

Walking by Drawing

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ABSTRACT

This paper describes a study of algorithmic living with Trace, a mobile mapping application that generates walking routes based on digital sketches people create and annotate without a map. In addition to creating walking paths, Trace enables people to send the paths to others. We designed Trace to explore the possibility of emphasizing guided wandering over precise, destination-oriented navigation. Studies of sixteen people's use of Trace over roughly one week reveal how walkers find Trace both delightful and disorienting, highlighting moments of surprise, frustration, and identification with GIS routing algorithms. We conclude by discussing how design interventions offer possibilities for understanding the work of mapping and how it might be done differently in HCI.

Author Keywords

Walking, design, geo-spatial navigation, algorithmic living.

ACM Classification Keywords

K.4.0 Computers in Society: general.

INTRODUCTION

In the 1967 artwork *A Line Made by Walking*, a field of grass presents residues of a path that artist Richard Long tracked up and down by foot [9]. Through walking, Long reshaped the environment to describe a trajectory of movement. The blades of grass bent underneath his feet to reflect the sunlight from above and produce a visible trace. In the decades since, we have seen the emergence of a different kind of path: mapping algorithms that prefigure walking routes based on Geographic Information Systems (GIS) data. Unlike the trails that came before them, GIS routes rely on algorithms to characterize and codify the physical landscape. They also share an important presupposition: walking is a destination-oriented, precise, and planned activity [5,9,13]. Whether embodied by GIS routing or fitness tracking systems, these computational traces often issue from a corpus of knowledge whose authorization and production remain hidden from the people using them [8,15].

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Drawing on studies of social mapping [1,11,25] and algorithmic life [6,8,15,33], we develop a complement to this technology for walking called Trace. Trace is a mobile application that transforms hand-drawn digital sketches into walking paths to share with others – thus introducing a unique form of digital communication to HCI: walking by drawing. Rather than aim for efficiency or competition, Trace relies on communication between the creators and recipients of walking paths. During field trials with sixteen people across Boston, Chicago and Seattle, Trace evoked surprising contrasts. On the one hand, people used Trace to extend their everyday interactions. They “slowed down” walking routines to encounter new features of their environment. Through the design of the routes and the accompanying annotations, they also turned walking paths into personal messages: engaging enigmatic riddles, love notes, and ruminations. On the other hand, people encountered Trace as deeply disruptive of familiar routines. Trace prompted people to explore areas they did not want to travel, sometimes revealing discriminatory behavior. Trace also obligated people to use scarce spare time and walk redundant paths — ultimately intensifying desires for efficiency and control. To reconcile these disconnects between people's perceptions and practices, the people we studied began to interrogate the procedural logics behind GIS-routing and see their neighborhoods through an algorithmic lens.

We use the development of Trace to examine how GIS algorithms might be done differently in the context of walking and navigation. How is GIS-supported travel achieved in practice? What do GIS algorithms translate, displace or change? What alternatives might be possible? As we describe in the paper that follows, this work has ramifications for not only design for urban mapping but also for our un-

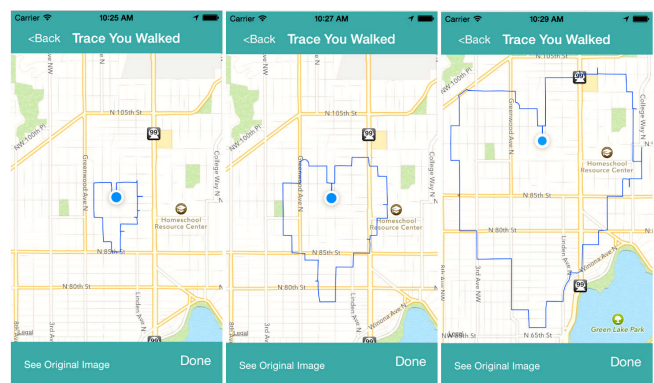


Figure 1: The Trace application enables people to sketch, annotate and send walking paths to others. The maps above illustrate a heart path adjusted for different walking durations.

derstanding of the forms of autonomy and engagement GIS systems make possible. First, it extends the spectrum of mobile navigation research to consider design for non-destination-oriented walking. In doing so, it raises the possibility of devising forms of travel independent of GIS-enabled precision and specification. Second, it operationalizes guided walking as a form of drawing to examine the social, political and communicative character of digital transport. Lastly, we contribute a study of algorithms through walking to a growing body of HCI research on algorithmic living that analyze the role of digital rules and infrastructures and their seemingly immutable form.

Our choice to study walking rather than driving or other forms of travel comes from a suspicion that the relation between walking and creative engagement can reveal important opportunities for improvisation in algorithmic life in ways that engage overlooked avenues of HCI inquiry around issues of autonomy and machine intelligence [31]. As we will see in the discussion that follows, it is by intervening in and breaking with GIS-routing practice that we may invite new recognition of the responsibilities and contingences that often challenge navigation activities more typically examined in HCI.

