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From Death to Final Disposition: Roles of Technology in the Post-Mortem Interval

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ABSTRACT

In this paper, we describe collaborative processes and stakeholders involved in the period from when a person dies until they are laid to rest: the funeral, final disposition of the body, and (in some circumstances) victim identification. The rich mixture of technologies currently deployed during this brief period are categorized and critically analyzed. We then reflect on the implications of our findings, both for the design of technology that takes the end of life into account, and for the wider HCI community.

Author Keywords

End of life, collaboration, coordination, thanatosensitive design, funerals, final disposition, victim identification.

ACM Classification Keywords

H5.3. [Group and Organization Interfaces]: Computer-supported cooperative work;

INTRODUCTION

The Human Computer Interaction (HCI) community is beginning to consider the design of technology for the end of life (EoL) and for memorialization [25,41]. In this paper, we bring the HCI community's attention to bear on the processes and stakeholders involved in the period immediately after death: the *post-mortem interval* (PMI). We acknowledge that this is a challenging and sensitive area [31]. It is also an important one, which we should not shy away from if we are truly to design technology to “*meet human needs across the life-span*” [26, p989] and beyond.

Previous research in this domain has taken various approaches – e.g. sociological [31], critical humanist [5], design-oriented [40] – yet a standard methodology is absent [25]. We are still learning how best to ‘do’ design for EoL. Our research adopted a process-oriented participatory approach, working in a hybrid interdisciplinary space where we could “*combine diverse knowledge with new insights*,

...learning reciprocally and creating new ideas” [30, p1062]. By adopting this approach, we gained a new understanding of a specific brief time period which is densely packed with collaborative activities, and which is increasingly supported and mediated by technologies.

In the first part of this paper, we examine the processes that occur in the immediate PMI, and the stakeholders involved in them. We focus on (1) the organization and conduct of the *funeral* and (2) the *final disposition* (the burial, interment, cremation, or other authorized disposition of a dead body). These processes are routine. The third process, (3) *victim identification*, is necessary if the deceased was the victim of a disaster, accident or suspicious death. Identification is usually essential before the funeral and final disposition can occur. Increasingly, stakeholders are using technology to expedite or augment these three processes.

In the second part of this paper, we identify how technologies are being used, highlighting the remarkable diversity of technology applications in the immediate PMI. The stakeholders involved are diverse, and go beyond the four groups (the living, the dying, the dead and the bereaved) previously identified in work that scopes thanatosensitive design [26]. We highlight the involvement of a fifth group, ‘*death workers*’ [42], comprised of the individuals who conduct specialized work after a death and support the preceding four groups. Death workers include funeral directors, celebrants, bereavement counselors, lawyers, police, coroners, embalmers and Disaster Victim Identification (DVI) workers.

In the final part of this paper, we consider implications for the design of technology that takes the end of life into account, and for the wider HCI community.

Our research focused on processes and stakeholders common to the UK, and is grounded in conformist Christian faiths, unless specifically identified as being otherwise. We acknowledge that processes and stakeholders vary across the dimensions of faith, community and country, and encourage research into how these dimensions impact technology design. However, such a discussion is beyond the scope of this paper.

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METHODOLOGY

In generating a shared understanding of this cross-disciplinary area, we adopted a participatory approach. The lead author framed the initial question of how technology is used in the PMI, and then interviewed three experts (EX) with specialist domain understanding, and invited them to collaborate. The experts were (1) Jan Bikker, a practicing forensic anthropologist, with field experience of victim identification in the aftermath of disasters worldwide, (2) Elaine Kasket, a practicing psychologist, who specializes in death and bereavement, and (3) John Troyer, a Death Studies researcher.

The initial interviews informed the design of subsequent semi-structured interviews conducted with 9 UK-based death workers (DW) (7 male, 2 female), who worked as funeral directors (n=2), funeral celebrants (n=3), social media entrepreneurs specializing in legacies and memorialization (n=2), a crematorium manager (n=1) and an international disaster management company representative (n=1). Acting as key informants, DWs were able to give insights into both their own technology deployment, and that of the many bereaved individuals that they supported – e.g. one of the funeral directors who we interviewed carried out around 500 civilian and military funerals a year.

