CrowdSolve: Managing Tensions in an Expert-Led Crowdsourced Investigation

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Investigators in fields such as journalism and law enforcement have long sought the public's help with investigations. New technologies have also allowed amateur sleuths to lead their own crowdsourced investigations — that have traditionally only been the purview of expert investigators — with mixed results. Through an ethnographic study of a four-day, co-located event with over 250 attendees, we examine the human infrastructure responsible for enabling the success of an expert-led crowdsourced investigation. We find that the experts enabled attendees to generate useful leads; the attendees formed a community around the event; and the victims' families felt supported. Additionally, the co-located setting, legal structures, and emergent social norms impacted collaborative work practice. We also surface three important tensions to consider in future investigations and provide design recommendations to manage these tensions.

CCS Concepts: • **Human-centered computing → Empirical studies in collaborative and social computing**; **Empirical studies in HCI**.

Additional Key Words and Phrases: crowdsourcing; crowdsourced investigation; expert-led crowdsourced investigation; sensemaking; law enforcement; fandom; true crime; design tensions

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1 INTRODUCTION

Law enforcement officials have sought the help of the public in solving crimes for centuries [45, 89]. In the United States, government agents such as federal marshals and county sheriffs distributed posters and handbills of wanted criminals since at least the mid-nineteenth century [2]. As technology advanced, these "wanted" posters were augmented with photographs, published in newspapers, and eventually aired on television in shows like *America's Most Wanted*, which has claimed responsibility for capturing over 1,000 fugitives from viewers' tips. Today, law enforcement agencies use websites and social media to request the public's help in ongoing investigations [e.g., 1, 3, 4].

While the format of these requests has evolved to new types of media over the years, the nature of the request remains relatively unchanged. That is, law enforcement officials seek pieces of information ("tips") from the public to further an investigation. Roles are predefined, with law enforcement controlling all major elements of the investigation, from selecting the targets to

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deciding which lines of inquiry should be followed up, while the public's contribution is limited to providing raw data. Trottier [97] refers to these law enforcement-led investigations as "top-down."

Simultaneously, with the emergence of new information and communication technologies, including online forums, ubiquitous digital photography, and powerful, free investigative tools (e.g., satellite imagery maps, reverse image search) have given rise to a new model of "bottom-up," crowdsourced investigations [97]. These efforts are organized online by members of the public to conduct investigations without the involvement of law enforcement professionals [e.g., 48, 81, 95]. Novices among the public seeking to become more involved in law enforcement experts' investigations have clashed with experts' desires for greater privacy, further complicating their interactions [56]. While some crowdsourced investigations have resulted in successes, such as locating missing persons [4], catching criminals [21], and supporting crisis response efforts [56], they are perhaps better known for high-profile failures involving vigilantism [98], or its online form, "digilantism" [81]. These include misidentifying individuals involved in the 2013 Boston Marathon bombing [81, 92], the 2017 Unite the Right rally [18], and the 2020 George Floyd protests [59], among others.

Despite this criticism, crowdsourced investigations continue to flourish and evolve [80, 103]. Therefore, it is important to understand the contexts in which they can operate ethically and successfully. In this paper, we report on an ethnographic study of CrowdSolve,[1] a crowdsourcing event that blended top-down guidance by law enforcement experts with bottom-up participation by a crowd of more than 250 amateur sleuths. Over the course of four days in October 2019, experts and the novice crowd collaborated in a co-located setting in Seattle, Washington, USA to investigate two decades-old unsolved murder cases. Using Lee et al.'s lens of human infrastructure [60], we examine the motives, experiences, and interactions that enabled success for all of its stakeholders, including law enforcement, the victims' families, and attendees. We also highlight how the event's organizers managed three key design tensions [94] within these infrastructures: experts vs. crowd, openness vs. security and privacy, and entertainment vs. reality. Finally, we discuss sociotechnical design recommendations for improving crowdsourced investigations in particular, and crowdsourcing more generally.

2 RELATED WORK

2.1 Law Enforcement Investigations and the Public

Trottier [97] posits that there are two primary investigative models for solving crimes: top-down law enforcement investigations and bottom-up crowdsourced investigations. Both involve collecting, processing, and analyzing information towards an arrest and criminal proceedings [42]. They differ along three primary dimensions: 1) which group is in control of the investigation, 2) what actions each group can perform, and 3) how information flows among the various groups. Below, we review prior studies of both models and draw parallels to citizen science, another type of crowdsourced investigation involving novices and experts.

2.1.1 Top-down investigations. Top-down investigations are the most common form of investigation. They are led and sanctioned by law enforcement officials, while the public plays a relatively passive role in generating leads as information sensors [31] and sources [17], rather than information processors. The flow of information is also highly restricted and unidirectional — from individual members of the public to law enforcement. Law enforcement actively collects information through open calls to the public, such as tip hotlines [74] and community policing events [53, 63], or passively by monitoring activities online and offline [67].

[1] https://www.crimecon.com/crowdsolve-seattle

Within HCI studies of law enforcement, Erete and Lewis [63] surfaced the importance of studying engagement between law enforcement and the public in online and offline settings because the two formats may afford different types of interactions in both character and content. In another domain, Lalone et al. [56] studied how crisis-response experts and novices interacted on Reddit. They found tensions between the experts' desires for privacy and the public's desire for information access, the rigid and hierarchical nature of expert investigations compared to the loose and easily reconfigurable public investigations, and what types of information each group considers relevant.

This top-down investigative model is similar to traditional citizen science projects where expert scientists direct novice volunteers to collect, categorize, and transcribe data, along with other basic tasks, while the scientists take on the advanced roles of data validation, synthesis, and analysis [58].

2.1.2 Bottom-up investigations. A second, more recent model enabled by the growth of networked digital technologies is the bottom-up crowdsourced investigation [97]. Here, crowds of non-professionals (i.e., the general public) take on a more active role in conducting their own investigations that do not involve — and may not be sanctioned by — law enforcement. Crowds coordinate their efforts to share, collect, and analyze information with others [93, 103] and even administer social and procedural justice [14, 47].

Although prior work has shown that crowds have the potential to scale up and speed up investigations [e.g., 17, 46, 99], undirected novice crowds may engage in potentially harmful behavior. This includes conspiracizing about [76, 87] and misidentifying target individuals [81]. More dangerously, it can involve digilantism [98] — a combination of online doxxing (publicly releasing sensitive details such as the target's home address) and embodied vigilantism (e.g., following a target or visiting their home). For example, crowds on 4chan tried to uncover a whistleblower associated with the impeachment trial of Donald Trump, even misidentifying and harassing individuals online [95]. Because of these and other similar incidents [81], Huey et al. [50] found that law enforcement officials are increasingly wary of soliciting help from the public, further complicating interactions between the two groups.

A related trend has occurred within citizen science, where novices can now more deeply participate in scientific investigations through bottom-up data validation practices [102] and crowdsourced data analyses [96]. However, according to Law et al. [58], leaders of such projects must "negotiate perceptions amongst peers and superiors, constantly demonstrating that they [are] doing real science and not public service." Similarly, crowdsourced investigations focused on crime may also need to establish their legitimacy in the eyes of law enforcement.

2.1.3 Expert-led crowdsourced investigations. In this paper, we describe and analyze a third interaction model that is novel to criminal investigations: expert-led crowdsourced investigations.

This model blends aspects from the two prior models and introduces new, unique elements. Borrowing from the top-down model, CrowdSolve involved experts that provided evidence materials to the crowd, focused the crowd's efforts on specific topics, and reserved the authority of drawing final conclusions for experts.

Borrowing from the bottom-up model, CrowdSolve was funded by attendees and primarily catered to their desires, with the secondary goal of helping law enforcement. Unlike either of these traditional models, CrowdSolve participants were given largely unfettered access to real, extensive law enforcement evidence and case files in a controlled, co-located environment, facilitating trust and security. They were provided with formal training in investigative techniques and tasked with analyzing and synthesizing — rather than collecting — evidence. Stakeholders not normally involved in crowdsourced investigations, such as expert trainers and victims' families, also made valuable contributions.

CrowdSolve extends to law enforcement a trend in citizen science and other forms of mixed-expertise crowd sensemaking where experts enable novices to go beyond basic data collection and categorization. Here, novices can begin to analyze, interpret, and even question the data [e.g. 57, 64, 68]. The sensitive nature of the evidence materials and activities necessitated a co-located, synchronous environment with physically printed documents. This approach stood in contrast to traditional top-down and bottom-up investigations, creating new affordances and constraints. In this paper, we explore how crowds participate in, and can benefit from, active engagement alongside experts, formal training, and unprecedented access to real law enforcement case files.