MAPS, ROUTES, AND WALKS

While maps have historically enabled precise and efficient movement through the world, they have equally become mechanisms for classifying and reducing it, often “reflect[ing] the maker’s priorities more than those of the culture(s) they depict,” maintains Rebecca Solnit, a San Francisco-based activist [25:13]. While Stamen Design’s Crimespotting maps visualizing crimes in San Francisco and Oakland (<http://stamen.com/projects/crimespotting>), aim for civic transparency, those same maps may also deter

people from visiting lower income neighborhoods, reinforcing social stigmas. In their attempts to use visual representation to segregate and repress certain populations, mapping exclusions reveal power hierarchies, urban tensions and discrimination, concurrently making such practices contestable. In *Infinite City*, Solnit positions maps as invitations to alter, add, plan and otherwise manipulate “in ways that texts and pictures are not” [25:8]. A map provides entrance to a physical landscape, enacting concrete connections to the world. Solnit draws attention to the power dynamics mapping processes often conceal. Dividing North America into various ‘local tribes’, for example, offered colonial Spaniards a comprehensible picture of Bay Area Native American territories for museum curation [25:8]. The practices and politics of mapping continue to pervade not only civic life but also the many GIS systems that inhabit it.

This recognition of cartography as a political project resonates with an ongoing attention to psychogeographical mapping of the 1950s. French Situationist theorist Guy Debord’s [7] theory of “drifting” (or *dérive*) emphasized a “playful-constructive behavior” emerging from the abandonment of familiar routines and an awareness of “the attractions of the terrain.” Decades later, a rich array of location-based media has drawn on this tradition to comment on the influence of mobile sensing on urbanization, spatial encounters, and processes of de-familiarization. The Broken City Lab’s Drift project [3], for example, presents a mobile application that users based on randomly assembled directions. Mark Shepard’s Tactical Sound Garden Toolkit similarly uses smartphones to enable people to “drift through virtual sound gardens” as they navigate urban spaces [20]. Christian Nold’s [16] bio and emotion maps use wearable devices tracking galvanic skin response to offer opportunities for reflection on people’s relationships with geographic locations and sensing technology. Chris Speed’s Walking through Time [27] mobile app allows people to view historical maps while moving through Edinburgh.

Revealing new cartographic features, several artists and cultural critics have explored the relation between mapping and human traces. British poet Iain Sinclair [23:19] imagined “templates of meaning” encoded into baroque architect Nicholas Hawksmoor’s London churches, connecting the location of the churches on a map to produce an image of the Eye of Horus, an Egyptian symbol of protection. More recently, artist Jeremy Wood has pioneered a growing movement of “GPS Drawing” that explores the use of GIS to create large-scale illustrations (see Nike+, MapMyWalk www.mapmywalk.com, Strava www.ilovebicycling.com/strava-art, and so on). Tracing paths of travel (foot, bike, car or plane) with Global Positioning Systems (GPS), the images range in diversity from marriage proposals to Internet memes. In “Surface Patterns: Walking Tours,” Jen Southern [26] reproduces audio tour walks without a map to reimagine such imagery as decorative prints.

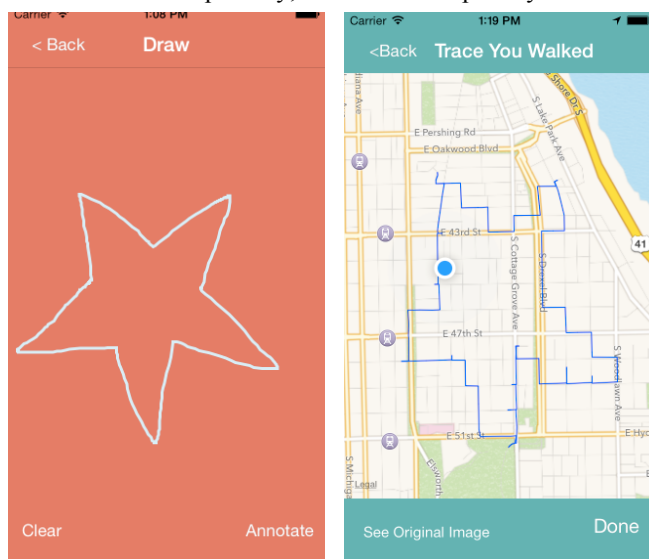


Figure 2: Plotting paths for a star introduced challenges. As one person described: “say you draw a trace for a circle it’s pretty unlikely it’s have you walk down the same streets but if it’s the shape of star then it’s more likely”.

The juxtaposition of drawn traces with cartography underlies an orientation toward mapping as primarily emotional, cultural and symbolic. Geographer Denise Cosgrove has written of the “imaginative processes of discovering and denoting our place within the world, and of ordering the worlds we experience through spatial representations: graphically, pictorially, even narratively and performatively” [4:68]. The practices and politics of mapping continue to pervade not only civic life but also the many GPS-savvy citizens that inhabit it.

However, travel has only recently relied on mapping and GIS. Citing Long’s walk described above, anthropologist Tim Ingold [9] recalls the practice of wayfaring, a process of retracing a path someone has travelled before. As an act of cultural reproduction, wayfaring for Ingold highlights links between walking and storytelling, wherein the line of a path or tale unfolds through space and time. Like a story one has heard before, the line has a way forward but no particular end and may ebb and flow. Walking and telling both rest on itineraries: markers that guide as opposed to specify trajectories. Contemporary examples include marches and protests such as the Million Man March in the United States. Such walks enact the values and beliefs of their members through claims to public space. Participants construe walking as social and political action.

This view of human engagement as both material and semiotic has begun to enter the HCI literature, particularly through the work of Lucy Suchman, Susan Leigh Star and Bruno Latour. These authors have emphasized the more subtle and supple relations between people and the algorithmic worlds they inhabit. Suchman [29] and Star [28] stress the influential ways “invisible work” permeate both technologists and technological (infra)structures. Latour [14:228] proposes the concept of “immutable mobiles,” whereby things become transportable while remaining stable in form, such as a projection system that “allows maps to be drawn with less deformation of shape.” wherein objects like th with increasing stability as displacements through transformations. In her introduction to *Human Machine Reconfiguration*. Suchman directly connects situated action with Ingold’s notion of wayfaring, foregrounding the centrality of new accountabilities and agencies. As our bodies travel through the world, we open up possibilities for becoming social and political agents as well.

