture of reflective and utilitarian reasons. In the utilitarian case, we saw people using Postulator as a system for practical reminders. For example, participants sent visual reminders of in-the-moment information, such as the location of items, visual cues, ads and coupons (Figure 3a). They also used Postulator to send reminders to other people. Participants expressed the benefit of sending image-based reminders over text-based reminders, where it was often more convenient and information rich to take a photo versus describing information via text.

While certainly valuable, we believe that these more utilitarian uses of Postulator may easily dissolve if a person was to use the system for a longer period of time since other tools already provide similar functionality (e.g., Apple's Reminder app). Thus, the remainder of our results focus on uses beyond such practical instantiations. Here we saw Postulator being used as more of a reflective tool. This occurred in three main ways: 1) Personal Memories and Reflection, 2) Greetings for Special Occasions in the Future, and 3) Perceived Butterfly Effects. We step through each of these reflective messaging styles next.

## 6 PERSONAL MEMORIES AND REFLECTION

First and foremost, our analysis revealed that Postulator was used as a way to share personal memories and reflect on the present or future. Thus, participants clearly saw Postulator as a means to change the nature of message sending from one of 'immediacy' to one that was slower and more thought-provoking. The fact that participants did this on their own accord, and repeatedly, shows that there was an underlying desire to do so.

### 6.1 Sending to Close Friends and Family

First, participants used Postulator to send introspective, reflective messages to their partners, close friends, and family members. Messages sent to longer periods in the future tended to carry more meaning for participants. Participants shared media from special moments in the present as well as images of things they saw in the present that they felt might have some cultural significance in the future. For example, P1 took a photo of a "No Smoking" sign and sent the image to a friend in 2054. In the caption, she asked "Are people still smoking in 2054?"

P14 (age 94) used Postulator to send personal memories and reminders into the future to his children, grandchildren and great grandchildren (Figure 3b). He wanted them to know that he was thinking about them even if he might not be around to see them or tell them this in person in the future.

Participants also sent playful messages to both short and long time periods into the future. Some of these were even sent to random times for surprise arrivals. For example, P20 (a mother) sent a playful message to her daughter the night before running a marathon together.

Sometimes participants would tell other people that they had sent them a message into the future. These situations often created additional anticipation for the arrival of the message.

*"I told Nora that I sent her a message to six years in the future. And she was like, 'what, what was it?' I told her I couldn't tell her. Because it defeats the purpose. But the fact that she knew she couldn't access it for six years, made her want to see it that much more, because it was unattainable... She joked about paying money to receive the message earlier." – P13*

### 6.2 Sending to Oneself

Participants also used Postulator to send messages to *themselves* as a tool for passing along good vibes or wishful thoughts as well as for setting goals and then checking-in with oneself. For example, one participant wanted to send positive sentiment to her future self about her current job which she loved but was worried that one day she would become jaded about it. P10 used Postulator to help 'ground herself' in the near future, for a trip to Bangladesh by sending herself positive images of her past vacation (Figures 3c and 3d).

*"I anticipated that it would be overwhelming when we first arrived. I wanted to send relaxing photos, like a picture of palm trees from our vacation in Hawaii and our grandkids... I sent words of encouragement because I was anticipating it was going to be sort of an ordeal. I found it quite helpful. I've enjoyed receiving them." – P10*

### 6.3 Self Reflection During and After Sending

Sending messages about personal memories and reflections into the future was not always as easy as it might sound. Our participants talked extensively about the emotions that such acts created and *could* create in the future. That is, they actively thought about themselves in the future as well as their recipient and wondered what the moments might be like when the messages would be received and what the people would be like. Some participants commented that sending messages into the future made them feel uneasy. For example, P8 sent a message 10 years into the future to himself, but it felt perturbing for him:

*"I think again, when I used it to send myself a photo of me on the moon, it made me very acutely aware that when I received this, it would make me look back, and inventory what I had done during the last 10 years...landing on the moon is not the goal I'm thinking of, but setting a goal in the future for yourself, and then you receive it, it will trigger something ...And it won't be something you have thought about over the last 9 and half years, or whatever, perhaps, and so it can kind of trigger some emotions of success or failure..." – P8*