2.2 Collaborative Sensemaking for Mixed-Expertise Groups

Pirolli and Card [85] define sensemaking as an iterative process that consists of gathering, searching, and extracting information, along with building a mental model to fit the information. Investigations in law enforcement are a classic example of sensemaking [77]. There exists a large body of work within CSCW and HCI studying and supporting sensemaking [e.g., 29, 65, 84, 86, 91]. Here, we focus on studies of collaborative (small group) and crowdsourced (large group) sensemaking, as well as mixed-expertise sensemaking.

Collaboration can augment sensemaking by parallelizing foraging and search tasks, in addition to providing diverse views and theories about connections among various pieces of information [85]. However, there are also coordination challenges, such as incomplete access to information and differences in background knowledge and skills, leading to varied interpretations and ideas [32, 39]. Prior work in collaborative sensemaking has focused on studying and supporting small, co-located groups (i.e., 2–10 people) [e.g., 39, 78, 100], or large, distributed crowds [e.g., 20, 29, 64]. CrowdSolve is a combination of both co-located crowdsourced sensemaking and collaborative sensemaking. The organizers divided the 250 attendees into three large groups and, at times, subdivided those large groups into smaller ones of 8–10 people each. Attendees later reconvened into the three large groups and into one large gathering of all 250 people. We study how CrowdSolve managed the intra- and inter-group coordination and communication challenges to sensemaking posed by such mixed group sizes [73].

Prior work has also explored ways to support sensemaking in groups with mixed expertise [13, 57, 99]. For example, Venkatagiri et al. [99] proposed a crowd-augmented expert workflow that combines the complementary strengths of experts — who have domain knowledge and relevant skills in journalism — with the speed and scale of novice crowd workers. In this approach, information flows bidirectionally as experts work alongside and guide novices who, in turn, augment the information collection and processing abilities of the experts. This model has been explored through system designs and lab-based studies in domains such as creativity (e.g., CrowdBoard [8]), citizen science (e.g., Curio [57]), and innovation (e.g., IdeaGens [13]). In contrast to prior work, we study crowd-augmented expert work "in the wild" and in the domain of law enforcement.

While prior work has focused on small group sensemaking for co-located crowds, or large group sensemaking for distributed crowds, we focus on large group sensemaking for a co-located crowd. Specifically, we study a real-world event where law enforcement experts guide — and are supported by — 250 novices. In contrast to some crowdsourced journalism efforts, where crowds can directly interact with subjects and conduct research in the field [6, 17], the high-stakes, crime-related aspects of CrowdSolve pose concerns such as leaking of sensitive case files and witness tampering. Attendees must sign non-disclosure agreements and rely solely on case files that the organizers share with them. We show that attendees face unique institutional, technological, and ethical constraints at CrowdSolve. Not only must they collaborate and generate new leads on two decades-old investigations in co-located, contained setting, but they must also deal with hundreds

of pages of case files generated by multiple detectives, all with minimal technological support mechanisms.

2.3 True Crime Fandom and Alternate Reality Games

Fandom refers to communities that are socially organized around their shared appreciation of an element or genre of popular culture. Fandoms can be powerful and transformative sites of social support [23, 49], learning [25], and creativity [27, 69], as well as sites of toxic behavior and targeted harassment [24, 55]. True crime fandom revolves around media that contain detailed, often sensationalized, fact-based accounts of criminal acts, such as murders and sexual assaults [30]. True crime media include television shows, films, and books. Podcasts are especially popular: true crime podcasts currently hold four of the top 10 positions on Apple Podcasts [5].

True crime, unlike many online fandoms focused on consuming and creating fiction, is unusual in that it is focused on real-life events that have social implications and pose ethical dilemmas. For instance, true crime fans have engaged in positive forms of collective action towards investigations and cases, ranging from justice reform [90] to uncovering new leads and overturning wrong verdicts [51]. However, the actions of true crime producers and consumers have also raised concerns about vigilante behavior [16].

Most closely related to our work here, Coombs [66] conducted a content analysis of posts on Reddit's r/serialpodcast that investigated the case of Adnan Syed [40], a man convicted of the murder of his ex-girlfriend, who pleaded not guilty. Coombs drew parallels between this true crime fandom investigation and other citizen-led investigations, such as how people engaged in collaboration, disseminated unverified information, and were constrained by the rules and moderators of the subreddit. Using the lens of fandom studies, he found that there is a unique tension between two of the fans' goals: one, to solve a real-life case, and two, to continuously create and engage with a "neverending archive" as a source of entertainment. Building on this work, we study how true crime fans engage with real investigations in CrowdSolve, finding a similar tension between entertainment and real-life progress in the investigation. Unlike Coombs [66], our study focuses on a primarily offline, co-located, and time-constrained event rather than an online community. While Coombs focused solely on Reddit users, we focus on the social dynamics between fans, experts, and law enforcement.

Also closely related to our work are Alternate Reality Games (ARGs) and their associated fandoms. ARGs involve fictional narratives that unfold both online and in the real-world, over multiple geographies and extended periods of time [71]. ARGs combine physical and digital artifacts to set up cryptic mysteries that are intended to be solved by crowds. To succeed, crowds must quickly share information and solutions, and leverage their varied expertise [33]. ARGs are also designed to be highly immersive [75], and some ARG designers even attempt to create learning environments [82]. Unlike ARGs, CrowdSolve focuses on two real police investigations, and "gameplay" is intended to be constrained to one physical venue and period of time. However, the event has other elements in common with ARGs, including fans' desire for immersive entertainment, and the goal of combining fans' collective insights and diverse skills to solve the mystery at hand. We extend prior work by focusing on a high-stakes event (CrowdSolve), and a fandom which has seen little research attention in CSCW or other fields (true crime). We also employ a different approach to investigating values and tensions (Tatar's Design Tensions Framework [94]).

3 METHODS

Initial contact. One month prior to the start of CrowdSolve, the organizers of the event contacted us based on a referral from a colleague, due to our prior experience with crowdsourced investigations. The organizers asked us to recommend tools and techniques that could they could use to leverage

the 250+ attendees' efforts in analyzing hundreds of pages of case files and generating useful leads for law enforcement. Over several phone calls and email exchanges, we provided recommendations from related work in crowdsourced sensemaking. Based on the nature of the two cases, we also suggested that organizers use GIS software (e.g., Google Maps) and collaboration tools (e.g., Google Docs and Sheets, wikis). However, given limited time and concerns about digitizing case files (detailed below), the organizers implemented only one of our suggestions: giving attendees specific and actionable sensemaking tasks.

Due to the unprecedented nature of the event, we believed that studying it would provide valuable insights for CSCW and crowdsourcing research. Through our conversations with the organizers, we learned more about their plans for the event and obtained their permission to study it formally. We determined that an ethnographic study [54] would be best suited to understanding the emergent norms and interactions surrounding the event. Our study was approved by our university's Institutional Review Board (IRB) and took place between October 2019 and January 2020. The first two authors attended the entire four-day event. We also familiarized ourselves with true crime culture through news articles, academic papers, and podcasts associated with the event and true crime more generally.

Goals. We used Lee et al.s' lens of *human infrastructure* to examine CrowdSolve as an example of collaboration between law enforcement and the public. Human infrastructure is defined as "the people, organizations, networks and arrangements that constitute [a] site as a collective entity" [60]. While Lee et al. focused on the human infrastructure of a cyberinfrastructure, we found that human infrastructure is also a useful lens with which to examine contexts where digital technologies play a smaller role [e.g., 22], including CrowdSolve's intentionally limited cyberinfrastructure. Of particular relevance to CSCW, we expected this lens would help reveal how, despite the minimal technological infrastructure, CrowdSolve enabled the crowdsourcing of sensitive information by leveraging the *human* infrastructure at the event. We also sought to examine the motives, experiences, and interactions of multiple stakeholders during the event — organizers, experts, victims' families, and attendees — especially their individual and collective contributions towards the greater infrastructure of CrowdSolve.

Reflexivity. All members of our research team are interested in identifying ethical and effective ways to enable novices to support experts in domains such as law enforcement and journalism. Our prior work has focused on issues of efficacy, power, and fairness in social-technical and crowdsourcing systems.

3.1 Data Collection

Two members of the research team physically attended CrowdSolve from October 17–20, 2019 in Seattle, WA. We used multiple methods to collect data both in-person and online: a survey, diary entries, participant and non-participant observation, semi-structured interviews, and focus groups. We also took detailed field notes throughout.

Terminology. We use the term *stakeholders* to collectively refer to the event organizers, law enforcement experts, victims' families, and attendees. *Attendees* refers to individuals who we observed through participant observation. We did not interview all attendees. *Participants* refers to the subset of stakeholders who participated in our study and completed the consent form, a survey, diary entries, and/or took part in the semi-structured interviews.

At the event. With the permission and support of the organizers, we sat next to the event's registration desk and distributed informational packets about our study. The packets contained a flyer advertising our study, consent form, survey, and instructions for submitting diary entries.