Participants were recruited at an international conference, *Death and Dying in the Digital Age* (organized by the Centre for Death and Society, University of Bath), and also through emails and phone calls. Research was subject to ethical approval at the University of Dundee. All participants gave informed consent to participation. Interviews were conducted by telephone/ Skype (n=4) or face-to-face at participants' workplaces (n=5). Interviews were structured around set topics which allowed for comparison across participants:

- How participants used technology to support their work.
- Participants' observations of how other death workers involved in funerals and final disposition used technology to support their work.
- How the bereaved used technology in organizing and contributing to the funeral.

Most participants volunteered much extra information. Interviews lasted between ½ - 3 hours, and were recorded and transcribed. Visits to workplaces (crematorium, church, funeral parlor, disaster management facility, home office) furthered contextual understanding and delivered surprising insights. For example, the crematorium manager claimed “*We don't use any technology at all here*” during a tour of his facility, yet demonstrated complex furnace control software. Analysis of the interview data was conducted and verified, and then themes were synthesized. Interpretation was member-checked with available DW participants (n=3).

Following on from the interviews, we conducted extensive systematic internet searches of products currently on the market, based on criteria generated from EX and DW interviews.

PROCESSES AND STAKEHOLDERS IN THE PMI

Despite its brevity, the PMI is densely packed with processes and stakeholders. We provide a description of these as a background to the subsequent description of the role of technology after the end of life, and the analysis of design implications. Table 1 provides a supporting summary of the activities and stakeholders involved in the two routine processes: the funeral and final disposition.

The Funeral

Consistent with other milestone events in people's lives, such as births and weddings, it is customary in the UK to mark a death with a ritualized social event. In the case of death, this event is a funeral. The funeral ritual serves as a point of discontinuity in the mourners' physical connection to the deceased, and hence helps mourners to accept the reality of the loss. At the same time, however, a 'good' funeral facilitates a sense of continuing bond to the deceased. It achieves this by interpreting and conveying an accurate picture of the person to the community through the eulogy/tribute, and by providing an opportunity for mourners to begin or continue the process of (re)constructing the deceased's identity [20]. This helps form a '*durable biography*' with which the living will continue to connect [42]. Failure of these processes may result in a 'bad' funeral that, in the worst case scenario, adversely affects the grieving process on an individual and community level.

Unlike other milestone events, there may be intense time pressures in organizing and conducting a funeral. Even when a death is expected, its specific date is not set in advance. As funerals are usually held within a week of the death, this leaves a short space of time in which to organize an event that brings together people from across an individual's social networks. Efficient event facilitation is essential. Organization and execution of a funeral is a collaborative process, involving a number of stakeholders, who are shown in Table 1. They include the deceased, the chief mourner(s)¹, the funeral director/ undertaker, the funeral celebrant, family and friends. The role of chief mourner may not always be taken by the legal next-of-kin: this depends on legal and social constructions over kinship and marriage, and the availability and willingness of someone to take on this role [39].

The deceased may have left instructions for how they wish their funeral to be carried out, and have paid for the funeral directors' services in advance. Otherwise, the chief mourner

¹ There may be more than one chief mourner; however, we refer to *one* chief mourner for simplicity in the remainder of the text.

Process	Task	Stakeholders								
		<i>De</i>	<i>CM</i>	<i>NK</i>	<i>FD</i>	<i>Cel</i>	<i>FF</i>	<i>Med</i>	<i>BgC</i>	<i>Gov</i>
Funeral	Appoint funeral director	Y	Y							
	Inform social network of death / funeral	Y	Y		Y		Y			
	Arrange venue, transport, flowers, catering	Y	Y		Y					
	Viewing the body		Y		Y		Y			
	Write eulogy	Y	Y			Y				
	Select music	Y	Y			Y				
	Attend funeral	Y	Y	Y	Y	Y	Y			
	Book of remembrance		Y				Y			
	Memorialization	Y	Y		Y		Y			
	Arrange bereavement counseling		Y		Y	Y	Y	Y		
Final disposition	Lay body out		Y		Y					
	Process death certificate			Y	Y			Y		Y
	Administration			Y						Y
	Purchase of burial plot	Y	Y	Y	Y				Y	
	Reserve crematorium for use		Y		Y				Y	
	Order coffin & headstone	Y	Y		Y				Y	

