

# Creating Stories for Reflection from Multimodal Lifelog Content: An Initial Investigation

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## ABSTRACT

Using lifelogging tools, digital artifacts can be collected continuously and passively throughout our day. These may include a stream of images recorded passively using tools such as the Microsoft SenseCam; documents, emails and webpages accessed; text messages and mobile activity; and context sensing to uncover the current location and proximal individuals. The wealth of information such an archive contains on our personal life history provides us with the opportunity to review, reflect and reminisce upon our past experience. However, the complexity, volume and multimodal nature of such collections creates a barrier to such activities. We are currently exploring the potential of digital narratives formed from these collections as a means to overcome these challenges. By successfully reducing the content to that most appropriate to the story, and by then presenting it in a coherent and usable manner, we can hope to better enable reflection. The means by which content reduction and presentation should occur is investigated through card sorting activities and probe sessions which nine participants engaged in. The initial results are discussed, as well as the opportunity, as seen in these sessions, for lifelog-based stories to provide utility in personal reflection and reminiscence.

## Categories and Subject Descriptors

H.5.2 [Information Interfaces and Presentation]: User Interfaces - *Theory & methods, User-centered design.*

## General Terms

Design, Experimentation, Human Factors.

## Keywords

Lifelogging, SenseCam, context and content information, storytelling, narrative, reflection, sharing.

## 1. INTRODUCTION

Introspection offers the ability to reflect upon our past experiences in order to examine the fundamentals of our nature - who we are and where we have come from [3]. Such reflection is guided by the 'mind's eye' in which we visualise and replay past events. This can be initiated either by a physical or digital artefact encountered, focused thought on present or past circumstances, or by serendipitous remembering cued by a seemingly innocuous source such as a fraction of a song heard in passing, or a fragrance caught on the wind. Through intentional or unexpected remembrance, our mind is sent reeling back to the event and through our mind's eye we can replay that experience in vivid, almost tangible detail. The mind's eye does not access our past episodes as mere facts or tacit knowledge of the experience, instead it shapes the facts and stored 'histories' into a rich story-form which retells the experience. Such personal narrative can bring floods of

feelings, emotions and related memories to the fore and allow us to explore the events in an immersive way. This remembrance and reliving of past events in story-form facilitates self-reflection, the analysis of our identity and the significance of this past experience to our sense of self.

The emergence of lifelogging technologies affords us the potential to record a digital account of our personal life histories. A lifelog collection seeks to collect as much digital data on the activities and life of an individual. Through a range of technologies, not only can the digital content encountered in our day-to-day activities be preserved but also an individual's current contextual factors determined, for example, through environmental- or personal- sensing [10]. The digital artefacts of significance to us are thereby automatically and passively assembled into a multimodal collection composed, for instance, of emails sent and received, text messages, web pages or documents reviewed or created, photos, videos, along with contextual factors such as places visited or people encountered.

During introspection the individual elements of memory and past experience are intelligently weaved into personal stories. These stories are hugely important to not only our reminiscence but also our identity [14] and our ability to communicate and share experiences [2]. Our internal life stories facilitate sensemaking of past-experience, support reflection and reminiscence, and also offer a medium for the communication and exchange of personal experience. There is potential for a lifelog to offer similar utility [5]. It is rich, voluminous and multimodal [6] and this affords, through the abundance of content and context data available, the automatic extraction of understanding for each episode, in addition to world knowledge about the life of the individual and their relationships to others. Brooks states that such understanding is essential to storytelling and consequently the knowledge we can extract from a lifelog should facilitate the reasoning required to produce a coherent and meaningful life story [4] and enable intelligent semi-automatic narration of its biographical events.

While the potential to automatically construct meaningful personal stories from such collections is empowered by its richness, the richness and volume of the collection is also problematic. While we can better understand what should be retold about a story, there is now so much content available to the retelling that it can be difficult to select those most appropriate. Thousands of artefacts may be collected passively in an average day and added to the ever-expanding collection. This sheer volume creates a significant challenge to reviewing or engaging with the contents and by consequence inhibits the potential for reminiscence and reflection. Automated computational methods, such as event segmentation [6], offer the ability to reduce the content into more manageable chunks, but even by aggregating it into higher-level semantic units, it still does not fully tame the collection. Within each 'event', a

wealth of multimodal content and context will be available, but there may be thousands of events each containing hundreds if not thousands of multimodal artefacts.