They also included our contact information, as well as a link to an identical online version which participants could share with others who did not have a physical copy. The survey asked for participants' contact information; demographic details (age, gender, and occupation); and open-ended questions such as their motivations for participating in the event, what they would consider a positive experience, and also asked for the names of similar events that they had taken part in before, if any. In total we distributed 230 packets to all stakeholders and received 45 signed physical copies and three online copies. Four other participants provided consent verbally.

At the start of the event, when all of the attendees were seated in the main conference room, the organizers introduced the first two authors as researchers and informed them of our study. We also took care to introduce ourselves as researchers throughout the event. We conducted both participant and non-participant observation in person, totalling approximately 60 hours. We attended sessions, participated in and observed group discussions, spoke with individual stakeholders, and facilitated informal focus group discussions during meal times. The organizers also invited us to the private Facebook group set up for the event, where we conducted non-participant observation from October 17, 2019 to January 30, 2020.

We received only three diary entries (two by phone and one by email) and interviewed two of these participants. Low participation may have been due to the time-compressed nature of the event, with attendees' schedules filled from early morning to 9:00 pm or later most nights.

With participants' permission, we audio-recorded all interviews except for one where the surroundings were too noisy. We also took detailed notes. All but one of the interviews were conducted in person during CrowdSolve; the other was conducted online four weeks after the event. We did not conduct any interviews on the first day to give participants (and ourselves) time to settle in. To avoid disrupting participants, we conducted interviews either before that day's program, during the break, or at the end of the day. Based on our observations of experts' presentations, individual work practices, and the collaborative work sessions, the first two authors periodically conferred on ways to adapt the interview guide. For instance, we observed that one team, to make better use of their time, assigned specific portions of the case files and a subset of expert prompts to each teammate to read and answer. This observation led us to ask the questions: "How did your team make sense of the case files to answer the experts' prompts? What would you do differently in the future?" We did not directly use the case files to seed our interviews. This is because we did not have access to the case files until they were handed out each day, and because they were hundreds of pages long, making it difficult to quickly develop specific questions.

We stopped conducting interviews when we reached theoretical saturation [88]. In total, we conducted 27 semi-structured interviews with 30 participants, totalling 10 hours (average = 22 min., minimum = 13 min., maximum = 60 min.).

3.2 Analysis

The first author transcribed all recorded interviews. In consultation with the rest of the research team, the first author conducted an inductive thematic analysis [10] of all of the collected data. As previously mentioned, we used Lee et al.'s work [60] as an analytic lens to highlight the human infrastructure underlying this event.

We identified four primary stakeholders: organizers, attendees, experts, and the victims' families. Some of the initial themes for organizers were conceptualizing the event, finding suitable cases, preventing information leaks; for attendees: desire for altruism, desire for entertainment, information overload, challenges in collaboration, wanting closure; for experts: providing training, keeping attendees focused; and for the families: regaining control, emergent norms.

To refine our analysis, we conducted a member-check [36] by presenting our initial findings to the organizers in January, 2020. This also provided the organizers with insights on the challenges

and opportunities that we found, which they could address or leverage in the second version of CrowdSolve, scheduled to take place in Chicago, IL at the end of February, 2020. We also received feedback on the final version of this paper from one of the organizers in January 2021.

3.3 Participants

Code	Name	M/W*	Age	Role	Occupation
O1	Kevin Balfe	M	—	lead organizer	partner at Red Seat Ventures
O2	—	W	—	organizer	true crime producer, journalist
O3	James Baysinger	M	—	organizer	insurance agent, true crime podcast host
OE4	Arthur Roderick	M	63	expert and organizer	retired US Marshal, consultant
OE5	Karen Smith	W	—	expert and organizer	retired detective, forensic consultant
E6	Grover M Godwin	M	61	expert	forensic investigator
E7	Mark McClish	M	60	expert	retired US Marshal, statement analysis expert
PD†	Mickey Hamilton	M	—	expert	TCPD lead detective for both cases
F1	William	M	—	Moyer's husband	—
F2	Sam	W	—	Moyer's daughter	—
F3	—	W	—	Bodine's family	—
F4	—	W	—	Bodine's family	—
F5	Tanner	M	—	Bodine's son	—
F6	Karlee	W	—	Bodine's daughter	—
F7	Taylor	W	—	Bodine's daughter	—
P1	—	W	27	attendee	private investigator
P2	—	M	27	attendee	musician and teacher
P3	—	W	30	attendee	speech-language pathologist
P4	—	M	35	attendee	private investigator, para educator
P5	—	W	46	attendee	tax accountant
P6	—	W	67	attendee	retired director of special education
P7	—	W	48	attendee	mechanical engineer
P8	—	W	39	attendee	clinical social worker and consultant
P9	—	W	28	attendee	forensic mental health specialist
P10	—	W	63	attendee	clinical psychologist
P11	—	W	39	attendee	—
P12	—	W	47	attendee	high school English teacher
P13	—	W	50	attendee	criminal justice and social science educator
P14	—	M	—	attendee	—
P15	—	W	—	attendee	—

Table 1. Participant codes and demographics. Some names have not been anonymized because they have been widely mentioned on the event's website, social media pages, and related news articles. † PD's views are his own and do not represent the views of TCPD. * We used an open-ended question to ask participants what gender they identified as; we received two response types: "man" (M) and "woman" (W).

Organizers and experts. We interviewed five of the organizers (O1, O2, O3, OE4, OE5) who were responsible for making high-level decisions that shaped CrowdSolve. O1 is one of two partners at Red Seat Ventures (RSV), a venture and consulting business. O2 works for RSV as a true crime producer, while O3, OE4, and OE5 have acted in consulting capacities and as hosts for previous RSV events. O3 runs a popular true crime podcast called *Hide and Seek*, OE4 is a retired US Marshal who has hosted several episodes of the TV show, *America's Most Wanted*, and OE5 is a forensic scientist who has worked on over 20,000 cases. We also interacted with, but did not interview, two other organizers who handled logistics for the event.

Apart from OE4 and OE5, we interviewed two of the four other experts at the event (E6 and E7). E6 is a criminal profiling expert who uses multivariate analysis to determine potential suspect profiles,

and E7 is a former US Marshal with expertise in detecting deception based on analyzing interview statements. While OE4 and OE5 helped to organize the event and acted as expert facilitators for parts of the event, E6 and E7 only acted as expert facilitators. OE5, E6, and E7 led one or more expert sessions. PD is a member of the Thurston County (Washington) Police Department (TCPD) and the lead detective for both the cases. He did not lead any sessions but answered attendees' questions during other experts' sessions.

Victims' families and attendees. We interviewed the Moyer family (F1, F2) once, and the Bodine family (F3–F7) twice. We interviewed 15 attendees (P1–P15) at least once. We interviewed several attendees twice (P1 and P2 together, P8, P10, P14). Some of the interviews included more than one attendee (P1 and P2; P8, P11, and P15).

4 ORGANIZING CROWDSOLVE

Using Lee et al.'s [60] lens of human infrastructure we highlight: (1) the various decisions, labors, and coordination activities required to organize the event; (2) the stakeholders' diverse backgrounds, motives, and definitions of success; and (3) how each of them played a crucial, interrelated role in the functioning of the event.

In this section, we foreground how the organizers conceptualized the event, their goals, the steps they took to find suitable cases, and finally how they set up the event to meet their goals.

4.1 Organizers' Goals for CrowdSolve

RSV has organized CrimeCon, an annual national true crime convention, since 2016. According to O1 (one of the two partners at RSV), many CrimeCon attendees over the years expressed that they wanted the event to delve deeper into a single case file. In response, O1's team organized CrowdSolve: a co-located event where a crowd of novice true crime enthusiasts would learn from, and be guided by, law enforcement experts as they collectively investigate a case. RSV is a for-profit company and one of its main goals is to maximize profit. For instance, the registration fees for the event ranged from $329 to $799 per attendee, with the more expensive tiers providing additional opportunities to interact with the victims' families and law enforcement. Correspondingly, we found that the event was marketed as providing deeper engagement for true crime enthusiasts.

However, similar to the attendees (discussed in Section 5.3), O1 highlighted an additional, altruistic goal for the event: "*My minimum benchmark for success is that our final report to [TCPD] includes a number of new ideas, leads . . . that are not B.S. That they feel like are worth their action and attention.*"

4.2 Choosing a Case to Investigate

To choose a case for CrowdSolve, the organizers first needed to develop selection criteria, then obtain law enforcement's permission, and finally get the victims' families to agree to participate in the event.