Table 1: Tasks and Stakeholders for Funeral & Final Disposition

De= Deceased; CM=Chief mourner(s); NK=Next-of-kin; FD=Funeral director; Cel=Celebrant; FF= Friends & Family; Me= Medical staff; BgC = Burial ground/ Crematorium workers; Gov=Govt/Municipal administrators;

will select a funeral director, if they intend to use one. A funeral celebrant² (e.g. religious officiant, humanist celebrant) is also selected and instructed, either by the bereaved or the funeral director. A venue for the funeral must be booked, potential attendees notified of the death and invited to the funeral, transport for the deceased and close family members arranged, the eulogy written and music chosen. In the immediate aftermath of the funeral, the chief mourner and attendees at the funeral may write comments about the deceased in a Book of Remembrance, or take other steps to memorialize them. Those experiencing a high level of distress may also seek out bereavement counseling – perhaps through a counselor recommended by the funeral director or celebrant.

While the nature of the event itself is likely to be shaped by faith, culture and community, its format is not static. As one celebrant described, in the past, “*you very rarely ...talked about the person ...there was never much in the way of real flavor (of the deceased)*”. However, “*what has happened over the years, in all sections of society, is that people are now much more intentional and informed about the funeral,*

and they want it individualized”. Individualization is achieved through use of “*...a bit of music they liked, some readings, some poetry, a few memories ...friends saying something about the person*”.

Final disposition

In contrast to the funeral, final disposition of the body is a predominantly physical and administrative process. This process may involve the chief mourner, next-of-kin, funeral director and associated staff, government and municipal departments, medical staff, and employees of a cemetery or crematorium. ‘*Next-of-kin*’ is a legally recognized administrative role, distinct from that of chief mourner. Separate people may fulfill these two roles - although such cases have arisen most frequently in same-sex partnerships where the couple cannot marry *and* the deceased has not designated a non-family member as the official next-of-kin.

Before final disposition can occur, a death certificate must be issued by the Registrar [9]. Issue is contingent on the next-of-kin providing numerous official documents, including a medical certificate signed by a doctor indicating cause of death, a birth certificate, and evidence of the deceased’s last address. The next-of-kin is also responsible for informing numerous government and municipal departments of the death – e.g. to cancel the

² In the UK, it is common for the celebrant to read the eulogy and lead the ceremony.

deceased's passport, driving license and government-supplied pension.

The body is prepared ('laid out') for final disposition by the chief mourner, or by the funeral director and their staff. A coffin and perhaps a headstone are chosen by the chief mourner. Once the death certificate is issued, the body is usually buried or cremated. If the body is to be buried, the location of a vacant plot in the cemetery must be identified, and its future occupant recorded by an administrator. The plot must be purchased - usually by the chief mourner or by the deceased when they were alive. If the body is to be cremated, a time slot must be booked at the crematorium.

Victim Identification

The funeral and disposition of the body usually occur only after the body has been identified. Identification may be required in cases of suspicious and non-natural death, medico-legal investigation and cases in which questions arise as to the identity of the deceased (e.g. when a body is washed ashore). In the case of a natural disaster, accident or deliberate attack – e.g. the 2010 earthquake in Haiti - identification may be a “*highly complex and sensitive task*” [21, p98] involving victims, their family and friends, and multiple agencies: governments, non-governmental organizations (NGOs) such as the Red Cross, local and international law enforcement agencies, medical teams, disaster management companies and Disaster Victim Identification (DVI) teams. Especially in a large natural disaster, this process may be conducted against a backdrop of infrastructure breakdown and escalating health risks, as transport and communication links are severed and basic sanitation fails. In extreme conditions (e.g. massive fatalities following a natural disaster), it may be impossible to identify all fatalities.

The agencies engaged in victim identification – notably the DVI team or forensic scientists - will draw upon ante-mortem and post-mortem data to assist them in their task [4]. For each potential missing person, ante-mortem data will be collected and may include medical and dental records, photos, and even criminal records, drawn from multiple sources. Those that knew the missing person also have a role to play in describing them, what they were wearing when last seen, and the personal effects that they commonly carried. Post-mortem data is assembled from the body and from artifacts at the scene such as jewelry and mobile phones. The DVI team will endeavor to find a match between ante-mortem and post-mortem data, and thus identify the missing person and unidentified remains.

