Experience Machines: Capturing and Retrieving Personal Content

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1 Introduction

Fundamental to human existence is the ability to capture, memorise and retrieve personal experiences and to share them with others. Can systems help us to capture and retrieve experiences? After motors have supplemented our muscles and sensors have supplemented our senses, emerging computer systems are on the verge of becoming intimate supplements to our memory. New generations of sensor technology, interaction methods and semantic computers enable the capturing and interpretation of a person's daily activities and the pro-active assistance of these activities. Semantic computers are the engines of rich digital autobiographic archives that are intuitively accessible for retrieval of personal content. New interaction methods turn computers into experience machines that allow a new and deeper sensory awareness of environmental, bodily and cognitive processes. We will see entirely new ways of experiencing information through combinations of sensory modalities (multimedia) and translations between sensory modalities (synaesthetic media).

This chapter describes the value and exponential growth of personal content, the urgent need of consumer applications to manage and utilise this content and challenging dilemmas related to capturing and sharing personal content.

2 Early Visionaries

The visionary road towards experience machines was laid out by Vannevar Bush in 1945. Bush was head of the US Office of Scientific Research and Development and coordinated the activities of some six thousand leading American scientists in the application of science to warfare (Nyce and

Kahn 1991). He wrote down his vision in an essay "As we may think" for the Atlantic Monthly in 1945. Bush foresaw the development of the Memex. The Memex was to serve as an aid to memory. Like the brain, the Memex would file material by association and could be consulted with exceeding speed and flexibility. With a keystroke it would run through a "trail of thoughts". Obviously his ideas of "associative indexing of information" are closely related to the concept of "hyperlinks" on the Internet as we know it today. Furthermore, Bush foresaw Cyclop cameras that are worn on the forehead and can photograph anything you see and want to record. To record all this he foresaw the microfilm that could reduce the Encyclopaedia Britannica to the volume of a matchbox. He based his visions on electro-mechanical devices, which is not surprising because the world's first electronic calculator (the ENIAC) was yet to be built and the transistor had yet to be invented.

According to Bush the Memex would lead to a total experience of observations, opinions and decisions of ourselves, friends and authorities. The Memex would be an intimate supplement to our memory. It was not until 1966 when Douglas Engelbart realised the first step of Bush's vision of man-machine interaction by demonstrating a desk-top personal computer with innovative interaction tools (basically the current PC, including videoconferencing) and entirely new ways of organising information (basically hypertext).

3 Why Would We Want a Memex?

Our natural human memory enables us to store, retrieve and associate information in a miraculous way. Memory access is direct, without the interference of interfaces that characterise digital memories such as keyboards, spoken commands or gestures.

However, the very brain mechanisms that make us so good at creativity and aesthetics are also responsible for our poor capability for the memory of details. In the course of time information becomes "inaccessible". Firstly, this may be due to the blending of pieces of old and new information into more general and abstract schemes. Secondly, our association methods may change when we grow older. Memory is at the service of expectations. In fact, people record experiences for the person they will be in the future. Thirdly, fatigue, stress and emotions can hinder the access to our memory.

This is where an intimate supplement to our memory would step in to support us in accurately retrieving information. It could illustrate topics

discussed with others, structure and order information for us in time, or recognise patterns and people. By this, personal digital archives would naturally become interwoven with our daily activities and communication.

4 The Growth of Digital Personal Content

Nowadays, we see that sensors and computing devices are miniaturised, that text, sound and images are represented digitally, and that people are connected through wired as well as wireless networks. We are gradually embedded in Body Area Networks consisting of sensor, actuator and communication devices that form extensions of our natural sensing and motor systems.

We have started using personal digital assistants (PDAs) to manage address books, calendars and "things to do" while we are on the move. Nowadays, PDAs are organisers and storage devices for sound, music, images and personal notes. They connect us to the information world on the Internet and form communication channels to colleagues and friends.