4.2.1 Developing selection criteria. O1 said that finding and selecting potential cases was *"probably the most challenging"* part of organizing CrowdSolve. It required aligning the organizers' goals for the event with external factors, such as the attendees' limited expertise, the amount of case information available, and legal barriers, among others. To help manage these considerations and determine what cases would work best, O1 decided to form an advisory committee. He drew on the relationships he built over the past four years organizing CrimeCon to populate the committee with investigators and detectives:

> *[They provided a] solvability factor in the case itself…Is there something that you [the crowd] could potentially impact? Or is this going to be a cold case forever? Or is this a case that is just completely reliant on a piece of science, like DNA?*

The committee believed that the "solvability factor" of a case was an especially important selection criterion. OE4, who was part of the advisory committee, described how he drew on his experience consulting for *Amerca's Most Wanted* — a TV show that leveraged crowdsourced tips from the public to find fugitives — to generate a three-page list of criteria that comprised the solvability factor. This included whether there was a suspect, if the district attorney's office was on board, and whether law enforcement was willing to open up their case files.

4.2.2 Finding potential cases and approaching law enforcement. After defining the criteria for cases, the organizers then needed to find potential cases. O1 said that one potential source of cases was the CrimeCon community itself. Fans, attendees, and victims' families would often pitch cases to the organizers to be presented at CrimeCon to the extent that their *"email [in]boxes are overwhelmed with pitches."* The organizers reviewed these requests to shortlist cases for CrowdSolve. O1 said that the fans, attendees, or victims' families would then introduce them to the local police department handling the case. However, the organizers said that they faced resistance from police departments because they lacked a track record of conducting such events. Even when the committee would get further into a conversation with law enforcement, they often encountered other challenges, such as *"the family hates the police, or…solvability factor is very low"* (O1).

4.2.3 Approaching victims' families. At times, the sheriff's office would introduce the organizers to the victim's family. O1 found that *"in every case, the families have been the most open to any sort of experience like this."* O3 initially pitched one of the two cases at CrowdSolve, the Nancy Moyer case (described below), to the organizers. Prior to contacting the organizers, he was investigating the case for his true crime podcast, *Hide and Seek* [9]. The case was first presented at CrimeCon 2019 by O3 and PD. When the organizers were searching for a case for CrowdSolve, they quickly realized that both TCPD and the Moyer family were interested in participating.

O2, who has worked as a true crime producer for the past 10 years, was the organizer responsible for approaching the victims and working with law enforcement to organize the case files. She would obtain the victims' family's contact information from the police department handling the case or would message them on social media.

4.3 Putting It All Together

We found that the organizers spent considerable time and effort in planning the event. Apart from general logistics involved in setting up an event for over 250 people, the two cases' unique circumstances influenced the structure of the event, including the experts that were recruited and how the case files were curated.

4.3.1 The two cases. Below, we briefly summarize the two cold cases selected for CrowdSolve.

Nancy Moyer, a 36 year-old mother of two, disappeared on March 6, 2009. Her body has not been found, and her disappearance has remained a cold case since then. In July 2019, O3 investigated the Moyer case for his podcast, and during his investigation, a suspect, Eric Roberts, allegedly confessed in a 911 call that he was responsible for Nancy's disappearance [34]. O3 later interviewed Roberts for his podcast, during which time he recanted his confession. However, this new development turned the cold case into an active investigation, causing TCPD to restrict the information that they could share with CrowdSolve organizers and attendees.

In turn, O1 said he worried that restricting information on the Moyer case would make it less immersive for attendees, since they would have less access than originally indicated. Further,

Roberts' confession might bias the attendees who were generating leads and ideas. Therefore, the organizers decided to find a second case for the event. O2 was already working with TCPD to present the Moyer case at CrowdSolve, so she worked with PD to choose another TCPD case for the event, the Karen Bodine case. O2 reached out to the family members on Facebook.

Karen Bodine, a 37 year-old mother of three, was found dead on January 22, 2007. According to the CrowdSolve website, Karen had a prior arrest record related to involvement with *"some unsavory people."* The lead detective, PD, believed that Karen's murder was associated with her involvement with drugs and those people.

As of this writing, PD is the lead detective at TCPD investigating the Nancy Moyer and Karen Bodine cases. Although several detectives prior to him had been assigned to the two cases, they have since been reassigned or moved to other police departments. Both cases remain unsolved.

4.3.2 Recruiting experts. Since the organizers were *"trying to do something that mostly is in the hands of professionals"* (O1) and the attendees had a variety of backgrounds and experiences, organizers first needed to make sure that all the attendees had a common set of skills and knowledge for conducting an investigation and approaching the case files. The organizers planned to have multiple breakout sessions throughout the event where each expert would educate the attendees on a specific aspect of the case. The organizers approached experts who had previously presented at CrimeCon or whome they knew from mutual connections. Two organizers, OE4 and OE5, acted in dual capacities as experts and organizers. O1 described how the experts were specifically chosen depending on the key elements of each case:

> *Here [Karen Bodine's case] was the autopsy, the manner of death, the statement analysis, deception analysis, the crime scene itself, and the photos…[For both] we've brought in two former US Marshals, we have a woman who's done 20,000 cases in her career, Dr. Godwin, a world renowned criminologist, and Dr. Smock, the only police surgeon in the world.*

4.3.3 Controlling access to information. To generate relevant new leads, the organizers decided to give attendees access to the case files. However, TCPD had privacy and security concerns around information being leaked and the potential for jury tampering. Consequently, the organizers made three interrelated decisions to control access to information at the event.

First, the organizers and TCPD required all attendees — including the first two authors at the event — to sign a non-disclosure agreement (NDA) stating that they would not share or discuss any sensitive information that they were provided at the event or present in the case files. Photography was also strongly discouraged. The organizers said that they instituted the NDA to mitigate, though not eliminate, the potential for information to be leaked and thus taint a jury pool.

Second, the organizers decided to have the event be entirely in-person, and to not use technology to share any sensitive information. The only online component was a private Facebook group to make announcements and connect attendees with each other. The organizers also did not share any sensitive information on the Facebook group.

Finally, as a result of the decision to not use any technology and to to further limit the possibility of information being leaked, the organizers physically printed the case files to hand out to attendees. At the end of each day, the organizers required attendees to return the case files, and counted them to make sure none was missing.

O2 said that both cases consisted of *"hundreds, if not thousands of pages of interviews, and reports, and photos,"* which contrasts with the many blurry photos she had encountered when working with other police departments. However, she described the files as organizationally *"just a mess"* and needed to manually curate the files before handing them to attendees. She found this task difficult because she needed to first organize the files and learn the structure, and second, understand what

TCPD needed help with and wanted attendees to focus on. In total, O2 said that the task took her approximately 350–400 hours to complete, occasionally working with OE5 and another organizer.

With regards to vigilante behavior, OE4 saw a possibility that some attendees would take the case into their own hands and interact with potential suspects. He went on, *"I think I've mentioned a couple times about screwing up the prosecution. But, you know, we try to warn them as much as we can. That's always going to be an issue."* OE5, on the other hand, was more optimistic and believed that the majority of attendees held altruistic motives with no ill intent.

4.4 The Event

The event spanned approximately $3\frac{1}{2}$ days from Thursday evening to Sunday evening. Because the organizers and TCPD were limited in how much information they could share on the active Moyer case, they decided only to spend the first $1\frac{1}{2}$ days on it. The remaining 2 days were allotted to the Bodine cold case, which could be explored in more depth, since it was not an active case. The event proceeded as follows (see Fig. 2 in Appendix for the complete schedule):

(1) OE4 presented an overview of the case, including a timeline and description of relevant evidence found.
(2) The organizers divided the 250 attendees into three large groups. For the Moyer case, the organizers divided attendees into three groups for only one breakout session at the end of the second day. For the Bodine case, the organizers divided attendees into groups much earlier — within the first three hours on Saturday.
(3) The organizers gave each attendee a packet containing a portion of the curated, printed case file that varied based on the group they were assigned to.
(4) The three groups rotated between different conference rooms for 45-minute expert sessions. In each session, experts discussed specific elements of the case, such as perpetrator profiles (E6), suspect statements (OE4), and in the Bodine case, the autopsy report and a walk-through of the crime scene.
(5) After the expert sessions, there was a two-hour breakout session where organizers instructed attendees in each group to form smaller teams of 8–10 people. Here, attendees worked to answer questions that the experts had identified as being potentially useful to TCPD, as well as generating other theories and ideas. There was one breakout session for the Moyer case and two for the Bodine case.
(6) After the breakout sessions, all the stakeholders convened in one conference room for a plenary Q&A session.
(7) On the last day, the organizers recruited a professional facilitation firm to elicit feedback from all attendees, both about the two cases and the event itself. This resulted in a Case Action Report (CAR) which the organizers shared with TCPD after the event (detailed in Section 6.1.5).

Our focus was primarily on step 5, the collaborative work sessions. These sessions were heavily scaffolded by the experts, who gave attendees specific observations to focus on or questions that they should answer in smaller teams. For example, in one session, the teams were asked to analyze a set of crime scene photos and answer a set of questions, such as, "Is there anything that may give you clues about her [the victim's] state of mind or her plans for the weekend?" The experts rotated among the different teams, answering their questions and responding to the ideas that they generated. PD also attended some of these sessions.