TECHNOLOGY DEPLOYMENT DURING THE PMI

In the funeral, final disposition and victim identification, stakeholders are increasingly using technologies to support the processes that they are engaged in, through:

- Facilitation of service provision
- Information seeking

- Mediated communications
- Personalization of artifacts/ events

Some technologies are designed specifically for purpose, others are repurposed. This technology deployment is not without problems, which we reflect upon here.

Funerals

Facilitation of service provision

The chief mourner's quest for a suitable funeral director may be facilitated by online searches. She/ he may even organize the funeral and burial/ cremation through an online funeral director – although this service is currently limited to the US and Canada [13]. Funeral directors can get online training in how to mobilize social media resources to attract potential clients via the internet³.

Funeral directors may also use technology to expedite routine tasks, to the benefit of their clients:

“I was with the husband of this lady that died and I've got an iPad. It beeped and up came an email from the local newspaper which confirmed the name of his dead wife and also had a proof of the way it (death notice) would look in the paper. I was able to hand him the iPad and he was like 'My God! That's really great!' I was able to get an approval on that literally in seconds.” Funeral director

Information seeking

The chief mourner(s) may seek advice online about how to organize a funeral. It may be difficult for them to identify which sites to trust. In the absence of consistent credentialing for sites, the bereaved are likely to make judgments on what online advice to take based on a professional 'designed' appearance, ease of understanding and ease of use [35], yet these sites may lack impartiality and reliable content. For example, [12] offers a “*free consumer information, education and resource community*”, yet the proffered services are provided through “*strategic (commercial) alliances*”. The same site provides bereavement advice based on Kubler-Ross's outmoded '5 Stages of Grief' model – a model challenged by empirical research [23]. Advice based on this model may be unhelpfully misleading and potentially distressing to bereaved individuals, by making them feel that the course of their grief is not 'normal'.

Mediated communications

Organization of the funeral may involve computer-mediated communications (CMCs). Although the initial meeting between the chief mourner and funeral director is likely to be face-to-face, subsequent communications may be mediated synchronously (e.g. Skype) or asynchronously (e.g. SMS). The funeral director may use email to manage potential conflicts between mourners:

³ <http://www.funeralfuturist.com/social-media-week/>

“... You can ensure that everybody gets exactly the same information at exactly the same time. Not keeping everyone informed is one of the big dangers you see. If you say to one person ‘Who do you want to receive the information?’ and they go ‘You better send it to him, ‘cos he’s the eldest’, you can end up with conflict within the family, because what happens if the eldest decides he doesn’t want to show the rest of the family? It’s a good way of resolving that problem.” Funeral director

CMCs may also be used to give news of a death and funeral arrangements to the deceased’s wider social network. Whilst those directly affected by the death are likely to be informed by the chief mourner in person or by phone, the burden of communicating to the wider social network may be alleviated through use of CMCs – e.g. use of emails and a posting on the social network site (SNS) previously used by the deceased. CMCs may also be used to avoid interaction, when those giving news do not feel like talking, yet need to convey information in a timely manner [24]. When the deceased has kept contact information for their social networks in a password-protected repository, and not shared their password, it may be difficult or impossible to give those in the wider social network the news, online or offline.

News also travels by word-of-mouth, and through ‘death notices’. Death notices are traditionally placed in a local or national newspaper, but are now frequently transferred online, either as part of the service provided by the newspaper publisher, or by the appointed funeral director. Some online sites for death notices are poorly implemented and display inappropriate advertising. For example, we searched for a death notice relating to a specific, recently deceased individual on one popular site⁴, using the person’s full name and location. Her husband had placed the death notice in the local newspaper. Unexpectedly, 3,602 results were returned in apparently random order for name and date of death, despite the deceased having an unusual name. The resulting search pages also displayed adverts for “Over 60s Dating Exclusively for seniors. Join free!” - overstepping boundaries of appropriateness.