To create a digital narrative, the volume of artefacts which may be included in a narrative must be successfully, intelligently and appropriately reduced to present it in an intelligible and engaging manner. However, the reduction and presentation of content to a narrative format is challenging. Given that a lifelog contains a large volume of content and context from a range of modalities, we must carefully consider how to: select the most appropriate content to the story from each event; and how to integrate this multimodal content into a coherent and aesthetically pleasing presentation. Additionally, the range of multimedia content requires us to contemplate the fluency of each of the media modalities and how this may impact on the end retelling. The question of presentation - understanding how a multimodal archive containing document, text, content and context data can be brought together to best enable storytelling - is explored within the study reported within this paper.

By working with users and their artefacts, we investigate how lifelog content may be reduced and composed into a digital narrative of past experience. The potential for such an archive, and the stories it contains, to empower reminiscence, reflection and exchange of personal life stories through digital technologies is also discussed as well as how these narratives might in turn become vehicles for the sharing of personal experience and for facilitating reminiscence.

## 2. BACKGROUND

Storytelling from lifelogs has previously been explored in a number of small scale studies which often focus on a single media modality, notably the SenseCam [13]. The SenseCam is a small wearable device developed by Microsoft Research in Cambridge, UK, that passively captures a person's day-to-day activities as a series of photographs. It is typically worn around the neck, and so is oriented towards the majority of activities which the user are engaged in. Anything in the view of the wearer can be captured. At a minimum the SenseCam will automatically take a new image approximately every 30 seconds, but sudden changes in the environment of the wearer, detected by the onboard sensors can trigger more frequent photo capture. Images from the SenseCam along with associated GPS location information are presented as a means to recount a 'trip-based' experience as a lightweight story. This takes the form of an animated slideshow composed from SenseCam images [9]. While this work is relevant, the full range of context that is potentially available within a future lifelog is not considered. Harper et al. [11] conducted a study with six participants into user-created digital narratives composed from SenseCam captured images only. While the outcomes are very interesting, particularly highlighting the usefulness of such images in reflection and reminiscing over life experiences, it does not offer insight into the composition of such narratives, but rather the perception of them. Additionally, given the volume at which such a collection might grow, the applicability of wholly manual composition of such narratives is questionable. It additionally does not directly address how the passively captured images might be narrated nor does it consider how multiple modalities of content and context might be used to support storytelling.

Appan et al. [1] explore the composition of digital narratives for everyday experiences using media such as photos, gathered during the user's day-to-day activities. They highlight several points of note. First, they found that more traditional narrative models, such as those used in cinema or in the Agent Stories

framework [4], appear unsuited to the communication of everyday experiences. Secondly, they assert that users do not want to spend time editing or authoring their stories. As a result, in the case of 'everyday narratives', they favour the use of an emergent story framework in which the story evolves through feedback and interaction from the user. Interestingly they also advocate the use of low-sample capture of media within their narratives, citing the complexities of volume, data management and convenience. However, the low sample rates and low volume collections that they promote cannot offer the richness of content and context required to understand the patterns and subtleties of a person's life. Using high frequencies of capture results in voluminous collections but it additionally allows reliable semantic knowledge about the world the owner occupies, the people they encounter or the activities they engage in to be garnered. Without sufficient understanding of the user and complete knowledge of their activities the potential for storytelling and of the clarity, comprehension and meaning of the resulting stories could be negatively impacted. The focus of the work presented here is to address the challenges raised by Appan et al. by hoping to offer realistic approaches to taming the voluminous lifelog content into coherent storyform.

While not focused on storytelling, Lee et al. [13] have previously examined the reduction of image-based lifelog content. Their goal however was not the provision of a story or narrative to facilitate introspection, but rather the provision of good memory cues to a person suffering from Alzheimers disease. Within this study, they utilised the Microsoft SenseCam [13]. Their participants were instrumented with the device for a short period, following which they were asked to engage in a card sorting activity in which they iteratively reduced the content to the item that provided the best cue. While the goals are not identical to ours, their evaluation method - card sorting [8] - was effective. It is as such, one we have adopted to investigate the reduction of lifelog content for presentation in storyform. However, in our study, the method was adapted to include the full range of content and context which may be present within a lifelog.