5 OTHER STAKEHOLDERS' MOTIVES AND DEFINITIONS OF SUCCESS

In the previous section, we presented the organizers' motives for developing CrowdSolve, the steps taken to organize the event, and the outline of the event itself. In this section, we present the motives of the law enforcement experts, TCPD, the victims' families, and attendees for participating in the event and their definitions of a successful outcome.

5.1 Law Enforcement Experts and TCPD

We found that the law enforcement experts — OE5, E6, and E7 — expressed a desire to help the lead detective (PD), TCPD, and the victims' families. In addition, the novelty of the setting, financial compensation, and the opportunity to showcase their expertise in an event that had amassed media attention positively influenced their decision to participate. For example, E7 noted that the event was the first of its kind and that he wanted to share his expertise with attendees.

As for TCPD, PD said that the police department was willing to participate in CrowdSolve for two reasons. First, since the two cases had not been solved for over a decade, the event might act as a catalyst for helping them make progress. For example, PD felt that there was not *"anything to gain for the family, the department, or anyone else by just leaving them in a room somewhere and having a detective look over them every four or five years."* OE5 described how attendees, despite being novices, could provide a new perspective on cold cases:

> *I've always known that the more eyes you can put on a case the more chances you have of solving it, especially when they go cold, especially when leads run out. Just because we're experts, so to speak, in the field, and we have experience, doesn't mean that we don't get tunnel vision, and that doesn't mean that we see everything.*

Second, PD believed that the experts *"alone are worth the money"* for the training they could provide to him and the attendees. He saw the event as an opportunity for TCPD to learn new ideas and get input from other law enforcement professionals with expertise that he did not possess.

5.2 Families

Both families said that they were excited to participate in CrowdSolve since it was an avenue that had not been explored before, but were willing to try since over a decade had passed and the cases had not been solved. F6 was in a state of disbelief that someone was trying to help solve her mother's case: *"I was like 'What! Someone who's paying attention to us?' Like, 'Are you kidding? Wait, is this real?'"* She immediately agreed to participate because she felt that the more exposure the case got, the better. F1 also said that CrowdSolve provided his family with a chance to *"put [the] case right back in the spotlight where there's more people looking at it"* and help move the cases forward. Their motives for attending the event were twofold: 1) to regain control over their loved ones' narratives, and 2) to help solve the cases.

5.2.1 "Setting the record straight". CrowdSolve provided the families with the unique opportunity to take control of theirs' and their loved ones' narratives, both at the event with attendees, and outside of it through the media. For instance, F2 said she often reads comments posted to social media about her mother out of curiosity, but that sometimes it upsets her and she tries *"to set the record straight and reply to their comments."* However, she finds it difficult to do so because people would often ignore her, not realizing she was Nancy's daughter.

While attendees might speculate and engage in rumor-mongering at CrowdSolve, F2 said that being at the event with a platform from which to speak allowed families a chance to clarify beliefs and facts, because they had *"some control to be able to let people know, 'Okay, here's what we believe really happened here.'"*

5.2.2 Families' definitions of success. During the event, both families said that the event was already a success since it could help move the cases forward in some manner. For example, it could give TCPD access to more expertise, or generate new ideas that might lead to a prosecution. They also found the risk of failure to be minimal. If nothing came of the event, they would be *"no worse off than [they] were before, so why not try?"* (F1). According to F1, the *"ultimate success"* would be to solve the crime. However, the two families were realistic in their expectations and did not believed that the event would immediately lead to the cases being solved.

5.3 Attendees

Attendees had diverse backgrounds and occupations that influenced their expectations of the event and what they believed would be a successful outcome. While some attendees were from the Seattle area, most had flown in from other parts of the U.S., Canada, and Europe. OE5 and O1 pointed out that the majority of attendees identified as women. Only six of the 35 survey respondents, and five of the 15 interviewees, had attended CrimeCon or a similar event. Two of the five had attended at least three of the previous four CrimeCons. Almost all attendees had a deep interest for, and fascination with, true crime media.

Attendees expressed four motives for participating and ways that they would measure the success of the event. They wanted to (1) engage in altruism, (2) have a unique experience, (3) learn more about the role of law enforcement, and (4) find like-minded individuals. We focus on the first two here, as they came up in nearly all of our interviews.

First, almost all attendees expressed a desire to engage in altruism by helping the victims and their families *"so that the family gets things that all families should get"* (P6) — i.e., closure. They felt that this event provided them with a way to do so. P14 said, *"When I heard about this, it was like for the first time the public — you, me — could be an investigator. Maybe I could do some good."*

Second, many chose to attend because the victims' families would be present, which made the event feel more personal. The attendees reported feeling more invested in the event. For example, P10 said that having the families present made it personal and real, and that it served as a constant reminder to be respectful to the victims. One attendee, P14, contrasted this experience to participating in online forums, and said that she did not see herself *"getting personally invested in a random crime and feeling that same passion."*

Some attendees with relevant professional backgrounds, such as psychologists or social workers, saw true crime events like CrowdSolve as a way to advocate not just for the victims of the two cases, but for all victims more broadly. P3 explained:

> *The whole true crime thing, it's not about any one event or one moment, it's really about this upwelling of understanding that's coming that we all need help with this. . . . I think [success is] more complex than just. . . "Does it solve the crime or not?"*

Even though CrowdSolve brought together attendees with varied backgrounds, almost all envisioned themselves contributing towards a form of social justice, resulting in a shared definition of what a successful event meant to them.

6 INTERACTIONS BETWEEN THE STAKEHOLDERS

While the organizers were responsible for envisioning, setting up, and running CrowdSolve, our findings also show that the interactions between the other stakeholders in the group were crucial for it to function properly. We focus on the most salient relationships: (1) between attendees and experts, (2) between the attendees themselves, and (3) between the attendees and the families.

6.1 Interactions Between Attendees and Experts

We find that the event acted as a sort of crowdfunding model, where the attendees' registration fees directly paid for the experts to be at the event. During the event, experts taught attendees new techniques that could be used to generate useful leads for TCPD. However, the relationship between them evolved in complex and occasionally strained ways.

6.1.1 Experts helped attendees learn and generate leads. OE4 said that CrowdSolve bringing together experts was *"very beneficial"* to all stakeholders involved. Experts not only helped PD and TCPD, but also the attendees themselves. Because the experts were chosen based on important aspects of each case, O1 said that they were able to provide attendees with a baseline level of training when looking through the case files. Many attendees said that the experts' guidance was valuable and ensured that they stayed focused on the task. P5 said that *"having an expert [meant] that you can just bounce ideas off of [them], they really get it because it's their field, and they're bouncing ideas back."* P7, an engineer by profession, found it *"very useful"* when one of the experts corrected a misconception she had learned from television about strangulation by *"pointing out the science of why it's not true,"* helping her to better understand the case.

Attendees also wished that they had access to additional experts beyond those at the event. For example, in Karen Bodine's case — in which Karen and many of the suspects were reportedly drug users — two attendees wished there was more instruction about the behavioral effects of drug use and addiction. This would have helped them to *"only ask the questions about her drug use that were really necessary to understand how to solve this crime"* (P8).

6.1.2 Some experts' presentations were distressing. Many attendees, as well as the Bodine family, found that some experts handled gory details and imagery better than others. P8 noted that the predominantly female audience (*"90 to 95% women"* (OE5)) may have included many survivors of violence. Some experts were more respectful and mindful of this audience, while other presentations were more insensitive and distressing. P12 described the variance in presentations:

> *[OE5] said 'I'm cropping these pictures and being very respectful, the family is here.' And so we did see some crime scene photos, but the way that she cropped them was very sensitive... And then we went into the second one where it was about strangulation... and he had pictures that showed her private parts that didn't need to be shown. So I could feel the tone in the room was very different. One of the family members got up and left... I thought that was really, really insensitive, and made a lot of us uncomfortable.*

This example demonstrates the tension between attendees' desire to be immersed in every detail of a case and the distress of being exposed to such macabre imagery. Further, not all of the experts may have had experience presenting to an audience of novices.

6.1.3 Experts were overwhelmed. Although the three experts said that interacting directly with the attendees was helpful, they were also overwhelmed by the 75 people split into 10 groups that were vying for their attention. P5 described the difficulty of getting experts' attention:

> *[E]ven when the experts were talking to us, people kept coming in and interrupting us... you get one table who just talks to them for the whole time. And everyone else is like "I didn't get a chance to ask them this or that."*

We observed that experts would walk between groups and answer multiple questions, but often about the same topic. Further, experts did not spend the same amount of time with each group, causing some groups to feel left out. Thus, experts' time and attention were not only spread thin, but may not have been allocated optimally.