Remote participation in the funeral itself is made possible through technology. This is becoming more common as population mobility, increasing secularity, and the ubiquity of social media erode the convention of attending a funeral in person [17]. The cost of travel and the swift turnaround time from death to disposition also play their part:

“We recently had a lady, she’d just turned 50. She died of cancer ...but she knows people all over the world. So we broadcast the funeral live. We had something like 60 computers watching it. Some people can’t afford to travel, or ...because of the short notice they can’t, so you stream it online. Now, we guesstimated that there was 100+, a family

of 5, lots of individuals, lots of little groups of friends who knew her, who sat down & watched it together.” Celebrant

Such remote participation raises questions of privacy, access and performance. It is common for webcast access to be by invitation only, controlled by a password [45]. The process of gaining secure access to the webcast may itself present an obstacle to legitimate viewing, through poor usability - e.g. secure access to one funeral webcast site involves a minimum of eight separate steps after the user has been sent the password [45]. Viewers of the funeral webcast may also experience technology failures, leading them to miss out on some/ all of the funeral [3]. Such failures may cause disappointment to the bereaved. Furthermore, as the funeral may be instrumental in helping the bereaved to accomplish one of the basic tasks of adapting to a death – accepting the reality of the loss [44] – a technology failure has the potential to interfere with progress through this task, which in turn could increase the risk of complicated grief [33].

Bereaved individuals who are significantly affected by a death may seek counseling that is mediated via the Web. It can be difficult for the bereaved to identify a reputable, qualified counselor online. Numerous ethics codes identify critical areas of concern in online counseling with vulnerable individuals: specifically, credentialing, duty to warn and protect, informed consent, and confidentiality [36]. The efficacy and ethics of commercial online counseling services certainly vary. Some offer superficial services – e.g. “365 days of emails to cheer you up!”⁵ Others offer interactive online videos and virtual meetings where “family members living in different parts of the world can come together online to share the healing process, under the guidance of a trained grief counselor”⁶. It is critical to note that bereaved persons may need the help of a professional to assess their needs, and to provide tailored intervention where there is risk – rather than just picking a service online without guidance. While the majority of bereaved individuals negotiate the grieving process effectively and well, grief is idiosyncratic, and a significant minority experience serious ill effects and negative outcomes, including early mortality [14]. The individual nature of grief means that ‘one-size-fits-all’ counseling services, online or otherwise, risk being ineffective or even harmful.

Personalization of artifacts/ events

Increasingly, technology is playing a role in the personalization of funerals. The deceased may have articulated how they want their funeral to be conducted in advance, perhaps using an end-of-life planning tool [7] to store music and photos for use at the service, and to propose

⁴ <http://www.iannounce.co.uk/>.

⁵ <http://www.mountcastle.net/grief-and-healing/365-days-of-grief-support>

⁶ <http://www.funeralone.com/aftercare/>

what should be said in the eulogy. Such tools are available online (e.g. www.aftersteps.com), and as an iPhone app (www.legacyorganiser.com). In the absence of posthumous instructions, the bereaved may prepare their own materials. They may draw on digital photos to create a personalized Order of Service sheet, or use a digital soundtrack to evoke memories of the deceased:

“He liked birdwatching. They sent him off to a chorus of birdsong they got from a CD.” Celebrant

A multimedia backdrop to the funeral service may be created to great effect, repurposing personal images, video and music:

“I did a funeral for a lady in her late forties. She'd done a parachute jump for charity not long before she died. That was projected onto a big screen in the church, the video of her doing the jump, and it was set to music, to ‘Viva la Vida’. People sat & watched that for 7-8 minutes and it brought her to life in some ways.” Funeral director

Personalization may be achieved through ordinary desktop software such as Microsoft Office, through software designed specifically for the task⁷, or through specialist commercial services [12]. Where digital artifacts are available, their repurposing is creating a new role amongst the bereaved. If a chief mourner lacks technology skills, they may seek help in preparing a digital tribute from (often younger) members of the deceased’s social network:

“His (the chief mourner’s) teenage step-daughter got the music together. He didn’t know how to do it.” Celebrant

Children and younger adults have traditionally been excluded from the organization of a funeral, and friends have often been disenfranchised in mourning [11]; however, friends and young people often have privileged access to a repository of information about deceased individuals via social networks, giving them a valuable part to play in constructing the deceased’s identity [42]. However, opportunities for personalization may be significantly reduced if the digital artifacts belonging to the deceased are password protected. No consistent mechanism exists across internet service providers to bequeath digital assets [7,28]. In the short term, this may limit the ability to create a personalized funeral tribute. In the longer term, precious resources which help people to grieve and to maintain a continuing bond with the deceased may be lost.