## 3. INVESTIGATION

The focus of the evaluation was to explore how voluminous content from a lifelog can be effectively reduced to present a coherent narration of a particular activity or episode. To achieve this participants provided an extract from their lifelog which aligned with a 'story' from their life. We then asked them to engage in a card sorting activity in which they arranged, selected and reduced physical representations of 'artefacts' from a lifelog collection to produce a multimodal story. This practice not only gave us insight into the cognitive processes by which lifelog content may be converted to story-form but also provided insights into the value of such stories for personal introspection and reminiscence.

### 3.1 Participants

Participants were selected opportunistically based on the availability of a SenseCam collection. A passively collected SenseCam collection for a minimum of one day was the only prerequisite for inclusion in the evaluation as it was the only component of an extended lifelog that could not be easily simulated. In total, nine individuals participated in the study, all of which were members of the research group, which is primarily engaged in information retrieval research. The majority were male, with only two participants were female. Additionally most ranged between the ages of 20-30. While participants were known to the investigators, results are not expected to be biased as they have no direct stake or

Participant	Story	SenseCam (skimmed)	Digital Photos	Email	Document	Web	Video	Other
1	1	1630 (78)		1				27
1	2	939 (79)		12	1	5		20
2	1	234 (79)		13				
2	2	379 (77)						
2	3	311 (80)		1				
2	4	193 (98)						
3	1	2109 (102)	97	8	1		1	
4	1	12805 (103)		7	1	1		
4	2	2902 (102)	7					
4	3	5398 (102)	7	25	4			
4	4	3493 (102)	11	1				
5	1	955 (81)	68					
5	2	4893 (76)	42	2		1	2	
5	3	329 (85)		2				
6	1	297 (75)		1	1			
6	2	87 (87)		2				
6	3	686 (87)		3				
7	1	2411 (77)		19	3			
7	2	916 (154)	30					
7	3	27 (27)		7		1		
7	4	270 (92)		1				
7	5	525 (77)		1				
8	1	741 (94)		4				
9	1	135 (135)		1				
9	2	400 (82)		4				
9	3	811 (83)		4		1		

**Table 1. Participant stories provided and the amount of digital content for each.**

involvement with the outcomes of this research. No incentive to participation was provided.

### 3.2 Materials

Prior to the experiment, participants were asked to briefly review their SenseCam collection in order to select up to five stories. They were instructed that a 'story' should be a personally significant activity they engaged in or an interesting event from their lives. They were told that the 'story' could range in duration from a reasonably short activity such as a meeting to a much longer timeframe that might, for example, include a holiday. While some of the participants had extensive collections spanning many months, most had more limited SenseCam collections and as such, were more constrained in the number of 'stories' that could be selected. Consequently two participants could only provide a single activity. Examples of the selected stories include: attending and presenting at conferences; personal holidays and sight-seeing; and socialising with friends/colleagues. They were requested to provide the images within good time prior to the evaluation session to allow for assembly of the artefacts into card format.

In addition to the SenseCam images and in order to simulate a full lifelog collection for the selected events, participants were asked to provide other digital content related to the story, which would have been created, reviewed or accessed during the timeframe of the story. For example a participant may have viewed web page(s) related to the conference they attended;

may have emailed a colleague or friend; or may have received an itinerary or ticket by email; they may have taken a digital photo or captured a video of something of interest; etc. They were asked to quickly, but not extensively, review their personal digital content for items of relevance and if content was available for the story, to provide it at the same time as the SenseCam images.

In advance of the experiment, the digital materials provided were printed and converted into a card format. As there were often several hundred SenseCam images provided per story it would be unrealistic to expect the participant to exhaustively review each image. As a result, the SenseCam images provided were temporally skimmed by selecting every *n*th image for inclusion. This automatically reduced the content to between 75 or 100 images depending on the complexity of the event and the amount of related digital content provided.

A breakdown of the stories provided by each participant as well as the types of digital content available for the construction of each story can be seen in Table 1.