Some messaging acts also created regret after the messages were sent. Here people would reflect on whether or not they should have sent the messages. We had purposely not included functionality in Postulator to 'withdraw' messages before their arrival because we wanted to see if such instances would occur

and they clearly did. Because the messages would not arrive for some time, participants had more time to reflect on their decisions to send particular messages. In some cases, this was not immediately desirable, but it did create personal reflective moments where people thought more about life. One could argue that in some cases this may ultimately benefit a person. It also reveals that the act of reflection is not a short-term thing. It can extend from the point at which someone contemplates sending a Postulator message all the way to the time when it is received. Of course, if the message is sent far enough into the future, the sender could easily forget about it.

The most prominent example of regret comes from P4 who sent a message to her boyfriend into the future after their breakup. She sent the message to him three weeks into the future to a point when they would both be back in the same city. The goal was to rekindle the romance.

## 7 GREETINGS FOR SPECIAL OCCASIONS

Nearly all of our participants used Postulator at least once to send a date specific greeting, such as a birthday or anniversary. Some participants sent many birthday greetings in one sitting, for different friends and family members. Some participants even sent birthday greetings over several years, one for each year. Participants had a mixture of feelings about this practice; some felt that it was beneficial while others disagreed and felt it was less thoughtful if birthday greetings were sent out all at once.

*"I think it's good. But if someone sits down and does all their friends in one day... They're like 'I'll do all my birthdays now'... It won't come out as thoughtful."* – P8

In some cases, using Postulator was a convenient way of sending birthday greetings due to travelling and time differences.

P14 sent birthday messages from her and her husband to their grandchildren so that they would continue to arrive after they passed away. However, she only did this for birthdays prior to the grandchildren becoming teenagers. When asked why, she said they would mean more to them when they were younger. Sending beyond one's lifetime is discussed further in subsequent sections.

## 8 THE PERCEIVED BUTTERFLY EFFECT

Participants also used Postulator in somewhat of an unexpected way where they tried to tie together different time periods and affect the future through the past. We call this a 'Perceived Butterfly Effect.' While it was not a true 'butterfly effect' where one's actions may lead to a cascading and, perhaps, chaotic sequence of events, participants perceived their actions as producing potentially strong effects on the future. Such messages were meant to send feelings about moments into the future, spark future conversations, and help maintain friendships. These messages or thoughts could have been shared presently, yet, instead, they were meant for a future time period that a person wanted to affect. Sometimes people wanted to share their feelings about a situation but did not want to do it in the present because it was simply too difficult or they feared the immediate consequences. Instead, they would send their true feelings as part of a Postulator message into the future where they fully expected that the message might change their future situations or relationships. Thus, time-delayed messaging allowed people to communicate in a way that they previously would not have been able to do, by using the passage of time as a medium.

For example, P9 would capture her feelings at the moment and try to express it to the future with the hope of trying to reinforce relationships down the road. In one example, she sent a message

to a friend in the year 2019 to congratulate her on her life achievements as well as to maintain and rekindle a relationship that she felt might deteriorate (Figure 3e). She described it as a way to change the future of their relationship through an act in the present.

*"That's when she'll be graduated from medical school. Also, the point of that, is that maybe over time we'll grow apart, with 4 years of her living far away...so just to reinforce our love...So its maybe a way to rekindle or spark a conversation later... Yeah it's kind of crazy like to throw a rock into your future... Its like the butterfly effect"* – P9

P8 described how she messaged her recent ex-boyfriend using Postulator to express her current feelings towards him. She used Postulator because she did not want to communicate instantaneously and disturb their current 'friend' status. She was okay, however, in having the message affect their relationship in the future, be it positively or negatively.

Participants described 'Butterfly Effect' messages as having potentially powerful consequences on the future. This made participants feel vulnerable because they did not know how people would react in the future, or if their messages would be viewed in a positive light. This finding is similar to the uneasiness participants felt about sending a reflective message into the distance future, knowing that things could change.