Final disposition

Information seeking

Those who are preparing the body for final disposition can access online training in how to do it, both through text-based instructions [10] and YouTube videos⁸. Information

is available on all aspects of final disposition, including embalming. Videos are not usually flagged as potentially disturbing to watch, despite their challenging content. While moderate/safe filters try to eliminate sites that contain explicit sexual content from video search results, they lack the sophistication to identify other ‘difficult’ and potentially distressing content – such as laying out or embalming a body.

Facilitation of service provision

The death of an individual involves an administrative final disposition, as well as a physical one. When reporting a death in the UK, next-of-kin can be drawn into a byzantine paperwork process involving up to 22 different government and municipal departments. In some areas, a central government service called *Tell Us Once* [43] enables next-of-kin to report the death just once. This automated service then facilitates the provision of updates to all necessary departments, reducing costs for the departments and effort and distress for the next-of-kin. However, this service is limited to government and municipal departments: it does not notify banks, utility companies, insurers, etc. Next-of-kin still have a vast array of individual companies to update. There is much to be done to streamline the routine administrative processes required once a death certificate is issued.

The routine processes involved in the management and care of cemeteries are gradually evolving, as municipal bodies, private cemetery owners and archaeological groups involved in the management and care of cemeteries adopt commonly-available technologies to facilitate records management, using mapping software to document the location of vacant/ occupied burial plots, where individuals are buried, and their date of burial⁹. Through a process of digital curation, the central database¹⁰ for UK burials and cremations also provides online access to cremation and burial records, digital scans of cremation and burial registers and books of remembrance. Such practices improve accessibility of information for the public.

Crematoria also deploy technology. In their case, it is to facilitate the safe, pollution-free operation of furnaces. Although cremation uses the same physical processes as it did in the 19th Century, the software¹¹ used to control the operation of crematorium furnaces is entirely contemporary [39]. As well as controlling temperature and operating time, the crematorium furnace software plays a key role in ensuring legal UK and EU emission limits are not breached. It is vital that the user interface for operating the furnace is straightforward: a furnace malfunction can result in an explosion, causing distress to the bereaved whose loved one

⁷ E.g. <http://www.funeralhymnsheets.co.uk/>

⁸ E.g. <http://www.youtube.com/watch?v=PdRC9SCvHl0>

⁹ E.g. <http://www.trail.ca/mapping/cemetery.php>

¹⁰ <http://www.deceasedonline.com/>

¹¹ E.g. <http://www.facultatieve-technologies.com>

was being cremated. Some crematoria also use tracking software, to ensure that the correct cremated remains (ashes) are returned to the bereaved. The tracking software hinges on the use of a ceramic or metal barcode tag (a remembrance code) which can withstand extreme temperatures [39]. The tag is placed in the furnace with the body of the deceased, and stays with the resulting ashes as they are processed and returned to the bereaved¹².

Personalization of artifacts/ events

Traditional methods of personalizing funeral goods (e.g. headstone, casket) are being augmented/ replaced by technology-based personalization. Funeral urns, used to store ashes, can now incorporate a screen that displays digital images of the deceased [16]. Further repurposing of digital images – and indeed of ashes – can be seen in the service offered by memorial artists¹³ who incorporate ashes into a painting. The painting is often based on a digital photo of either the deceased or a favorite location that they had. QR codes and RFID tags attached to headstones [1] enable visitors who carry an internet-enabled phone to discover additional information about the deceased. Content is usually provided by the bereaved. The use of technology in these contexts calls for technological longevity. UK graveyards contain headstones that are many centuries old, with durable stone inscriptions which provide vivid insights into the lives of the long-dead. Will QR codes and RFID tags be as durable, as technology storage and access methods evolve with rapidity?

The search for funeral goods may be facilitated through online shopping, where the chief mourner may find a wider range of goods than is offered by the average local funeral director [15]. Internet-based marketplaces can deliver increased personalization and customization of products, and competitive pricing strategies [2]. However, the online provision of funeral goods has encountered opposition from some in the funeral trade, who have traditionally acted as a lucrative ‘one-stop shop’ in providing goods and services to the bereaved. In many US states, online sales of coffins and memorials are also constrained by regulations [8]. This situation is at odds with competitive practice in other retail spheres, but is on the cusp of change as the US considers legislative changes.