### 3.3 Method

In order to better contextualise the participants' use of the SenseCam and to understand if they had engaged in storytelling and reminiscence using their lifelog artifacts, participants were initially probed about their experiences with the SenseCam through a short informal interview. This lasted between 10 and 20 minutes. In the interview, participants were asked about the

periods of their lives they had captured; the types of experiences, which they had captured through lifelog technology; the frequency and purpose of review and access to materials passively captured; and reminiscence as a result of such access.

Following this interview, participants engaged in a card sorting activity [8] for each story they had previously selected using the materials they provided. This consisted of three steps: a verbal recounting of the story; a visual review of the SenseCam images for the story as a high-speed playback; and finally the main card-sorting task.

Participants were first asked to recount the experience in their own words, instructed to do so as they would normally. This served a twofold purpose: first to provide comparison between conversationally relayed stories and digitally communicated stories; and secondly as the materials provided did not contain any contextual (location, people, relationship), emotional or thematic information, it provided a means by which these items could be garnered quickly. As the story was told, salient people, places, emotions and themes were noted by the investigator on flashcards which would later be provided to the participant.

Next, the participant was asked to review a high-speed playback of the SenseCam images from their selected story. While doing this they were asked to comment upon any important elements of the story that they may have missed in the conversational recounting. This served to ensure that the contextual items presented during the card sorting were as complete as possible and not wholly contingent upon the person's recollection of the activity. Furthermore it provided an opportunity to examine the difference between the recollection of the episode and the passively captured account of it. Participants were requested to comment upon noted differences between the two briefly following their review of the high-speed movie.

Finally, the participants were presented with the artefacts from their story in card format. Each participant was typically provided with between 75 and 100 SenseCam skimmed from their collection; along with any other digital images; their digital content printed; and also handwritten contextual factors. They were instructed that these should be considered to be 'objects' which could be used to tell the story of their selected activity. They were also advised that they should compose a 'multimodal collage' of their story and they should select the objects which best retold and embodied their selected activity. To achieve this, they were instructed to reduce the content to the 50 items which best represented the storyform. Participants were also asked to 'think-aloud' [16], paying particular attention to their reasons for including or removing particular items of content. This allowed the cognitive processes involved in the internal decision-making and choices relating content reduction to be made more obvious. Once the participant was satisfied that they had appropriately presented the episode with 50 items, they were then asked to then further reduce the story to the 25 most important elements using the same instructions. They iteratively reduced the content from 25 to 10, 10 to 5 and 5 to one single item using the same procedure.

The session with participants was video taped to preserve a record for later analysis. Figure 1a & 1b illustrate the card sorting activity and content reduction.

#### 4. RESULTS AND DISCUSSION

We now present the results of our evaluation paying particular attention to the potential of these artefacts within reflection and

reminiscence. As the evaluation mixed both qualitative and quantitative outcomes, both will be discussed in tandem.

The initial interview with subjects provided some insight both into their general use of life-logging technologies and their current utility in reflection. The participants varied widely in the length of time they had spent wearing the SenseCam. Some of the individuals had only worn the device for very brief periods (i.e. 2 or 3 days). These were days of particular interest to them, and for which they had explicitly decided to preserve a record of, such as a trip abroad. This accounted for 4 of the 9 participants. A further 2 participants engaged in capture for a period of approximately one month. Finally, the remaining three participants had passively and broadly recorded their life experiences for protracted periods of more than 5 months.

While the periods that participants captured varied greatly, their review practices were fairly consistent. Most of the participants did not review their collection with any regularity nor did they do so for personal reasons. Most of the review was prompted by the use of their collection in experimental work - either as an examination to remove undesirable content that they would not want others to see or as required by part of an investigation. Participant 4, who engaged in passive broad recording of their life experiences, stated that the volume of their collection and a lack of appropriate tools by which to review their materials discouraged them from such personal inspection.