To bridge the traditional and the digital world, consumers have started to digitise experiences captured on traditional media such as paper, plastic and magnetic media. Until now, our autobiographic archives consist of drawings, photos, videos, notes, tapes, financial and medical files, stored in various corners of our houses and offices. These archives are often incomplete, inaccessible, without labels and fragmented. Some of them even gradually decay. In the digital era all these media are digitised and stored in electronic networks, which are accessible through hand-held devices. Digitisation may save our memories. New experiences are directly captured with digital photo and video cameras, with mobile phones, body sensors for heart rate and blood pressure, etc.

Collections of personal content on PCs grow exponentially because people share their collections. When we experience an event, we rely on the aggregations of other experiences and experiences of others to shape the experience.

The digital archive of even one person in 2020 is likely to consist of Petabytes of linked images, documents and audio; the potential for extracting useful knowledge from this archive is stupendous, and only limited by our imagination.

5 Management of Personal Content?

Interestingly, tools for managing personal content have not come much further than media players, image browsers and calendars. Even digital information about an activity or a person exists in many different information worlds such as email folders, document folders, address books, calendars, audio-visual databases, websites, and phone conversations. All too often, these worlds have unrelated structures and varying or non-existing indexing rules. Moreover, the storage systems have no semantic understanding of their content and interconnections. It is therefore impossible to integrate these information worlds into a sufficiently complete "story" or "experience".

There is a great need for tools to analyse and filter personal content at a semantic level and tools for organising personal content conform to the mental representations of their users. Last but not least, we are desperate for tools that help us integrate, organise, retrieve and experience previously captured content. Nowadays, Virtual Reality is commonly used to experience computer generated synthetic worlds for the purpose of design, training, and entertainment. However, tools for experiencing our own personal content or "real reality" are still in their infancy and often limited to only a few scientific areas. The average consumer is left with an intimate but inaccessible digital supplement to his autobiographic memory.

Companies such as Microsoft do recognise this problem. The software in the *MyLifeBits* project is designed to support people with the annotation, clustering and rating of personal content and with quickly retrieving the right information at the right time. Although these efforts are presented under names like "surrogate brain" the focus is more on storage and retrieval than on cognition and experience.

Remarkable progress with respect to experiencing "real reality" has been made by Steve Mann (University of Toronto) who, for the last thirty years, has worn a headset (wearable wireless webcam) as if it were a part of his own body. This vision system not only records daily experiences, but also provides intelligent feedback based on these recordings. It acts as a personal visual assistant and allows him to record, interpret and "augment" his everyday experiences.

6 Towards Experience Machines

Combining these two developments, that of growing personal content and that of new means to organise content, we may expect to witness the evo-

lution of wearable digital autobiographic archives. Nowadays personal digital assistants help us with planning, address information, communication and making notes. Soon they will be able to capture our environment audio-visually and store our perceptual experiences. They turn into personal content managers. Personal content managers will be able to capture, filter, store, analyze and retrieve continuous streams of audio and video. They will be able to understand sensory information at a semantic level and proactively support us in our navigation and conversation by presenting personal content at the right time and the right place. They will help us recognise people and places. In the end personal content managers will turn into experience machines and will provide experience on demand.

Experience machines will let us share multimedia experiences across networks, pass experiences on to others and to next generations. This development is in line with Waterworth's observation that most computer artifacts that are currently in interactive use function not as 'cognitive' tools (tools that help the user process information better) but as sensual enhancers, as essentially perceptual artifacts (Waterworth 1997).

Virtual reality techniques make it possible to experience synthetic worlds based on computer models of geometric objects and visualisations of abstract data. This gives us the opportunity to experience working on the bridge of a ship before it is built. If computers were able to analyze and model the structure of the real world fast enough we would be able to remotely experience real world scenes in real time. This would allow telepresence. For example, this would upgrade watching the world cup finals on television to experiencing running around between the players – real time – without really being there. The next step is not to model the actual real world, but to model the past based on a person's digital memory of autobiographic multimedia data. We will then be able to re-experience the first time we kissed a girlfriend, including multimodal feedback about what we saw, heard and said, and various forms of bodily and contextual information.