Victim Identification

Facilitation of service provision

Before the attack on the World Trade Center, “*software tools for storing, tracking, comparing, annotating and curating (DVI) data had never been considered a priority in North America*” [6]. Since the attack, there has been considerable effort invested into developing such tools, both in North America and worldwide. Although victim

identification is ultimately reliant on human expertise, DVI software tools can speed up efforts in disasters involving a large number of deaths. Automated comparison of ante-mortem and post-mortem data can expedite the matching process and provide a shortlist of candidates [4, 22]. Technology deployment may involve multiple systems, and stakeholders from multiple agencies and/or governments. Some systems integrate multiple identification methods - e.g. Plassdata™, used by Interpol, performs matches on dental features, physical and medical characteristics, personal belongings and DNA. Other systems are designed to use a single identification method - e.g. OptoSearch™ calculates the frequency of occurrence for specific or generalized eye or eyeglass prescriptions [4]. However, such custom-designed software is costly. National efforts and laboratory-based solutions using standard PC applications such as Microsoft Excel spreadsheets and Photoshop have also been used in a number of disasters - e.g. [32].

The multiple stakeholders and systems involved in victim identification can create data management and integration challenges, exacerbated by international variation in standards – e.g. in the UK, identification of 7 corresponding fingerprint characteristics between ante- and post-mortem data constitutes a confirmed match, yet in the US, 15 characteristics are required. Further problems can be caused by inconsistent naming conventions: cultural variations on ‘family name’ and ‘first name’ may cause confusion, causing investigators to look for the wrong person – e.g. ‘Wayne John’, rather than ‘John Wayne’. These challenges can impact adversely on timely victim identification, unless a central system is put in place to integrate data. As far as we are aware, Kenyon Response™ [19] is the only system to do this.

Information seeking & mediated communication

In addition to specialist DVI software tools, Web 2.0 applications have been used in disasters, circumventing organizational barriers to share information between government and non-governmental organizations (NGOs), family and friends [18]. These applications have assisted in victim identification, reuniting families and friends, and organizing aid – e.g. the Facebook site *Haiti Earthquake Hotel Montana*¹⁴, (also used more recently to maintain a social network amongst those bereaved in the earthquake and to commemorate the anniversary of the event), and Google’s *Person Finder* (used in the aftermath of natural disasters, such as the 2011 New Zealand earthquake and the 2011 earthquake in Japan¹⁵). An international cohort of volunteers and relatives have contributed data to *Person Finder*, by scraping websites and extracting information

¹² E.g. <http://www.matthewscremation.com/technology/security.aspx>

¹³ E.g. <http://www.cremationsolutions.com/>

¹⁴ <http://www.facebook.com/#!/pages/Haiti-Earthquake-Hotel-Montana/245595172631>

¹⁵ <http://japan.person-finder.appspot.com/?lang=en>

from blogs, texts and tweets, then adding relevant information to the site. This surge of benign global activity has had many positive benefits. However there have been some issues with information validity. Instances of malign individuals (trolls) giving fake reports of deaths [29] were met with a swift response by Google.

DVI teams may also use Web 2.0 resources to gather ante-mortem data, to help them to identify victims when routine methods fail. Images available on SNS of a suspected victim can provide vital clues to appearance, showing features that family members are perhaps unaware of. For example, family members may not know that the victim had a distinctive tattoo on their body, yet the victim may have shared a photo of it with friends via an SNS. DVI teams may face difficulties in accessing these materials, depending on the privacy settings in place for the SNS page. Further, if the next-of-kin asks for the victim's SNS account to be closed, this vital resource is lost to the DVI team.

IMPLICATIONS FOR DESIGN

Fresh design insights can be distilled from consideration of the roles played by technology after EoL, and the identified problems.