*"I guess the fact that you were acting upon the future, is a powerful thing, ... you are doing something now, that has repercussions, or affecting your life in the future...it's kind of powerful to do something, in a time that you don't own usually, so that idea, of being able to do that, was beautiful."* – P4

Participants also felt that they could affect the future in an even more profound way by sending messages to a time when they felt they would no longer be alive. The repercussions of this were harder to imagine in such cases though. Participants also described uncertainty around whether or not it would be rewarding or creepy to receive a message from a deceased relative. For example, P14 expressed positive feelings around the idea of sending messages to his family members, thinking that it "would be interesting because they would all of a sudden remember old Poppa." When asked to expand on this feeling, he sounded less confident. Instead, he started to realize that he did not know how the recipient would feel about receiving a message from a deceased loved one.

Participants also sent messages to a date when they knew they would be collocated with the (presently distant) recipient. They expressed the desire to be around the recipient so they could share the media together and spark future interactions.

## 9 DISCUSSION

We now summarize our study's main findings and discuss the implications for time-delayed messaging technologies.

### 9.1 Utilitarian vs. Reflective Uses

First, our study highlights an interesting juxtaposition of usage when it comes to time-delayed messaging systems. While we did not devote much space to it in our results, many people used Postulator as a tool to send personal image-based practical reminders for themselves or others in the near future. This is likely a consequence of present day culture, attitudes, and technology design, which promotes a usage paradigm of task completion and busy lifestyles. Clearly people in our study used Postulator to move beyond such practices, yet the fact that they occurred is still important. It suggests that when given a tool that

supports messaging over time, people will easily see it as a means to help control and manage their busy lifestyle. They may even venture to thoughts of ways of better managing incoming email or text messages so they can view them when and how they want. Designs should carefully consider this as it is both an opportunity for time-delayed messaging technologies as well as a hindrance. On one hand it shows that time-delayed messaging systems might be valuable for people, but perhaps in the wrong way. In this sense, it may easily be a hindrance to systems that are trying to slow down present day society to show the value in instilling a more reflective practice when it comes to media sharing.

In contrast to the utilitarian uses of Postulater, our study revealed that participants highly valued being able to create and send personal memories and reflections to family and friends in the future. The fact that messages could arrive at a particular time meant that people could think about and plan for these moments. Participants were able to make use of current photos that otherwise lacked present value by sending them to the future. Having control over when media is shared allows people to reflect on what is important now and what will be important in the future (e.g., knowing your photo will be only be viewable in 10 years changes the decisions of what to include in the photo).

Thus, we believe that tools like Postulater offer an interesting way to manage multimedia and provide a more meaningful way to preserve and share memories. Stumbling across an old photo on a future device is valuable, yet we feel that systems like Postulater would provide additional significance to such moments. This includes any added caption as well as the notion that a particular photo was specifically chosen to be sent to a certain time period. Richer information about the photo is provided because the record is made near the moment of capture, rather than later, when received, and also because it comes from another source (e.g., another perspective and time period). This illustrates that time-delayed messaging tools should consider the social aspects of information sharing across time (e.g., the stories and annotations that go along with shared items), rather than just acting as personal digital time capsules for preserving memories. It is also clear that tools like Postulater are able to encourage users to become more aware of their present and future environment. Additional features could be added to further promote this awareness, such as prompting users for interesting meta-data (e.g., location, temperature, feelings) to accompany shared media.

## 9.2 Positive Emotional Responses

Postulater clearly brought out an emotionally rich response from our participants. Compared to the rather mundane feelings they had when sending out emails or posting to social media, participants expressed a myriad of emotions and feelings towards Postulater and their use of it. Sometimes these were very strong. On the positive side, senders expressed excitement and anticipation for their messages, both in terms of the recipient's reaction, as well as knowing that at a future point in time they themselves may have forgotten about the message. Clearly this suggests valuable design opportunities for systems similar to Postulater. In addition, we also see ways that excitement and anticipation can be further supported. For example, designers might consider including random send-date functions, or they might hide media from a sender's device until delivery date. Systems could also send recipients a warning message immediately after the delayed media is sent (i.e., a message stating that an item has been sent and when it will arrive) to reinforce user anticipation. Participants also expressed excitement about sending messages to times when they knew they would be

together with the recipient so they could share the arrival of the message together. Future systems could further support this user goal by being location or context-aware, and deliver messages when both sender and recipient are together on a particular day.