Furthermore, we can share and integrate archived personal experiences from many persons into a "collective experience" yielding fascinating applications in the field of crisis management and rescue teams.

Confidence in the further realisation of Bush's vision is reinforced by recent advances in areas such as search technology, computer vision and graphics, and natural language processing. Real world modelling techniques are being developed in the robot vision world. Recent successes in machine analysis and machine learning have indicated that many of the problems that were previously considered hard enough to require cognition are in fact solvable in a purely data-driven manner.

7 Recent Developments

Experience machines are fed by the personal content of their users. Users or consumers become producers and distributors of their personal content and experiences. The amount of personal content stored on hard disks is already huge and will grow exponentially because also information flows such as telephone calls and email are expected to be systematically archived in the near future. The market for adequate tools to adequately manage, share and experience this content is huge.

7.1 How Much Content Is There World-Wide?

The School of Information Management and Systems at the University of California at Berkeley (Lyman and Varian 2003) analysed information storage and information flows world wide for the year 2002. They estimated the annual size of new information recorded in storage media, and heard or seen each year in information flows. The following conclusions were drawn:

Recorded information (print, film, magnetic, and optical storage media)

- Print, film, magnetic, and optical storage media produced about 5 Exabytes of new information in 2002 (1 Exabyte = 1,073,741,824 Gigabytes). 5 Exabyte are equivalent to 37,000 times the content of the Library of Congress collection. It should be noted that the lower bound of this estimation is 3.4 Exabytes (after correction for compression and duplication of content).
- The category “magnetic” (representing 92% of the total) includes videotapes, audiotapes, digital tapes, miniDVs, floppy disks, zip, audio MDs, flash, and hard disks. After correction for compression and duplication, videotapes make up for 39% of this category, MiniDV for 37%, and hard disks for 12%.
- The category “film” (representing 7% of the total) includes photographs, cinema, films made for TV, TV series, direct to video, X-rays. Photographs make up for more than 50% of this category.
- The category “paper” represents only 0.01% of the total.
- Newly stored information grew about 30% a year between 1999 and 2002.

Non-recorded information (information flows such as telephone, radio, TV, and the Internet)

- Information flows contained almost 18 Exabytes of new information in 2002.
- Telephone calls make up 97% of the total information flow, including both voice and data on both fixed lines and wireless. Most of the calls are person-to-person. Only 13% of the calls are wireless.
- The second largest component of the information flow is the Internet (3% of the total information flow). Email is good for 83% of this component. Email generates 400,000 Terabytes of new information each year with 31 billion emails sent daily. One third of email traffic is personal.
- The World Wide Web contains about 170 Terabytes of information with 2.1 billion static web pages.
- These information flows are expected to be systematically archived in the near future.

7.2 How Much Personal Content Is Produced per Person per Year?

Based on a world population of 6.3×10^9 people, almost 800 Megabytes of recorded information are produced per person per year. Videotapes and miniDVs are dominant magnetic media, mostly containing personal content. The storage on hard disks is expected to grow due the use of digital cameras. In 2002, about 28 million digital still cameras were purchased worldwide, compared to 63 million analogue cameras. Consequently, the total number of digital images created annually in the US is expected to rise from about 14 billion in 2000 to 47 billion in 2004. Interestingly, owners of digital cameras take three times as many pictures (700 a year, see PMA meeting 2000) as owners of traditional cameras.

The most dominant information flow is telephony, which accounts for three times as much digital information per person per year than recorded information. With the advance of Voice over IP (VoIP) and the integration of VoIP with PC applications, we may expect most of the digital information flow to be stored, adding to a total growth of 2,900 Megabytes of content per person per year.

7.3 The Evolution of "Personal Content Management" Products

Already now digital personal content surpasses professional content by far, and this trend is expected to be ever-increasing. It started with multimedia documents, digital communication (Internet), the digital acquisition of photos, video and music and the use of PDAs for basic office applications. In the next decade, we will see a more systematic and automated acquisition and storage of sensory data and information flows, feeding into what may be called our "prosthetic memories". During this evolutionary process we will see a need for products like:

- *Personal archive manager*: This manager relates the structures and metadata of digital information from various sources into a coherently accessible personal archive. It integrates sources at a semantic level, e.g. email folders, document folders, address books, calendars, audio-visual databases, websites, and telephone conversations.