This perspective has resurfaced in recent conversations on algorithmic life budding from within cultural studies and science and technology studies. Historian of science Lorraine Daston [6], for example, describes the spread of “algorithmic rules” to many disciplines through “rules of rationality [that] replaced the self-critical judgments of reasons.” Media scholar Tarleton Gillespie shows how algorithms become categories of fact or truth, asking whether they can ever be ‘wrong’ [8]. Likewise, sociologist Scott Lash [15:71] proposes examining algorithms through their “compressed or hidden” rules to become “pathways through

which capitalist power works.” However, these assertions may tell us little about the critical work algorithms do as our practices change. According to science and technology studies scholar Malte Ziewitz [33], “such theorizing often ends up further mystifying the phenomena it seeks to clarify.” Inspired by Harold Garfinkel’s “demonstrative experiments,” Ziewitz describes an ethnomethodological exploration of mapping he conducted in his Oxford ‘classroom’ wherein he asked students to explore the city guided by algorithms rather than maps.

Our Trace project and the concept of drawing-by-walking developed below emerged from our early engagements with these areas of theory, art practice and research. Firstly, we take up questions raised by Ingold and Suchman around improvisation and accountability in the domain of GIS technology. Secondly, we use concerns of the aforementioned locative media artists to reimagine the potential of GIS to shape and contest new algorithmic relations. And lastly, we draw together methodological tactics of Ziewitz’s algorithmic walk with Wood’s GPS drawing to develop drawing-by-walking as a mode of design inquiry. In drawing and walking the algorithm we reimagine the material trace [20].

DRAW TO WALK: THE TRACE DESIGN PROCESS

Our design team sought to investigate and further define this concept of walking-by-drawing through interviews examining the form and location of GIS-technology in people’s walking routines. We recruited avid walkers from public online postings, including a part time dog walker and a photographer. We conducted ten semi-structured interviews lasting one to two hours. Interviews took place in person or over the phone in order to gain insight into the preexisting walking habits of the people we studied and their initial impressions of the Trace concept. We recruited participants through flyers and online ads. Interview questions focused on people’s walking habits, motivation, and priorities. Based on insights we gathered from these interviews and social studies of mapping [1,11,25], we developed the following design guidelines for Trace.¹

Travel over Transport: Non-destination-oriented Routing

The people we interviewed described several walks that accompanied a particular task, such getting to work or running errands. When the walk became time-constrained, they described seeking out the quickest route. When asked about wandering, several people expressed that they enjoy wandering in areas where they will most likely find an interesting shop or restaurant. This widespread focus on geolocatable destinations prompted us to investigate alternatives. Drawing on theories of social mapping [1,11,25], our design team built Trace to explore how GIS-supported travel could emphasize travel over transport.

¹ All participant names are pseudonyms.

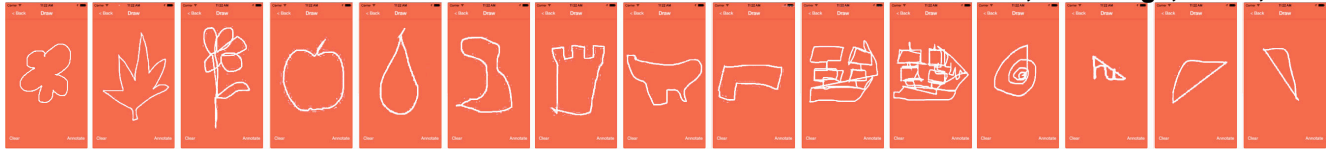


Figure 3: A selection of drawings created by people using Trace. Common themes included (left to right): objects in nature (cloud, leaf, flower, apple, raindrop); curiosities and jokes (hourglass, bigfoot, United States); seafaring (fish, sailboat); symbols (spiral, “hi”); grids for walking (triangle, triangle, “pen15”).

Improvisation: Highlighting Emergent Engagements

Our interviews highlighted multiple occurrences of wandering in parks or less urban areas, as people found these walks more scenic. Sarah, an artist, related that she frequently travels with her partner and will often take the first day in a new city to wander and get acquainted with the area. She described an experience of wandering during a trip to New Orleans in which she admired the architecture: “a lot of the buildings have wrought iron balconies that look like black lace.” To account for such moments of discovery and to explore conceptual connections between walking and improvisation [9], we designed Trace to stress emergent engagements over planned activity.

Disorientation: Embracing the Unknown through Wandering

People brought up a number of concerns for safety associated with walks. Many discussed not wanting to walk at night and not feeling safe wandering in certain neighborhoods or around busy intersections. Hailey, a university employee, described experiences of sexual harassment, such as others catcalling her and even being flashed, while walking. Revisiting theories of social mapping [1,11,25], we designed Trace to expose and engage the safety concerns that come with disorientation through wandering.