**Figure 1(a - Above) & (b - Below): A participant engages in the card sorting activity iteratively reducing the content to that most important to the narrative.**

The expensive nature of conducting a review of lifelog materials was highlighted throughout the sessions with all participants. While the high-speed playback of SenseCam images can be considered a reasonably efficient way to review lifelog content, it was still time consuming often taking several minutes to complete a review of a story which spans just a couple of hours. For example user 1 had a story that was just over 6 hours in duration. In this time, they amassed 1,630 SenseCam images for which the review took 2:43 minutes. User 5 had a story spanning a day and a half for which the high-speed review took over 8 minutes, by the end of which the user had become visibly disengaged from the content. The stories

within this study were constructed from reasonably short isolated episodes, but one might imagine that as a lifelog grows to encompass more life experiences, these stories may be constructed out of a series of related episodes. Using a high-speed playback in such scenarios would lead to even more impractical viewing times and a real risk of the viewer disengaging or abandoning the content. Furthermore, when engaging in the manual construction of a story from the 'lifelog' artefacts, participants needed to spend a great deal of time appraising and inspecting each of the content items. The process of story construction took users between 20 minutes and one hour depending on the complexity and volume of content provided. We can clearly see from this that the manual review, even for short periods, is both timely and expensive given the volume of content a lifelog contains. As such the time required to manually explore such a collection is prohibitive, discouraging personal review and creating a barrier to reflection from such content. This finding, albeit obvious, quantifies the need to successfully and automatically reduce lifelog content into storyform, selecting only the most relevant content required to allow a user to infer meaning.

However, despite the users' lack of prior personal review and the expensive nature of such an activity, there is obvious potential for the artefacts to empower remembrance, reminiscence and personal introspection. This could be seen clearly throughout the sessions. The users delighted in the process of examining the artefacts: often pouring over them and sharing the experience(s) the artefact triggered. Users 1, 3, 5 and 7 particularly engaged with their material, most likely as their stories were of highly personal non-habitual experiences. While reviewing their artefacts, these participants often paused to reflect upon artefacts of significance. The artefacts in question often represented a 'sub-story' - an anecdotal encounter which occurred as part of the larger story, but which was not required for the main story's coherency. When 'thinking aloud' about these 'sub-stories' the participants tended to do so with excitement, using highly emotive language reflecting the affective quality of the experiences and these artefacts' ability to provoke reminiscence. These anecdotal encounters typically had been forgotten by the participant, but once recalled were perceived as highly valued within the overall experience. As such, they were frequently preserved during content reduction and maintained down to stories formed of only 5 items.

By providing a factual account of past experience, the lifelog not only helped to recall forgotten elements but also helped to disambiguate 'false memories' or 'misattribution' of the experience. This was seen with user 5 who provided a story about attending a conference. They unknowingly began to mix elements of attendance at one conference with another. As soon as they viewed the lifelog material, they became aware of their error and were able to quickly identify the erroneous elements within their conversational recounting of the story. The lifelog can perhaps help us to recover from such 'sins of memory' [15] which include: transience or the decreasing ability to access memories that occurred some time ago, absent-mindedness or general forgetfulness; blocking or the temporary inability to retrieve information that we know; misattribution or incorrectly assigning a source to a memory; suggestibility or false memories; and bias or the exertion of an affect on past memories by current knowledge and beliefs. The lifelog and its artefacts amount to an unbiased highly factual storyteller and this may have really interesting implications for reflection driven by its contents. In the case of user 5, this factual account served as a grounding by which true recall of an account could be facilitated. So, while our memory of the past, and our consequent storytelling based on memory, can be biased or

even false, a lifelog's will not be. As such, it can juxtapose recalled experience with a factual account and provide interesting opportunities for introspection and self-examination.

However, the disjoint between the remembered and the factual account must be born in mind particularly when attempting to construct a story. Stories are not factual accounts and as such we must consider how 'honest' or true to fact do we need to be when narrating past experience. Conversely, the lifelog can provide a highly detailed factual account of an activity through both content and context, e.g. who was encountered, when were they encountered, how long were they encountered for, what the activity was, etc. However, often this is an all too detailed account, skewed from the remembered. During the construction of their first story, user 1 noted that the temporal aspects of the remembered story form do not always align with that of the lifelog's account. In this story, the participant was sight-seeing while overseas. They noted how the SenseCam's visual record of the activity gave prominence to walking around the city, due to the large amount of time required to get from site-to-site. However, walking did not feature greatly in either the conversation or digital stories. Both favoured the points of interest encountered and explored by the individual. These, by comparison, only featured briefly in the visual recording. By implication, the lifelog account presents walking around the city as highly important to the activity - so much so that the participant commented specifically on this. This disjoint between the memory (or storyform) and the lifelog was again seen by User 2 Story 2. Here, the time recalled spent talking to a friend was much less than in the lifelog account and as such the significance of this was misrepresented. This disconnect supports Harper et al's [11] position that the SenseCam, and perhaps more generally lifelogs, are not an analogue for the experience. By trying to better align a lifelog with the storyform, we hope that the disjoint between a lifelog and the remembered accounts might be minimised.