Funerals

While technology can play a useful role in organizing and carrying out a funeral, problems of *credibility*, *appropriateness*, *access* and *usability* emerge. Some of these problems generalize beyond the context of the PMI. Websites containing credible information and services may be hard for users to identify - not only for bereavement counseling [36], but also for health, politics and finance [37]. Recommender systems fail to make wholly appropriate recommendations for users who search online [38], whether the user is the widower viewing their wife's death notice online who we described earlier, or a US lawyer unaccountably receiving recommendations for Korean news broadcasts [46]. Users' desires for ease of access may be confounded as tensions persist between the diametrically opposed needs for security and usability in password-based systems, whether their goal is to access a secure funeral webcast or to legitimately withdraw money at the cashpoint [27].

Final disposition

When conducting an administrative 'final disposition', the absence of a seamless central process to inform all interested commercial, governmental and municipal parties of a person's death leads to increased effort and distress for the next-of-kin. Can technology designers mitigate this process by creating a comprehensive version of the *Tell Us Once* service [43] which reduces or eliminates costly duplication across commercial, government and municipal boundaries, and calls on the next-of-kin to take a single administrative step, rather than many separate ones?

Instructional videos for final disposition highlight the inadequacy of current video 'safe' search facilities. Users vary in what content they find offensive/ distressing – e.g. a funeral director and a university student will almost certainly differ. Final disposition videos highlight the need for personalization of safe search categories that go beyond current ones for merely sexual/ pornographic content.

The question of technology longevity, raised in relation to QR codes and RFID tags, generalizes to the question of how we design for memorialization, and to storing important information in any context. With the rapid evolution of technology, there is a risk that vital data becomes unreadable in the future. How can we ensure that this risk is eliminated?

Victim Identification

Even when data is readable, we have described how it may have different meanings to different stakeholders, and result in unnecessary confusion. The integration problems experienced in DVI, generated through the use of multiple systems by multiple stakeholders, highlight the need for international, cross-cultural consistency in the design of universally common data items such as a person's name.

The use of SNS data as a piece of the puzzle in victim identification creates a new role for SNS accounts – and perhaps a need for a new status category. Some SNS (e.g. Facebook) already allow next-of-kin to memorialize a deceased individual's account. We propose that an additional status should be "*Missing*". Associated with this status, read-only rights of access could be granted to recognized agencies that are assisting in the search for the individual in question. Rather than messages to reconnect being disabled (as they are when an individual's page is memorialized), these messages could be replaced with requests for network members to contact a central point, if they have information that helps to find or identify the missing person. Such a change would assist DVI teams and police.

We have described the remarkable leveraging of human goodwill which has emerged from the global use of Web 2.0, as information about those missing in recent natural disasters and accidents was input and analyzed. The abuse of Web 2.0 by 'trolls' in the wake of these events [29] provokes questions of access and accountability. Enabling continued use of Web 2.0 in this socially benign vein, whilst excluding irresponsible trolling and fake reports, remains a worthwhile challenge to be addressed.

DISCUSSION

In broadening existing discussions of technology design for EoL to include a critical, underexplored time period and its stakeholders, we have two aims. Firstly, to motivate designers to consider ways in which personal data has utility after a user's death, beyond recent HCI work focusing on bereavement and memorialization. Secondly, to

inform the design of technologies that help to coordinate processes in the PMI, through provision of new cross-disciplinary understanding of technology deployment.

In this paper, we have focused specifically on three processes involved in the PMI, where technology acts as a servant of the stakeholders by facilitating provision of services and information, mediating communications, and assisting in the personalization of artifacts and events. The adoption of a process-oriented participatory approach allowed us to combine knowledge across the disciplines of HCI, forensic anthropology, psychology and death studies, and to draw on the knowledge of professional death workers. Through this approach, we developed a fresh understanding of the role that technology plays after EoL, and the associated problems.

The brief period from death to final disposition involves a series of remarkably rich collaborative processes, made up of sets of discrete, complex and sensitive tasks, carried out by stakeholders with clear roles. While the specificity of roles and the time pressures involved in PMI task completion are common to many CSCW activities, the sensitivities of the PMI and the extreme ‘remote location’ of the central actor (the deceased) generate unique demands. Through this uniqueness, we hope to create a lens that can offer fresh design insights for the HCI community, drawing on the concept of “*extra-ordinary users*” and the opportunity for “*radical starting points*” [34, p257] to inspire fresh solutions which generalize beyond the PMI.

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