6.1.4 Attendees provided useful leads. Experts found the format of the event was similar to, but better than, a tip hotline for multiple reasons. First, OE4 explained that the event was focused on people analyzing evidence and generating new insights to help police. In contrast, PD said that tip hotlines rely on an eyewitness account and that often people don't know what information law enforcement may need. Second, the attendees were not anonymous and experts interacted with them in real-time. Therefore, experts said that they were more willing to trust the attendees' insights that were strongly grounded in the evidence. PD added that with anonymized tip hotlines, communication is one-way, and attempting to follow up on a tip can be frustrating.

According to the experts, the baseline training that attendees received allowed them to provide new perspectives and generate potentially helpful leads. PD said that some of the ideas suggested to him by the attendees and experts were useful, since they were things he had not thought of yet. This was one of the main reasons TCPD had agreed to participate in CrowdSolve in the first place (see Section 5.1). For example, PD planned to follow up on an attendee's suggestion of a forensic paint database:

> *Somebody pointed out that the Royal Canadian Mounted Police have a paint database, and they can do some spectrometry on one of the paint flakes that we've collected in this case and possibly tell me the make and model of the car that it came from.*

Despite years of training, PD said that he learned valuable techniques from the experts, e.g., he pointed out how E7's statement analysis technique would be useful in interrogating suspects.

6.1.5 Synthesizing attendees' leads. Apart from the facilitation session on the last day, there was no structured way for attendees to submit their ideas to experts or the organizers during the event. During the single facilitation session, attendees rotated among groups of different sizes and shared their ideas with each other. Some of this information was written on large sheets of paper stuck to the walls, or using Post-it notes grouped into three categories: ideas, actions, and questions. The facilitators also used a mobile website to survey and quantify attendees's thoughts and project them on a large screen as dynamic word clouds for everyone to see. After the event, the organizers asked attendees to answer questions in a survey about specific suspects and other thoughts that they may have. The organizers then synthesized notes from the facilitation session and the two surveys into a Case Action Report (CAR). The CAR was shared with TCPD after the event.

Although the facilitation session allowed attendees to discuss their thoughts and ideas in a structured manner with others, it occurred at the end of the event. Some attendees likely would not have remembered every valuable idea that they had, and multiple attendees had already left the event at that point of time.

Because we signed the same NDA as attendees, we are unable to describe the CAR in detail. At a high level, it mostly contained attendees' thoughts about potential perpetrators and next steps for law enforcement to take, ranked based on how many attendees felt that way. The organizers said in a Facebook post after the event that the CAR was well-received by PD and was "*generating quite a bit of enthusiasm among the detectives and the cold case unit.*"

6.1.6 Attendees wanted closure. Six weeks after the event, the CAR was shared with attendees on the Facebook group, and included responses from PD to their questions. However, there was no way for attendees to follow up with the experts. Many wished that they had more information about what would happen after the event, such as whether they would be able to communicate directly with PD or the other experts about the two cases in the future. P1 proposed an online forum for this purpose:

> *You know, I keep thinking what happens after this weekend… do we just kind of go back to our regular lives? … If there's somewhere where [PD is] like, "Okay, I'm focusing on this*

particular case, Karen's case, I'm going to login to the server. Okay, people have questions. Yes, I checked the DNA for that." And now we can continue having that dialogue in a way where he can also maintain it.

Apart from wanting to receive periodic updates, attendees wanted a way to continue working on the two cases even after the event. Indeed, on the Facebook group, one attendee said said that they would create a Google News alert for the cases. On the other hand, experts were financially compensated for their participation only during the event, and may have been reluctant to participate after the event ended.

6.2 Interactions Among the Attendees

The attendees started to form a community, but faced challenges when it came to the collaborative work sessions. These challenges ranged from teams lacking the requisite expertise, context, or technology when reading through the case files, to collaboration challenges, such as sharing information between teams and structuring group work. Further, a few attendees engaged in behavior bordering on vigilantism during the event.

6.2.1 Teams lacked organization and expertise. Within the three larger groups, attendees were asked to form small teams of about 10 people. However, we observed that without explicit guidance, they were often formed in an arbitrary manner. For example, P15 said that her team's group discussion felt unstructured and rushed at times because her team did not choose a group leader. As a result, some teams struggled to stay focused on the task at hand. P12 explained how she refocused her team's attention by pointing out when the topic of discussion drifted: *"That was the way to silence those voices, because we're not helping them by having that conversation, we're helping them by answering questions that they [experts] have asked us."*

Some attendees also wished for more people with relevant expertise in criminology and psychology in their teams. They suggested offering a scholarship or special rate to encourage students in those fields to attend CrowdSolve.

6.2.2 Attendees experienced information overload. Attendees were enthusiastic about having access to real police case files. We observed that some took detailed notes and often discussed their findings and summaries with each other in person. Despite their enthusiasm, many attendees reported experiencing information overload when reading through over 100 pages of case files and analyzing multiple witness statements. In P9's words: *"Oh my God. It was driving me crazy. I had to start writing names down because I couldn't keep people straight."*

Even though the case files had been organized prior to being handed out, some attendees felt that they lacked context about what they and other groups were given. For example, P14 said he felt limited without having access to the entire set of case files: *"I can't do anything if I don't have the whole puzzle."* Although it might have been prohibitively expensive to provide each attendee with a printed copy of the entire set of case files, P14 instead wished for a shared Google Drive where attendees could read and search the case files digitally, but public access was restricted, attendees' actions were tracked, and printing and saving local copies was disabled.

Although attendees were each given a small portion of the case files, we noticed that they struggled to synthesize and make sense of what they were given. Complicating matters further, attendees did not always know how long they would be able to keep the case files, and wished that they were informed earlier about how much time they were allotted. P1 and P5 wanted to have access to case files even prior to the event starting. P8 explained that having case files and setting expectations prior to the event would be beneficial because many of the other attendees she spoke with did not have (or make) time to read through the case files.

6.2.3 NDA made attendees wary of using technology. A few teams reported using software like Google Docs, Google Earth, and spreadsheets to work on the cases. One team used Google Docs to synthesize multiple conflicting witness statements, while another team used Google Earth to determine the distance from a potential suspect's home and the location where the victim's body was found. Other teams also used spreadsheet software, like Google Sheets and Excel, to create a timeline and synthesize their findings. In contrast, we observed that teams that did not use any software at all faced difficulties in collaborating effectively.

Despite these efforts, many attendees said that they were unsure about what types of software, if any, they were allowed to use. This confusion may have arisen because the NDA prohibited attendees from retaining case files verbatim, but allowed attendees to retain information that they had synthesized from the case files. However, some attendees demonstrated awareness of, and concern about, the security of different cloud-based tools. One attendee explained how their team struggled with this issue:

> *We were using Google Docs and realized maybe that's not secure. So we were trying to figure out how to compile information properly other than just sticky notes. And the best we came up with was like an Excel spreadsheet that we could print.*

6.2.4 Sharing information between teams was challenging. Attendees wished for a way to easily share information between teams during the group sessions. Because attendees in each team did not know what information others had, what questions they were answering, and what leads they had generated, there was duplication of effort. Further, aside from individual attendees' responses being collected during the facilitation session at the end of the event, there was no way for attendees to view and build on information that others had submitted. P8 described an ideal scenario where each team knew what other teams had generated by *"having each group write up their findings, their report, their theory, in a way where we can all share it… in a Facebook group or something else."*

6.2.5 Some attendees' actions were concerning. Despite OE4's warnings, a few attendees planned or actually engaged in behavior tending towards vigilantism. Some attendees admitted visiting the place where Karen Bodine's body was found, and one shared photos of the site on the Facebook group. Others visited nearby libraries and geology laboratories. These activities concerned other attendees who found out about them, including P8:

> *I definitely think it could promote vigilantes to take matters into their own hands. I mean, even in the Facebook group, people are spending all this time going to these neighborhoods. And I think there's some danger in going and hanging out in front of yards of people who are persons of interest, because people are going to get paranoid.*

While P8 was primarily concerned with the physical safety of attendees who visited crime scenes and potential suspects' homes, O1 mentioned the issue of potentially tainting a jury pool and thus hurting the prosecution's case at trial.

6.3 Interactions Between Attendees and the Families

Although the attendees and families valued each other's participation in CrowdSolve, social norms and expectations between the attendees and the families were initially unclear and evolved as the event progressed. On the whole, both families found the event worthwhile.

6.3.1 Families made attendees feel invested and provided useful information. Nearly all attendees said that the presence of the victims' families made them feel heavily invested in the event. They said that the families' presence was an integral part of CrowdSolve and reminded them that the event was *"not just an intellectual exercise"* (P10). P14 explained how the families' physical presence reminded him exactly why he was at the event: to help solve the two cases.