There is however a significant challenge to achieving this. Within our evaluation, we saw that the conversational story does not directly map to the digital representation constructed by the participant. While emotional language was often used in the conversational storytelling, and although it was provided on flash cards as an object for use within the 'digital story' assembly, participants, with the exception of user 7, quickly removed any affective expression. This behaviour may stem from the backgrounds of the participants; however, it is more likely that the emotions are communicated in an alternative manner - perhaps through the image content selected, or as a result of internal narration - making their explicit inclusion redundant. Also, contextual explanations of the actors or settings were often seen in the conversational account. These contextual factors were provided to the user and often initially used for exposition when at the level of 50 or 25 items within the story, but they were often completely removed when the story artefacts were further reduced. Participants stated that these factors were implicit based on the presence of other content and as such understanding of the context around the story could be assumed or inferred. Furthermore, the conversational account was often highly temporal providing a play-by-play account of the salient activities within the experience. However, the digital account was typically not arranged as such. Participants clustered content around the major themes of the story ensuring they were appropriately covered by the content available. Content was neither chosen nor arranged based on temporal flow - although highly temporal accounts were seen in some of the stories. For example those constructed by users 4 and 8 - but rather based on the most salient themes from the story. This is shown in Figure 1(b).

This in particular highlights a marked difference between the communication of a personal story as compared with a narrative assembled from the digital artefacts present within a lifelog.

## 5. FUTURE WORK

The goal of our work is to construct coherent and personally meaningful stories from a lifelog collection. The largest challenge to this is the extremely large volumes of multimodal content contained within a realistic lifelog archive. However, the experiment presented in this work has yielded cues as to how content from such a collection may be successfully and appropriately reduced into storyform. Through further review and deeper analysis of the experimental outcomes, it is expected that a model for the selection of content from a lifelog can be realised. By examining and understanding the practices by which the participants organised and reduced the content, we can seek to integrate these into the computing components, which will generate the story from a lifelog archive.

To enable storytelling from such collections, we are in the process of gathering large-scale realistic lifelog collections from four participants. The participants will record their life digitally for a one-year period and by using a range of techniques and technologies we aim to collect as rich a collection as possible. To this end each participant will capture: all desktop activity and content; all mobile activity and content; personal context using Bluetooth, GPS, Wireless network presence and GSM 'sniffing'; SenseCam images; and biometric readings. Utilizing the knowledge gained from this study in combination with the availability of a large-scale lifelog, we will next undertake to build a semi-automatic narrative generation engine as described in [5]. The structure of the narratives will be event-oriented as suggested by the related work in [1]. In the authoring process of this system, users will browse the archive in an 'event-oriented' manner. They will locate and select the episodes which are relevant to the story, marking them for inclusion. After which, they will be asked to make basic plot and aesthetic choices to determine the presentation of the narrative. The presentation format of the narrative will be based on the findings of the evaluation outlined in this paper. Following this the system will enter a generation process in which the selected content and author choices are constructed into a coherent story. With such a system implemented, we will be able to evaluate the role of stories generated from extended long-term lifelogs in enabling personal reflection and sharing of meaningful life experiences.

## 6. CONCLUSIONS

Lifelogs offer the ability to capture day-to-day activities through digital technologies. Like our memories, these have the potential to be assembled into narrative form and through these narratives reflection and reminiscence can be facilitated. The artefacts contained in a lifelog have clear potential to support and facilitate such tasks, however, the challenge is to correctly identify the appropriate artefacts so that they can be drawn into the story. We have outlined the initial results of a user evaluation which highlights the distinctions between lifelog content, conversational storytelling and digital story forms, and by consequence the challenge in successfully reducing and assembling the rich voluminous multimodal content of a lifelog into a coherent, meaningful story. The value of these artefacts in reflection seen in the sessions with users, however, provides strong motivation for such effort and further investigation.

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