- *Briefing assistant*: Automated updates or briefings before going into a meeting or conversation. The mental workload of a person is usually determined by three factors: the level of knowledge based working, the time left to finish a task, and the frequency of task switching. The last factor causes the person to switch between mental models and task context, which can be considered an "expensive" operation. The briefing assistant could reduce the work load by making us quickly familiar again with the status, context, and action points of a task as captured at the moment of switching to another task. First prototypes of wearable briefing assistants were produced at the MIT and named Remembrance Agent (Rhodes 1997). They display one-line summaries of note-files, old email, papers, and other text information that might be relevant to the user's current context. These summaries are listed in the bottom lines of a wearable head-display, so the wearer can grasp the information with a quick glance. Briefing assistants can also improve conversational skills for patients with Alzheimer's disease as showed clinically by Bourgeois (Bourgeois 1990).

- *Intelligent illustrator*: Nowadays, people have only limited freedom of illustrating their actual arguments due to fixed Powerpoint presentations or photo-albums. In the near future, we will see forerunners of experience machines in the form of content management systems that support us during conversations or presentations by providing the right illustra-

tion at the right time based on dialog based topic detection and agenda based context extraction.

- *Prosthetic memory*: A real time visual recogniser based on a camera built in your sun glasses. It recognises people, traffic signs and buildings based on personal experiences and external databases. First prototypes of visual prosthetic memories have been constructed and used by Steve Mann[1], including wearable face recognition and "déjà vu" functions.

- *Collective experiential system*: A synthesised global perspective of multiple ongoing and archived personal experiences. First prototypes have been developed and tested for rescue workers and crisis managers in the Informedia project "Experience on demand" at Carnegie Mellon University (Wactlar 2000).

- *Knowledge extractor*: Extracting useful patterns and knowledge from unlimited personal archives with application areas such as medical informatics and criminal investigation.

8 Challenges Ahead

The evolution of experience machines is driven by tremendous scientific and engineering challenges in the area of non-intrusive multimedia event capturing, real-time storage, semantic analysis, and intuitive interaction techniques with wearable devices. Further, we have to tackle numerous questions related to the protection and sharing of digital experiences.

- *Experience capturing: Multiple sensor and multiple perspective acquisition techniques for capturing the environment, actions, and context of an event.*

  Capturing techniques include traditional sensors for 3D sound and 3D sight that are well developed and even surpass human capabilities, and sensors for touch, taste and smell that will be developed relatively soon. This also encompasses the registration of bodily information such as body movement (including gestures), heart rate, blood pressure, or transpiration as indices of emotional behaviour. Capturing techniques also include the registration of environmental parameters such as position and height (GPS), temperature, humidity, wind force, and sun power.

[1] See http://eyetap.org

Wearable sensors are part of the personal area network and can be embedded in hand-held devices (PDAs, phones), in head-mounted devices (eye glasses, ear pieces), or in clothes (smart clothes). For first prototypes of visual capturing devices see Mann and Niedzviecki (2002) and Sawahata and Aizawa (2003).

Moreover, event capturing can make use of fixed sensors in the environment that give you a different perspective and / or public information sources such as radio, TV and internet. Finally, it should integrate the information of wearable sensors of other persons that are actors in the scene captured.

- *Real time storage and semantic analysis of experiences: Sensor information must be analysed at a semantic level, filtered, combined and stored in a multimedia system.*

  Database systems: Storage should be for a lifetime and longer, adaptable to new hardware and software, allowing new types of questions to be asked such as age, context and society changes.

  Storage: How can we store high volume multimedia data streams in combination with local, remote, and distributed storage devices? To what extent do users trust the usage of remote storage devices for their valuable personal memories?