## 9.3 Negative Emotional Responses

In contrast, participants also experienced strong emotions that were more negative, such as feelings of apprehension and regret when using Postulater. This was often because Postulater caused people to reflect on their current relationships with friends and family, as well as contemplate how their relationships may change in the future, or what life might be like after their death. It is because of this that we feel the way in which time-delayed media sharing systems are designed is extremely important. What may seem to be simple design decisions can easily cause dramatic emotional effects in the present and in the future.

First, there is an issue with what might happen between the point at which a message is sent and when it arrives. For example, relationships might deteriorate or strengthen while a message is waiting to be sent out. Messages could then have unintended emotional effects, e.g., causing good relationships to turn bad. Some participants talked about being able to retract messages after they were sent in order to overcome this problem. Another solution might involve focusing such systems around self-sharing, as opposed to directly sharing with others. For example, one could send a message to herself in the future. This message could then be reviewed before it was forwarded on to the actual recipient. However, focusing the system around self-sharing, as opposed to directed-sharing with others, may dramatically change the experience of the receiver, where the effect of the perceived time delay might be diminished. Another solution might allow users to review messages closer to the date of delivery. Yet, again, this might diminish the perceived effect of time. We purposely did not include such features as we felt without them one might be even more careful about sending messages into the future, and, thus, be even more reflective. Clearly this remains an open design problem with no obvious 'right' solution. In any respect, designers will need to carefully think about the ways in which messages can be sent, whether it is directly to other users or to oneself as a part of a review process.

Second, there is a question of how far into the future it is appropriate to support messaging and, perhaps more importantly, whether or not people should be able to send messages beyond their own lifetime. That is, if a system could conceivably be guaranteed to be around 'forever,' what restrictions might be appropriate for limiting such usage? The thought of having a message arrive in the hands of a loved one after one has passed away caused a mixture of feelings for our participants ranging from happiness in being able to stay 'present' even after death all the way to confusion and sadness over how one may react to the message. Paper letters have the capability of staying around for long periods of time even after one's death. Yet moving this idea to a digital technology creates potentially different consequences. One could, for example, send large amounts of messages to loved ones in the future (after one's death) where it becomes overbearing, intrusive, or even 'creepy.' What makes this even worse is that the sender would not be around to deal with the social consequences or repercussions of such acts. Again, there is no easy design solution and designers will need to carefully think about the likely effects created by limiting (or not) the usage of time-delayed messaging systems.

Third, there is a more obvious question around user-confidence in a system's longevity, which could affect emotional responses.

The disappearance of seemingly important messages due to server failure or a discontinued service could cause negative emotional effects especially for people who send very purposeful messages. This presents an ethical dilemma for designers and companies that may offer such a system.

#### 9.4 Beyond Postulater

Finally, we believe our findings offer broader implications for slow technologies, in general. First, it is likely the case that slow technologies beyond Postulater will also be used for more conventional purposes that match present day cultural practices rather than the 'slowness' and reflective nature that such technologies are trying to promote. People are very used to carrying on their existing routines and patterns of behaviour, and this is sometimes not easily changed, even with the introduction of a new technology. As such, designers should anticipate such usage and even consider how they can leverage it in order to draw users into changing their practices. Second, our results showed that slow technologies like Postulater can elicit strong emotional reactions. Again, this is likely broadly applicable to systems beyond Postulater since other slow technologies will similarly promote acts of contemplation and reflection (this is indeed the goal of slow technologies), which we found to be the source of strong negative emotions. Designers of slow technologies more broadly should work to balance such emotions with the benefits that slow technologies can bring to people.

#### 10 CONCLUSION

This paper contributes an understanding of the ways in which people send time-based multimedia messages to others, their reflective practices as a part of such sending, and their the emotional responses. We identified different behaviors and uses for such a system, including the ability to send personal memories and reflection, share time-based practical reminders, affect future time periods via the past in a form of a perceived Butterfly Effect, and create greetings for special occasions. Overall we feel that time-based messaging systems provide users with opportunities that are not easily possible with current communication technologies. However, design work in this space should tread lightly as people can easily feel anxious or concerned about sending messages too far into the future where they may not know the eventual effects of such messages.

#### ACKNOWLEDGMENTS

We thank the GRAND Network of Centres of Excellence and NSERC for funding this research.

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