Reflecting on the event, many attendees were happy to have indirectly helped the two families, both by paying for the experts to be at the event and generating new leads that might enable TCPD to solve the cases. As mentioned in Section 5.3, providing this assistance to the families was one of attendees' main motives for attending the event. Some attendees, like P6, even consoled the family: "*I walked up to each of them separately and hugged them. That's just [the mother in] me.*"

F6, a family member, found that the attendees were very compassionate and sympathetic when speaking to her, and welcomed these expressions of support. However, other attendees expressed skepticism about how altruistic CrowdSolve could be. P12 questioned the commercial and publicity-oriented aspects of the event, and whether it was designed to actually help the families, or if it was solely a money-making enterprise. P12 saw these as competing tensions, saying, *"if you really want to help, you would avoid [the] commercial piece."*

Beyond the sympathy and motivation, the families' presence also provided attendees with unique and potentially valuable information. P14 found that the families also helped to answer questions that no one else could answer because *"they know things that maybe aren't in the reports."*

6.3.2 Uncertain norms around sensitive topics. All the attendees were experiencing the event for the first time, and social norms developed as CrowdSolve progressed. Attendees were initially unsure how to interact with the families. For example, P12 recalled wondering, *"What kind of social dynamic do we have, both in the room and then outside?"*

Between attendees and victims' families, we found that attendees hesitated to bring up certain potentially upsetting topics in the families' presence, such as a victim's drug use. Consequently, a few attendees wished that the families were not always in the same room, so that they could ask experts questions without having to worry about being respectful towards the families. The attendees' reticence may have been well-intended but counterproductive, since it did not necessarily align with what the families wanted. For example, F1 and F2 said that they were happy to answer any questions that would move the case forward:

> *Sam [daughter] and I have told them, there's not much we haven't heard at this point. And so we've actually had to ask people "No, please be direct with us. Don't talk around it. If you have a question, we're here to solve something, ask us a question directly," and then they will. And then when they don't get this horrified response from us, then they actually feel better.*

6.3.3 Families' overall reflections. Despite the families' enthusiasm to participate, we found that CrowdSolve still took an emotional toll on both families. Not only did they have to recollect possibly painful memories of Karen Bodine and Nancy Moyer, but they also heard about and viewed distressing descriptions and imagery, and interacted with many of the 250 enthusiastic attendees. The Bodine family advised that future families who might participate in similar events that it requires a great deal of mental preparation and it would be helpful to set low expectations. One family member recommended that organizers *"[give as much] notice as you can give and [set] expectations for the family on what's going to be discussed and shown."* Overall, however, the Moyer family felt that the event helped to move Nancy's case forward, one of their main goals. One family member said: *"after 10 years, things really start to feel like they've stagnated… but this puts it in the forefront, and it hasn't been in the forefront for years."* The Bodine family was also moved by the attention that Karen's case received and how supportive the attendees were.

7 DISCUSSION

As reviewed in Section 2, public participation in law enforcement investigations has primarily followed two models: top-down and bottom-up. The traditional top-down model limits public

participation in investigations primarily to providing tips to law enforcement. The growth of information and communication technologies has enabled novice crowds to self-organize their own bottom-up investigations [56]. However, the methods and outcomes of many bottom-up crowdsourced criminal investigations have been criticized by victims' families, law enforcement, and the media [e.g. 16, 81, 95].

The CrowdSolve model. In the previous section, we used Lee et al.'s [60] lens of human infrastructure to magnify the social conditions and activities that led to the emergence of an unprecedented infrastructure: CrowdSolve. We have argued that CrowdSolve represents a third model of crowdsourced investigations, *expert-led crowdsourced investigations*. It consisted of two dimensions: a unique collaboration environment and contributions from several distinct stakeholder groups.

First, CrowdSolve's highly controlled environment granted participation to only those who paid registration fees and signed confidentiality agreements, and collaboration occurred in a synchronous, co-located, and largely offline manner, over a defined time period. This setting served to build and maintain trust among all stakeholder groups involved while also providing privacy and security for sensitive evidence and discussions. Such boundedness of time and space contrasts with many forms of crowd-work and true crime fandom, as we discuss below. Second, each of the four stakeholder groups meaningfully contributed to the event. The organizers chose investigations and prepared microtasks. Novice crowds with diverse backgrounds completed the microtasks, scaling up the investigation. Experts provided crucial training and guidance to the novices. Finally, involving impacted stakeholders motivated the crowd and provided useful information.

Together, these two dimensions enabled CrowdSolve, a crowdsourced investigation of sensitive information which — in contrast to many bottom-up investigations — all of the stakeholder groups deemed a success by their own definitions. We found that PD reported receiving useful new perspectives and leads from attendees and the other experts to follow up on, without sensitive information being leaked. Additionally, our findings show that the event satisfied attendees' motives for helping the victims' families and law enforcement while providing them with an immersive true crime experience. Finally, the two families felt that their voices were heard and the event moved their cases forward.

Tensions in the design space. However, within any human infrastructure, there is the potential for friction, because various stakeholders have different motives that can lead to conflicting actions [60]. Tatar [94] argues that tensions exist at the junction between what is and what ought to be, and in the actions taken to negotiate that difference. Foregrounding such tensions in a system can be valuable because it allows for configurations to surface that may "make or break a system" [94].

Next, we discuss three interrelated tensions that the CrowdSolve model exhibited and detail aspects that worked well and those that can be improved upon in the future. The first tension is between the control of the *experts* organizing the event and the *crowd* of true crime fans participating in it. The second tension is between the conflicting goals of *opening up* the two cases for a crowdsourced investigation, and preserving the *privacy and security* of the victims and their families. The third tension is between the *entertainment* aspects of the event and the *reality* of the murders and their real-world consequences.

7.1 Experts vs. Novice Crowds

We contend that CrowdSolve successfully leveraged the complementary strengths of experts and novice crowds in three ways. First, the organizers invested considerable time and effort in the planning phase to make it suitable for crowdsourcing. They worked with law enforcement to find cases that would benefit from crowdsourced attention and had the support of victims' families. They also curated and pre-processed the case files to provide the crowd with access to relevant,

high-quality information. Second, the organizers secured the participation of law enforcement experts who served dual roles. They ran training sessions to teach relevant investigative skills to the attendees. They also led discussion sessions where they provided high-level guidance and leadership to keep the crowd focused on making progress. Third, the event activities were organized in ways to take advantage of the large scale of the 250–strong crowd. Sessions were parallelized, with each group led by an expert, and focused on specific topics. As a result, we found that the experts not only helped attendees learn, but also that attendees applied this knowledge to generate new and useful leads for TCPD.

Design Recommendation 1: Crowdsourcing can speed up and scale-up investigations. However, not all types of work can be easily decomposed into microtasks [43, 58]. For instance, rapidly developing crises may make it infeasible to design complex crowdsourcing platforms [7] or expertise may be limited but must be quickly scaled up. CrowdSolve's expert-led crowdsourced investigation model can be applied in such situations that require flexibility and rapid scaling-up of effort. Experts can train and guide novice crowds in a synchronous and easily appropriable [38] setting to enable novices to complete more complex macrotasks without building additional technological infrastructure.

However, there were three aspects of the event that can be improved upon in future expert-led crowdsourced investigations. First, despite organizers' efforts to design clear microtasks, attendees reported that their team discussions were often unstructured. Second, the short session durations and large number of teams meant that teams had to vie for experts' attention. Further, attendees from different teams often asked experts the same questions. This resulted in an inefficient use of both attendees' and experts' time. Third, although the experts found attendee-generated leads useful, they did not seem to note down these leads. The only formalized attempt to capture them occurred at the end of the event when a professional facilitation team was brought in.

Design Recommendation 2: Crowdsourced investigations might benefit from redistributing leadership [70] from the organizers and experts by assigning a team leader to each team. This team leader could help to divide work and facilitate discussion among team members, providing more frequent opportunities to reflect on and synthesize findings. They could also coordinate with other teams to decide which questions to ask the experts, using theirs and the experts' time more effectively. To further reduce the burden on formal leaders, team members could provide shared leadership, as seen in Wikipedia [105], by informally performing some leadership behaviors, like providing feedback.

7.2 Security and Privacy vs. Openness

Echoing Lalone et al.'s [56] findings in crisis informatics, we found that the CrowdSolve organizers had to manage the tension between openness and security and privacy. On the one hand, opening up the cases and sharing as much information with attendees as possible would simultaneously maximize the chances of discovering new leads and facilitate an immersive, true crime experience. On the other hand, the organizers also had to weigh the privacy considerations of the victims and their families, as well as law enforcement's desire to maintain a viable legal case and avoid tainted juries. These considerations affected decisions about what information to share, as well as how to prevent the information from leaking beyond the group.

We found that CrowdSolve's organizers employed a variety of regulatory mechanisms that allowed law enforcement to provide the crowd with unprecedented access to case files while minimizing the risk of inappropriate behavior. Lessig's New Chicago School theory [61] provides a framework for identifying these mechanisms and analyzing their effectiveness. His theory posits that human behavior can be regulated by laws, norms, markets, and architecture.