  Operating systems: A person's memory will contain Petabytes of data and last for decades. How should these data be stored in a way that maximises accessibility and reliability?

  Artificial intelligence: How can we interpret audio and visual data at a useful semantic level, with a minimal amount of annotation and guidance from the person? This includes the automatic recognition of relevant persons, objects, signs etc. How do we transcode semantics across different types of information channels? How do we classify, relate and summarise events and activities, learn useful generalisations from the interpreted data and generate ontologies? What are the relevant data dimensions for future retrieval? What metadata and models are needed for personalised story telling (Davenport 2004)?

- *Intuitive interaction techniques for remembering: A proactive natural interaction environment that lets users experience specific content at the right time.*

  User models: How can we use personal archives to create personal profiles that represent people's knowledge, experiences, intents, abilities in a coherent and useful way? How can we adapt interfaces, web pages and documentation so that they are well matched to a person's profile and cognitive maps (Newby 2001)?

  Experiential systems: How can we use different types of sources of information and knowledge about a person's experience to build a coherent and consistent multimodal Virtual Reality model of that experience? What are useful generative models of an experience? We need formal models for interactivity and immersion in such experiential systems (multimedia grammars, feedback). We need formal mechanisms of evaluation of experiential systems (models, user study methodologies).

  Display technology: We need innovative wearable display techniques for non-intrusive mobile experience feedback (miniature head-mounted audiovisual displays, foldable displays, retinal projections, etc). For first products in this field see DeVaul et al.(2003) How can we use environmental displays for feedback on personal experiences (ambient intelligence)?

  Augmented experiences: How can we map senses that people lack naturally (e.g. ultrasound, infrared) to our natural senses with the purpose of augmenting experiences? How can we map sensory information of one modality to another (e.g. sound to vision or vice versa) for the purpose of adaptation of presentation modes to communication context or sensory disabilities.[2]

  Proactive recall: How can we use a user's speech (subject), location, time, company and context to support him proactively in his activities based on previous experiences? Human memory does not naturally operate in a vacuum of query-response pairs. On the contrary, the context of a captured event – such as the physical location, who was there, what happened simultaneously, before and after – provides valuable cues for

[2] For developments in this field see http://www.visualprosthesis.com/sensub.htm; http://www.informatik.umu.se/~jwworth/sensedoc.html

recall and association with past experiences (Rhodes 1997; Tulving 1983).

- *Privacy and security: Protection and sharing of experiences.*

  Privacy: Personal digital archives generally contain information about other people (correspondence, pictures). How can we protect people's privacy? Should other people have control over information in other people's memories and how can this be realised? To what extent do we want to share digital experiences with friends or inherit the memories from our parents?

  Security: How can we prove both to the scientific community and to the general public that memories are secure from attackers (Fitzgibbon and Reiter 2003)?

  "Eternal" memory: What is the psychological and social impact of "eternal" personal memories that people inherit from their parents and pass on to their children?

9 First Steps Towards Experience Machines

a) Informedia Programme (Carnegie Mellon)

The Informedia programme at Carnegie Mellon started in 1994 under the supervision of Howard Wactler and is sponsored by the National Science Foundation (NSF) and the Defense Advanced Research Projects Agency (DARPA). The research projects focused on integrated speech, image and language understanding for creating digital video libraries (Informedia I project). In 1999, it was followed by the Informedia II project which concentrated on video information summarisation and visualisation.

The subject discussed here came into focus in 1997 when a project was started with the name "Experience on Demand" which developed tools, techniques, and systems allowing people to capture a record of their experiences unobtrusively, and share them in collaborative settings spanning both time and space. Personal EoD units recorded audio, video, position (GPS) and other sensory data, which could be annotated by human participants. The EoD system synthesised data from many EoD units into a "collective experience" – a global perspective of ongoing and archived personal experiences. The technology could be applied for remote crisis management teams.