Motivation through Surprise

After hearing a brief description of Trace and viewing a demonstration of how to use the application, we asked interviewees how they might use Trace. Some people were interested in creating surprises — for example, an “*anniversary gift*”: sending a partner on a walk and having her return to a special celebration. Jill, a student in Seattle, expressed the desire to create a location-specific walk for her long-distance boyfriend. She liked the idea of sending him to certain places, such as a particular shop or bar, as a type of a scavenger hunt. Roger, an IT Specialist in Bellevue, expressed that he could use Trace to motivate himself and his wife to exercise. The notion of using an unexpected endpoint as inspiration for walking led us to design Trace to reveal the full path upon its completion.

THE TRACE APPLICATION

Trace is an iPhone application for *draw-to-walk* interaction: creating walking routes based on digital sketches. The application converts hand-drafted digital sketches into GIS-based routes that can be shared with others - thus enabling unique engagements through walking. The application consists of two parts: (1) Draw and (2) Walk. Using the Draw function, people can *send a Trace* in three steps:

- *Sketch*: People sketch diagrams with their finger on a blank mobile phone canvas (Figure 4b). They can tap “Annotate” to move to the next screen or “Clear” to erase and start over. Like Southern’s prints discussed above, we chose to enable drawing on a clear canvas without a map to encourage alternate connotations and aesthetics, which resists a direct association with particular locations in geographic space.
 - *Annotate*: People can associate digital media (images, audio, text) with any point along the line of their sketch. When their recipient later walks the Trace, they will receive the media along the path in the correlated geographic location (Figure 4c and 4d). Building on the work of Chris Speed [27] and others (e.g., [3,17,26]) around location-based information and Rosner and Ryokai’s [21] narrative maps depicting the geographic locations people knit, we chose to enable the appearance of annotated messages while walking.
 - *Send*: People send their Trace path to one or more contacts, labeling the Trace with an optional title and description (Figure 4e). This orientation toward communication through embodied messaging builds on our prior work on communicative traces [20, 21].
- Using the Walk function, people *receive a Trace* in two steps:
- *Select*: People can choose how long and which ‘Trace’ (the walking route) they would like to walk (Figure 5b and 5c).
 - *Walk*: People view a map highlighting the upcoming segment of the journey and describing it in text. As people walk the path, they receive instructions on where to head next and annotations left by the Trace creator. People can turn off automatic routing instructions (using the phone’s GPS) to move through the itinerary manually. When people finish the path, they can view the entire path and the image used to generate it (Figure 5d and 5e).

Implementation

We implemented Trace as an iOS app that can run on an iPhone 4, 4S or 5 running iOS 7 or higher. These phones feature a touch screen, a built-in GPS receiver, and Wi-Fi capabilities. We wrote the software in Objective C using the Apple Software Development Kit.

To create a Trace, people draw a closed-loop diagram and embed multi-media (text, photo or audio) annotations on the drawn Trace. The application saves the created Trace

with its title and description. To retrieve a Trace, people first choose the duration they wish to walk and then select a Trace. Once they select a Trace, the application calculates a route and plots it onto the map.

The application uses the MapKit SDK to calculate a route with a three-step algorithm:

Step 1: we determine the starting and ending location (latitude and longitude coordinates) based on a person's GPS position.

Step 2: we choose a scale that adjusts the size of the drawing over the map based on the intended duration.

Step 3: we take the projected picture on the map and “snap” each point onto roads.

Each fragment of the path has a start and end point, and the end point of a path is the start of the next one. When the iPhone approaches the end point of the path, the application displays the next segment. At the end of the route, people return back to the initial starting point. While walking Traces, people also encounter annotations as they get close to a trigger point embedded in the original drawing. We save participant responses to a database on Parse.com so that we can connect dyads. During field trials, we released our prototype to people using the TestFlight application.

TRACE IN PRACTICE

After developing Trace, we used the application for three weeks to experience it ourselves and iteratively develop its design. We discovered shorter walks produce several redundant stretches (walking up and down the same block). To account for some of these hurdles, we refined the walking algorithm to include fewer (but still some) redundant stretches, introduced a manual button for moving through directions, and allowed people to see the final path and Trace. We used public online postings for recruitment in three cities: Chicago, Boston and Seattle. We chose major cities with different densities and layouts to examine the varying city landscapes and civic cultures in relation to

walking.

We studied sixteen people's use of Trace over five to twenty days to create 33 walks and over 150 test Traces. Four participants made just one walk in 5 days while others engaged Trace repeatedly over a longer period of time. We made the application available to anyone who requested it (barring installation issues) and monitored use on Parse.com.

People ranged in age (21-56) and profession, including a part time dog walker, an employee for the Massachusetts Bay Transportation Authority (MBTA), and a lawyer engaging issues of rights to public space. Five people owned dogs and took regular walks with their dogs. We recruited dyads for the study through flyers and online ads, including siblings, romantic partners, and married couples. Four people used the application alone, without sending Traces to a partner. In one case, the iPhone we installed Trace on belonged to both a mother and daughter. Interview subjects differed from our study subjects; we invited all interviewees, and only three completed our field study. After introducing each person to Trace, we asked them to install the application on their own phones so that they could take walks with Trace as easily as they might use their phone or GPS. We also asked people to fill out an online diary for five days (in a Google Docs form). Diary questions included: What motivated you to create (or not create) a Trace today? How did you decide to walk this particular Trace? How did this Trace compare to other walks you've taken?