The organizers leveraged existing laws by having attendees sign an NDA to discourage them from sharing information beyond CrowdSolve — a tactic also used by some corporations to protect sensitive data processed on internal crowd platforms [41]. Such "leaks" could hurt the case and instigate public debates over the guilt of potentially innocent suspects. As of this writing, to the best of our knowledge, no information has been leaked outside the event, thus achieving one of PD's and the organizers' objectives for the event.

Next, the organizers fostered social norms for appropriate behavior within the event. For instance, attendees were instructed not to engage in vigilante behavior. Many attendees reported accepting some responsibility for creating a positive impression of the event in the eyes of law enforcement and the general public as being beneficial in helping to solve criminal investigations. However, some norms were not embraced by all attendees or were not clearly set. For example, a small number of attendees visited crime scenes and some attendees were uncertain about how to act towards victims' families. Although visiting decades-old crime scenes is not explicitly vigilante behavior, it was against the organizers' instructions and might further embolden other attendees.

Design Recommendation 3: Relying on social norms may not have been entirely successful because the event was $3\frac{1}{2}$ days long, and norms take time to be established in a community [26]. Crowdsourced investigations should strive to establish norms through recurrent events focusing on other cases and set up private online forums for attendees to continue discussion.

Finally, the organizers used markets to make the event more attractive to potential attendees than competitors, such as bottom-up investigations on Reddit or Facebook. In exchange for paying a registration fee, attendees gained unique opportunities, such as access to case files and training from law enforcement experts. The registration fee also caused those who were willing to pay to feel more invested emotionally and financially. However, those same commitments of time, travel, and money may have also excluded many potential attendees.

Design Recommendation 4: To broaden participation by reducing travel requirements, events such as CrowdSolve could be held simultaneously at multiple locations. Less sensitive parts of an investigation could also be conducted virtually before or after the event. For example, in our findings, we highlighted how some attendees visited local libraries and geology laboratories to conduct further research. This decoupling also paves the way for social learning via legitimate peripheral participation (LPP), as in online communities for citizen science [79], software development [104], and, most closely related to our work here, fandom [28]. LPP allows newcomers to start with smaller time and monetary commitments and gradually increase their participation. During an event, experts could assign some low-risk tasks to attendees who attend virtually, such as finding and corroborating information through zero-touch open-source research [35].

Lessig's fourth mode of regulating behavior is through architecture. As Lessig notes, most forms of architecture, such as laws of physics and major social and cultural forces, are beyond the influence of individuals. The notable exception is computer software [62]. However, the CrowdSolve organizers prohibited attendees from using digital technologies and instead used physical architectures such as using printed copies of case files and limiting physical access to the room. The decision to limit the use of digital technology had downstream implications for handling the case files. Despite attendees' enthusiasm, many reported experiencing information overload, and were unable to use software tools to support their sensemaking tasks. Further, attendees could not access outside data sources to complement the case files.

Design Recommendation 5: We are cautious about increasing the use of technology [37], especially online tools, given the sensitive and real-world nature of these investigations. There are two major security concerns. First, as the experts expressed, there is risk of information being leaked accidentally or intentionally by the attendees. Second, as we heard from the attendees, concerns around unauthorized access by outsiders remain. Yet, the potential of software and online networks

to support collaborative sensemaking is well-established in the CSCW literature. One solution, building on the assumption that attendees are co-located as in CrowdSolve, is to provide access to digital tools using an offline intranet. This approach could allow co-located teams to leverage collaborative software for sensemaking [e.g., 12, 39, 44, 64] while creating friction against accidental or intentional data leaks enabled by unrestricted internet access. When co-location is impossible, a more complex solution may be to divide case files into smaller information slices such that the crowd is given just enough global context with which to conduct their analysis and work collaboratively, while minimizing the potential for damaging information leaks. Specific slicing techniques could include directing workers to evidence documents based on time frames [15], named entities like suspects or locations [64], semi-supervised clustering techniques [44], or privacy-preserving task assignment algorithms [11].

Critics of prominent failed crowdsourced manhunts often point to the public deliberation of potential suspects as a fundamental flaw that inevitably harms innocent people [18, 81]. Large-scale public participation is seen as inseparable from unrestrained, often damaging, speculation, dooming the entire enterprise [72]. CrowdSolve challenges this assumption. It employs an alternative model where a potent combination of regulation mechanisms, coupled with expert training and oversight, allows large-scale novice crowds to investigate difficult topics in a controlled environment. Future work can explore how CrowdSolve's affordances for supporting crowdsourced sensemaking while protecting sensitive data can be adapted beyond law enforcement to high-stakes investigations in other domains, such as journalism, human rights, and counterterrorism.

7.3 Entertainment vs. Reality

We found that attendees' enthusiasm for true crime blurred the boundary between entertainment and reality. This enthusiasm led to invested participation, but it occasionally bordered on fetishization. We also found that attendees also desired closure, but were limited due to the nature of criminal investigations.

The organizers' unconventional yet beneficial decision to have the victims' families at the event supported attendees' dual desires for altruism and immersion. The families' presence helped attendees empathize, heightened the stakes of the event, and strongly motivated attendees to work hard and generate leads. We also found that attendees were able to glean additional, valuable information from the families that was not present in the case files.

Design Recommendation 6: Involving representatives of the people most impacted by an investigation — in this case, the victims' families — can improve crowd behavior in at least three ways: increased motivation, greater access to information, and greater empathy. Other domains of crowd work can also leverage this approach. For example, citizen scientists analyzing data related to pollution effects on a particular community would benefit from interacting with local residents of that community, not just experts (i.e., scientists) guiding the investigation.

While many attendees witnessed the families' presence in a positive way, some sought out entertainment and objectified those who were involved in the two cases. For instance, when experts displayed images or described gruesome details in the sessions, we noticed attendees glancing at the families to gauge their reactions. Though problematic, this behavior at CrowdSolve was less severe compared to other fandom communities where perpetrators are often obsessed over and even sexualized, such as through fan fiction [83]. While other immersive experiences, such as ARGs, thrive on extreme immersion [75], CrowdSolve benefited from the organizers and experts constantly warning attendees that their actions had real consequences.

Events like CrowdSolve may offer few opportunities for attendees to obtain closure. Many attendees reported wanting to follow up with experts to ask more questions and with TCPD to learn about the progress of the case. Like Coombs [66], we found that requests seem to arise from

attendees' competing goals. They want to see the case solved, but — like a serialized true crime podcast — they also enjoy engaging with the twists and turns of an ongoing investigation.

Continuous engagement can be challenging for two reasons. First, experts were compensated for participating in the event, and even though they might be invested in its outcome, it would be expensive to retain their services after the event. Second, the legal and procedural constraints of criminal investigations mean that law enforcement cannot share detailed updates with attendees until the case is solved or they intentionally release information through the media. After the event, the organizers did provide some high-level findings to the attendees that TCPD allowed them to divulge, but only because the attendees were still under an NDA.

Design Recommendation 7: While there is no easy solution for providing closure at the end of crowdsourced investigations — especially those dealing with cold cases — organizers should ensure that there are other avenues for long-term interaction and communication with participants. For example, as mentioned above, continued engagement can happen through LPP [28] before or after the event, or by participating in events about other cases. If there is an NDA still in force, organizers can share high-level updates with attendees on a private forum, such as the informal Facebook group created by CrowdSolve attendees.

By framing volunteer crowd work as an act of fandom, leaders and requesters can come to see crowds as more than just interchangeable human processing units (HPUs) [19] or a "human API" [52]. Instead, crowd workers often seek to form communities around shared passions and goals, such as learning new information, solving problems, and, in the case of CrowdSolve, seeking justice. As in games with a purpose [101], organized efforts, like CrowdSolve, allow participants to indulge in their passions while also contributing meaningfully to society.

8 CONCLUSION

We conducted an ethnographic study of CrowdSolve, an unprecedented co-located event where law enforcement experts trained and guided over 250 true crime enthusiasts in generating new leads on two decades-old unsolved cases. Using the lens of human infrastructure, we examined the motives, experiences, and interactions that enabled its success for all stakeholders involved, from law enforcement and the victims' families to the attendees. Finally, we uncovered three important and interrelated tensions within the human infrastructure and provide design recommendations that can help resolve these tensions. Crowdsourced investigations can be a powerful mechanism for engaging the public and helping to solve real world investigations, but require careful consideration to ensure that they are done safely and effectively.

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A APPENDIX

(a)

(b)

Fig. 1. (a) CrowdSolve attendees lined up to ask experts and the family members questions. (b) Attendees working to synthesize each others' leads during the facilitation session on the fourth day, with the first author in the background (left). Photo credits: Red Seat Ventures, LLC (used with permission).

Fig. 2. This is the schedule of events at CrowdSolve. Each column represents the schedule for each of the three large groups that the 250 attendees were divided into. Photo credits: Red Seat Ventures, LLC (used with permission).

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