Building upon the technology developed under Informedia the project CCRHE was started in 2001. CCRHE (Capturing, Coordinating & Remembering Human Experience) developed systems enabling people to query and communicate synthesised records of human experience derived from individual perspectives. These records were transformed into meaningful resources available retrospectively. The technology is applied in ongoing projects such as *CareMedia* in the domain of geriatric care and clinical studies. Through activity and environmental monitoring in a skilled nursing facility audiovisual records are captured and analyzed, thus empowering specialists with greater insights into patient behaviour.

b) MyLifeBits Project (Microsoft)

MyLifeBits is a project of the Media Presence Group of Microsoft's Bay Area Research Center (BARC) in San Francisco. The project is both an experiment in lifetime storage and a software research effort aimed at building multimedia databases that chronicle people's life events and make them searchable.

MyLifeBits uses Microsoft's enterprise data management platform SQL Server 2000 with Index Server supplying a full-text search (SQL = Structured Query Language). The database scheme is very simple: there is one table for resources, one table for annotation links, and one table for collection links. MyLifeBits makes stories easy with Interactive Story by Query (ISBQ). ISBQ enables users to make queries, then drag and drop selections from the query into a story. There are two story types: a slide show and a time sheet. The slide show allows images to be dragged and dropped into a sequence with captions added, an audio clip to be spoken for each image, and audio clips for background music. The time sheet is a composition of multiple time lines. Resources are dragged and dropped into each timeline. It is stored using XML.

The lifetime storage experiment is carried out by Gordon Bell who "has captured a lifetime's worth of articles, books, cards, CDs, letters, memos, papers, photos, pictures, presentations, home movies, videotaped lectures, and voice recordings, and stored them digitally. He is now paperless, and is beginning to capture phone calls, television, and radio"(Microsoft Research 2002). The *MyLifeBits* software has been designed to support him with the annotation, clustering, and rating of this information, and with quickly retrieving the right information at the right time. Articles appear with the titles "Logged on for life", "My life in a Terabyte", "Saving your bits for posterity", "back-up brain", "virtual brain", and "surrogate brain". The focus of these activities, however, is more on storage and retrieval than on experience.

c) WearComp Project (University of Toronto)

Steve Mann is a professor of engineering at the University of Toronto and calls himself the first Cyborg (Mann and Niedzviecki 2002). His focus is on wearable computing, capturing, and experiencing. For the last thirty years he has worn a headset (wearable wireless webcam) as if it were a part of his own body. His glasses actually act as a very compact electronic studio since they contain several lasers, diminutive video-cameras, and half-a dozen tiny computers strapped to his body. This vision system not only records daily experiences, but also provides analyses and intelligent feedback based on these recordings. It acts as a personal visual assistant and allows him to record, interpret and "augment" his everyday experiences.

Examples are freeze-frames (enhanced learning), annotated computer induced flash backs (déjà vu's), an agent for remembering places and people, and way finding (based on stacks of key frames in video recordings). Furthermore, the system learns from information access patterns.

d) LifeLog Programme (Defense Advanced Research Projects Agency)

In February 2004, the Pentagon cancelled its so-called LifeLog project, an ambitious effort to build a database tracking a person's entire existence. Run by Defense Advanced Research Projects Agency (DARPA), the Defense Department's research arm, LifeLog aimed to gather in a single place just about everything an individual says, sees or does: the phone calls made, the TV shows watched, the magazines read, the plane tickets bought, the E-Mail sent and received. Out of this seemingly endless ocean of information, computer scientists would plot distinctive routes in the data, mapping relationships, memories, events, and experiences. LifeLog is not a programme to track terrorists, but analysts believe its research may continue on the classified side of the Pentagon.

e) Shadow (University of California at Berkeley)

Shadow is an experience capture system proposed by Landay and colleagues at the computer science department of the University of California at Berkeley (Landay et al. 2001). Shadow is an experience capture system that will enhance our capabilities to recall, find, explore, create, manage, and share information. The basic concept underlying Shadow is to have a long-lived, roaming, personalised process follow a user wherever s/he goes and "know" everything s/he does. The motivation for this is based on a simple premise: events, experiences, and information from our past are

useful in the present. Through multimedia capture, inference, and filtering, the Shadow will help augment personal and group experience, memory, and knowledge.