Engaging Walks as Creative Things

While designing walks for each other, the drawn walks represented a range of concerns: aesthetic, artistic prowess, the observed environment, and particular jokes or memories. For example, Lulu described aiming for humorous and delightful images that symbolized her relationship with her Trace partner and boyfriend Pablo. Lulu met Pablo at a French cultural center in Boston a few months before using Trace and decided to give him a Trace that might amuse them both. She first thought to draw a heart but wanted

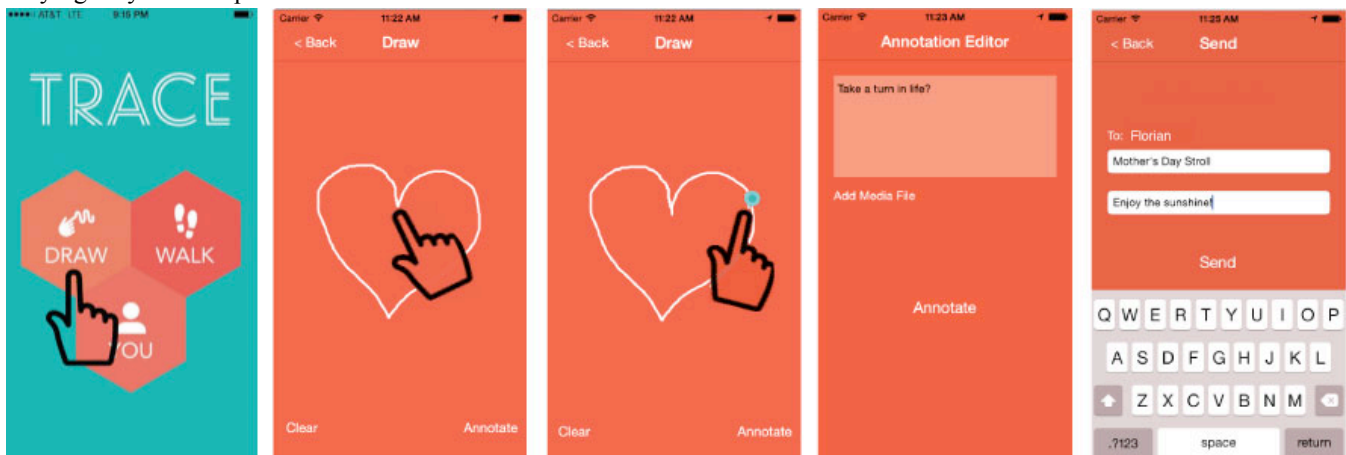


Figure 4: To draw a Trace (from left to right above): (a) touch the “DRAW” button, (b) drawn an image, (c) add one or more annotations by selecting an area of the drawing, (d) add text or media (image, audio) to your annotation, (e) provide a title and description for the Trace to send and save.

something more particular to their relationship. When she tried to draw the outline of France, she found it too difficult to recognizably sketch (or recall). Instead, she found herself drawing an outline of the United States, the country that brought them together, as Pablo came from Columbia and she grew up in the United States. To celebrate this convergence Lulu placed annotations along the outline of the States to evoke what she called “*clichéd American phrases*” such as “*best country ever*” and “*star spangled*.” She decided to walk the Trace with Pablo in downtown Boston one Sunday afternoon.

Similarly playful, Jordan, a 26 year old computer programmer living in Seattle, described wanting to give his partner of five years, Annika, “*a chuckle at the end*.” He sent Annika images of “lude” and humorous drawings such as “pen15” that Annika later described finding funny. Jordan spoke of wanting to try “*hand crafting the experience a little better*.” One aspect of this craft entailed “*place[ing] annotations along the route to give hints and as you go along and you’d have the aha moment about what this experience is about*,” he explained. After recounting her Trace walks, Annika described the application as “*the art of walking*.”

While such communication between couples prompted humor and inventive exchanges, people created a majority of walks for themselves. Many drawings described things in the world (e.g., raindrops, leaves), and others detailed words or reflected visual sensibilities. Sam, an artist, described how he had “*been working with symmetry recently*.” His first Trace took advantage of this symmetry while describing a familiar object: an hourglass. Others had a particular aesthetic in mind: “*I wanted a squiggly circle*.” Often this entailed recreating the drawing more than once to produce more desirable curves, avoiding the automatically closed loop, or creating simpler paths. Sometimes people preferred abstract diagrams: patterns, textures, or simple shapes. As we will discuss, one aspect of these smooth and

abstract designs was the experiences they might evoke for the walker along the way.

Perceptions of Familiarity and Safety

In designing new routes and interpreting them, people described feeling compelled to engage the unfamiliar. On Jake’s walk through his own neighborhood, for example, he encountered “kooky” city dwellers he likely wouldn’t have met on his own. One woman Jake called “*very unique*” he described as “*not a person that I necessarily have a model for in my head*.” Although he wandered in his own neighborhood, he came across moments he perceived to be “*a little strange*.”

This unfamiliarity could sometimes become problematic. Like most tools for generating mapping routes, Trace’s automatic route generation did not account for “unsafe” areas of the city, raising ethical concerns for participants if the areas present real high risk of harm. One participant worked at the border of two neighborhoods in South Boston: the South End and Roxbury. “*The front of the building is in a good part of Boston and the back is in a bad part of Boston*,” she explained. During a routine walk from work at the end of the day, Trace directed her to walk in the Roxbury area. Describing this area as “*one of the scariest places in Boston*,” she chose to end her Trace. In doing so, she raised questions of territory: how GIS-enabled tools figure into the process of carving racial, ethnic, and class-based boundaries. In calling out differences between what Tara described as the “good” and “bad” neighborhood, Trace began to chart discriminatory behaviors.

While some people might not exercise the same judgment as this participant who ended her Trace, a few participants came prepared to engage and dispute issues of spatial inequality and claims to public space raised by the Trace system. A prime example is Gillian, a civil justice lawyer living in Jamaica Plain, one of the greenest and most politically active neighborhoods in Boston. Growing up in Roches-

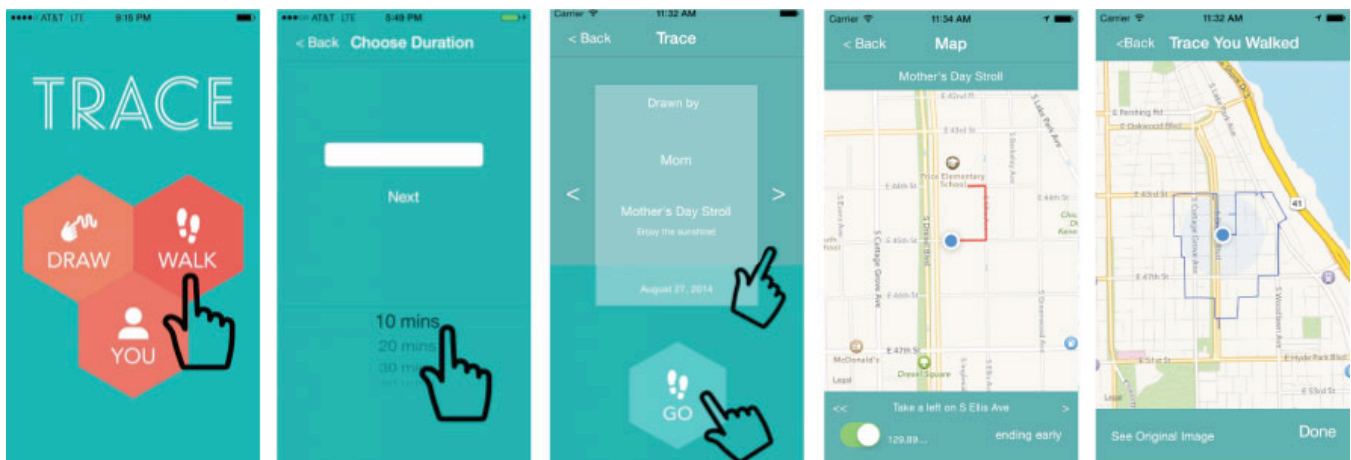


Figure 5: To walk a Trace (from left to right above): (a) touch the “WALK” button, (b) select the duration of the walk, (c) follow directions provided on the application and use the switch to toggle off the automatically updated directions (based on GPS signal), view annotations along the way, (d) walk the Trace, and (e) view your completed walk.

ter New York to ‘countercultural’ parents, Gillian associated walking with civic action. On one of the Vietnam moratorium days, she led her seventh grade class out of school to join the march. As a student and later lawyer, she participated in several marches such as the first Earth Day Walk for Water and the AIDs Action Committee. Reflecting on her neighborhood today, she explained: *“Walking into Jamaica Plain is an act of making community constantly.”*

However, even in Jamaica Plain, rights to public space could be difficult to protect. Though she was now 56 and, in her words, *“of an age when I don’t get harassed down the street,”* Gillian has still received recent catcalls. She was quick to point out that such experiences suggest that women’s limited engagements with public space remain readily curtailed by experiences of being followed or harassed.

Gillian’s walking experiences made her more reflexive on her own right to the city: *“[it] made me think about how I take for granted that the sidewalks belong to me as much as anyone else. That wherever we are, that we have a right to be there. That I belong there as much as anyone and that these spaces should be hospitable to me as much as anyone.”* Gillian cast walking as not only an opportunity for public engagement but as call for social change: a responsibility to leave the world better than how she found it. She recalled helping her parents create a ‘pocket park’ – a small recreational garden accessible to the public – by reclaiming land from an abandoned walkway when she was young. Now living in Jamaica Plain, she sought to fight for what urban theorist Edward Soja [24] might call ‘spatial justice,’ wherein human rights issues take on distinct meaning at different geographic scales and sites. Karen, who used Trace during a work trip to New York City one week, similarly described running the Boston marathon this year as *“remembrance about what happened last year.”* Walking became important for the solidarity it could enact.

‘Slowing Down’ and Reflecting on Desires for Efficiency and Control

Several of the people we studied described developing a capacity for noticing their surroundings while using Trace. In describing this heightened awareness they noted multiple engagements that introduced a different pace to daily routines. Jake walked four Traces in neighborhoods he usually biked or ran through but rarely walked: *“For me one of the most surprising things is we went down an alley way that was right next to our house but we hadn’t been through before,”* he explained. Another participant similarly discovered a new path to a local park in her neighborhood while taking a walk with her friend one evening with Trace. Though the street she walked was only adjacent to her house, she hadn’t explored the area before because she usually took paths reachable by car. Re-discovering features often overlooked in everyday environments invited unexpected surprises.

Beyond locating new paths, the unrolling of directions one segment at a time had the unexpected effect of creating breaks and therefore opportunities for engagement, or what one Seattle resident called “interesting encounters” in his neighborhood. While using Trace, a Boston resident told us she *“made it a point to walk different routes every day.”* Walking became a practice of discovery. For brothers Sam and Jake, walking a trace designed in the shape of an hourglass created unintentional pauses in their walk for *“seeing various people and just talking to them,”* Jake noted. They stopped to watch a young boy play soccer and chat with a women gardening who loved the clean Seattle air. Reflecting on the experience, Jake explained: *“there was a social element to it that we hadn’t necessarily thought there would be.”* Participants not only found the pauses accommodated moments for discovering new dimensions of their environment, they also allowed for fresh encounters with the people and situations already there.

While we sought to design for walking without a destination, encoding experiential qualities of walking proved challenging, and in some cases impossible. Busy lives and routes made carving out time for a leisurely or non-‘functional’ walks difficult. One participant described not “expecting” the application to have considered her well-being. Another person explained:

Realize I need to not be limited by the dog - probably better to try a few out before having any limitations. Also allow myself to be more exploratory than planned as well - have to let go of known expectations of space.

Relinquishing “known expectations” meant developing an alternate sensibility about geographic location as well as the efficiency of a route. To reproduce the sketched diagram on city streets, the application reduced the gesture of the hand to points and, in turn, a location along geographical blocks. This had the unexpected effect of prompting people to “double back,” as one person noted: walking the same block(s) more than once to create single lines that resembled the drawing. Annika described this process as disorienting:

It feels unnatural to walk the same path. Usually people only walk down the same path if they’re making mistake. So it’s pretty unusual to do that on purpose. [...] I don’t think I’ve ever turned back and walked back unless it was a mistake.

Like moving down the same road more than once, participants also discussed the demands Trace made on their time, challenging their desire for reaching destinations. Tara, for instance, a call center employee in Boston, described her routine walks in terms of the time they took: *“walk 20 mins to and from work everyday. walk 30 mins to and from the gym everyday. walk my dog twice a day for 15-20 mins.”* Helen, a consultant and educator, described wanting to use Trace to exercise but finding few opportunities to do so. *“I had such a short period of time and it’s usually relegated to*

rudimentary repetitive exercising,” she explained. “Trace was more exploratory and unknown.” To make time, Helen walked her dog while using Trace but found it difficult to stick to dog friendly areas.

Without the purpose of dog walking, the people related destination-less walking to a loss of autonomy and control. After using Trace over a week, one participant compared Trace to an experience taking acid for the first time: she recalled walking around the same block with a high school friend for two hours, completely fascinated by the world around her. The process of creating a trace presented an equally distinct opportunity for taking an otherwise unusual (and at times redundant) walk.

Seeing like the Algorithm

Before beginning the study, most participants had a very different view of how Trace would utilize their drawing. Familiar with marks that *follow* their movements on digital maps, some described envisioning a process of drawing by walking (as enabled by applications such as the Fitbit). Trace, by contrast, guided people according to a drawing and revealed the path at the end of the journey. Although people received segments of the journey along the way (one to three blocks long), these small segments only hinted at the path yet to come.

This juxtaposition between the trajectories of walking and drawing led to important breakdowns in use. Initially disorienting people, Trace concealed the walking route from the person drawing. *“I didn’t quite understand the sizing and how that would translate timewise and spacewise so it was challenging to walk the actual trace as planned based on the park we went to with the dog,”* Helen explained. Translation here referred to reducing the hand-drawn mark into a path that could move along blocks of a city, a process of conversion revealing the (invisible) infrastructure of mapping. After walking her partner’s star-shaped Trace, another participant explained: *“I think for the more distance the lines have from one another the less likely it is to make you go down different streets. Say you draw a trace for a circle, it’s pretty unlikely it’ll have you walk down the same streets but if it’s the shape of star then it’s more likely.”* People began to follow how the conversion of diagonal lines to a path on a gridded city produced small redundant stretches (see Figure 2). For some, this meant adjusting their drawings to suit city blocks (creating rectangular shapes, for example). Other challenges developed while taking short walks that left little geographic space for an image to emerge. For example, Karen’s 10-minute walk while visiting New York City enabled her to do little more than walk around a block. At other times, the GPS failed to synch with GIS satellites to accurately locate participants (particularly when people began their walks inside). Such struggles generating smooth walking routes prompted people to reflect on the (broken) functioning of the GIS algorithm and whether it could be trusted.

Taking advantage of these breakdowns, a few participants oriented their journey using what they learned of the algorithm, determined to use Trace with a destination. Jordan drew two squares that resembled the blocks he stood adjacent to. Others tried aligning Trace with a particular direction and drawing a line in the direction they sought to head (pointing the line north and drawing toward their destination, for example). While heading to the gym one day, Tara drew up in the direction she wanted to walk and then lifted her finger at the end. Since Trace created a closed loop from any drawing (ensuring the end point), she had created a loop she would only half-use. This had the unusual effect of causing her to take a meandering walk that she chose to abandon without reaching its end.

“THE ART OF WALKING”

While travelling by foot remains a central activity in the lives of the people we studied, GIS-enabled technologies have begun to complicate these experiences. Within the spaces we studied, modes of travel have transitioned from trail following to mapping and now GIS routing, introducing new and different complexities to our experience of the sites and communities through which we move. Our work has shown how the algorithmic traces of GIS technologies might present challenges to turning travel into (or returning it to) a form of communication.

Trace ultimately helped us expose these tensions as opportunities for questioning our everyday tools. Though some people found our prototype’s limited instructions unfamiliar and struggled to engage its rhythms, other people began to welcome the constraints as providing a view into routing. Still others found the work presented a strange intervention into their daily walking routines. Trace opened up new experiences for participants along routine walks and prompted a return to older forms of travel without destinations. In some cases, experiences of walking unknown paths provoked participants to reconsider the place of GIS technology in their daily lives. These observations emphasize the tensions underlying design for itinerant movement and the difficulties of supporting the negotiation of agency. In the sections that follow, we discuss considerations for HCI research that emerged from these tensions.

Challenges of Design for Enchantment

Our work has surfaced challenges in developing enchantment through GIS routing technology. We found that the combination of unfolding instructions and asynchronous messaging confused people without leading them to loose interest in the path. Participants often discussed a process of defying the technology (‘confusing the GPS’), and sometimes reflecting on the procedural logics devising their route. However, the redundant stretches and often mundane settings (selected based on route rather than sightlines, for example) also prompted frustration. This contrast points to the difficulties of designing for curiosity. Although people desire to remain in control of their technology, satisfaction

and wonderment could emerge from allowing the (invisible) algorithm to lead the way. Participants described how reconciling these conflicting aims remained a challenge throughout their use of Trace.

Despite concerns for controlling the walk, the Trace application prompted forms of surprise and delight when participants received new Traces. Participants broadly related these experiences of being ‘caught up’ in moments of wonderment to the social relationship they had with a partner (a long distance relationship), the difficult circumstance of their health (for example, cancer), or their routine responsibilities (dog walking, creating labor opportunities for members of a community). These situations prompt us to consider ways of attending to the intricacies of mundane activities as opportunities for enlivening the everyday.

McCarthy and colleagues [16] have highlighted the concept of enchantment as an experience through which we become awakened to the wonder of life with and through our technologies. Yet, with few exceptions (e.g., [10]), this potential for imagining more intimate relationships with technology has remained under-examined in the design and repair of interactive systems. We found that Trace drew people in to the point of disorientation, amplifying their attention to the minutia of GIS while leaving few familiar cues for them to steady their gaze. In this sense, our work contributes to an understanding of enchantment within HCI by pointing to the challenges of developing emotional attachment to the unknown. Building on prior studies of the interplay between speculation and autonomy [31], we suggest using design interventions that probe commonplace technologies like GIS and the intimate forms of agency those technologies make possible.

The Algorithmic Wayfarer

Our work has also revealed how routing can have itinerant features that expose the always emergent nature of algorithmic life. Creating walking paths by sketching allowed participants to ignite serendipitous connections already underlying their daily interactions within their cities. For some participants this surfaced in response to shifting weather conditions (e.g., drawing a raindrop, thundercloud or leaf discovered on the ground), while at other times this called on aspirational ideas (e.g., the two-masted sailboat that flaunted drawing skills). Several participants relied on abstract shapes to figure out how the mapping algorithm worked for themselves before creating messages for others. Curiously, one participant noted that having access to the original drawing enabled her to see how the application “*lends itself to those kinds of paths.*” Here we find an obvious but notable capacity to reexamine algorithms in daily life by considering their connections to more traditional modes of mapping through sketching. Yet, the participant’s response above suggests a more nuanced view: that people may not currently live a life of algorithmic awareness, and by introducing new ways of recognizing and interacting

with algorithms, we raise the possibility of not only understanding algorithms, but *identifying* with them, too.

These observations may have theoretical and material ramifications for our current understanding of algorithms in HCI. In our study we found the process of creating walking routes became less prefigured and more like the “*art of walking*,” to recall Annika’s phrase. This approach suggests we imagine alternative modes of mapping that could disrupt, relocate, or disorient rather than direct. Future programs of research could examine this capacity for re-engagement (and displacement) through design: using new mapping tools to trouble the necessity of a destination and invite new forms of expressivity and value. Finding less prescriptive and propositional ways to align new geographies with emergent social and civic engagements remains an important challenge for HCI.

While exposing elements of its underlying logic, the Trace application notably sparked slower experiences of walking. Odom, *et al.* [18] describe similar shifts in their recent studies of slow technology. Yet, if the application had been put to use over several months, this heightened awareness might have led to more instrumental ends. People might have responded to the ongoing misdirection, redundancy or confusion by putting down the application altogether. As other projects have sought to examine through cartographic interventions (see [5]), this project has not offered a corrective to problems proliferating from the rampant use of GPS. Rather, our study has used technological development to engender new lines of inquiry into the character of algorithmic life.

Discrimination by Design

Conventional mapping software can sometimes direct people through hazardous conditions, deteriorating roads or dangerous neighborhoods — taking people to places they may not want to go. Trace amplified this experience. Without controlling for where people walked, Trace guided people to places in the city that seemed disconnected from their daily lives and values. Although people described not wanting to visit some places in their city, for better or worse, Trace still found ways to point them there. This quality highlighted differences in the density and diversity of cities and neighborhoods. Seattle produced few “unsafe” encounters, while in Boston several people noted shifting neighborhoods on their walk and, in doing so, drawing social boundaries, both literally and figuratively. Because the Trace application was not designed for efficient routing but for wandering, people began to think less about where they wanted to go than where they were.

Furthermore, this study has asked us to consider the role GIS algorithms play in shaping our moral visions around claims to public space. As walking remains an act of public and civic engagement, we have a responsibility to continually probe and modify how GIS algorithms to accommodate and account for those who use and rely on them [32]. For

example, how do GIS algorithms embody assumptions about walking speed? How do they account for safety, inaccessibility or geographical constraints? As we move forward with this work, we aim to examine opportunities for making these assumptions contestable. How they become part of people's lived experiences of public space raises important questions of pace, expressivity and autonomy for mapping technology today and in the decades to come.

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