f) Lifestreams (Yale University)

In their Lifestreams project (1996–2000) Freeman and Gelernter developed a file management system based on time-ordered streams of documents (life-streams) that you created or that other people sent you. The stream starts with your electronic birth certificate and contains person centred pictures, correspondence, bills, movies, email, and voice mail. Moving beyond the present and into the future, the stream contains documents you will need: reminders, calendar items, to-do lists, and so on. Lifstreams provides contextual cues for managing information and allows to label future events, such as meeting times that trigger alarms shortly before they occur (Freeman and Gelernter 1996).

g) ACM Workshop CARPE 2004

Finally, the research community organised the first ACM Workshop on Continuous Archival and Retrieval of Personal Experiences (CARPE 2004, October 15th in New York). This workshop brought together researchers from around the world to share their findings and insights into this burgeoning field.

10 Business Models

Certainly there is commercial interest in better ways of organising, integrating, searching, and interactively presenting personal content. Many commercial enterprises are built around search technology and have an interest in extending the types of data which can be searched. However, most commercial R&D is focused on short-term incremental improvements. Long term research is necessary to develop robust and trusted management tools for safeguarding your digital memories. Privacy and trust will become extremely important issues when personal content is concerned, let alone secure accessibility at any place and any time. The successful development of universally trusted protocols may require that no central authority controls privacy, and may thus depend on open standards and open research.

Basically, the sharing of multimedia personal content is a consumer-to-consumer economy. Experiences can be shared for free (P2P) or can be

commercialised for entertainment or educational purposes, resonating with the concept of the "experience society" described by Pine and Gilmore (1999) and the "dream society" analyzed by Jensen (1999). In fact, the TV "reality soaps" in which we share the experiences of well known personalities are first examples of personal content sharing. Broadcasting your activities or even your aquarium on the web are first examples of P2P "content sharing". Service providers facilitate this process by providing storage and transport networks, retrieval tools, and perhaps by acting as experience brokers.

Business models for Internet commerce can be defined and categorised in the following basic categories:

- *Brokerage model*: bringing buyers and sellers together. A broker charges a fee for each transaction facilitated and usually operates in the B2C, B2B, and C2C markets. Example: eBay.

- *Advertising model*: an extension of the traditional media broadcast model in which content and services are provided mixed with advertising messages which may be the sole sources of revenue. This model works when viewer traffic is voluminous or highly specialised. Example: Google.

- *Infomediary model*: collecting, analyzing, and selling data about either consumer behaviour (for marketing campaigns) or about producers and products (for buyer assistance). Example: Nielsen.

- *Merchant model*: wholesalers and retailers sell manufacturer goods and services based on list prices or through auctions. Example: Amazon.

- *Manufacturer model*: companies sell their products directly and compress the distribution channel. Success is based on efficiency, improved customer service, and a better understanding of customer preferences. Example: Dell Computer.

- *Affiliate model*: affiliates provide user click-through to merchants. Merchants pay per click or offer a percent-of-sale. Example: Barnes & Noble.

- *Community model*: voluntary contributions and open sharing of content, software, and knowledge by community members. Revenue is generated from related services like systems integration, product support, tutorials, and user documentation. Example: Red Hat.

- *Subscription model*: users are charged a periodic fee to subscribe to a service, independent of actual usage rates. Example: America Online.

- *Utility model*: this "on demand" model is based on actual usage rates like in traditional metered services such as electricity and water. Example: Telephony companies.

The business models for commercialising tools and services for managing personal archives, for mobile access, and for experience and sharing of personal content fall into different categories. In particular: the Manufacturer model (direct sales of management tools and services), the Utility model (mobile access and experience), and the Community model (sharing experiences). The analysis of personal archives and knowledge extraction for medical or financial purposes may fall into a variant of the Infomediary model in which the results are sold to the user him- or herself. A sort of Infomediary model for content management is seen in the UK where companies commercially exploit services such as content management and access of medical records.

11 Outlook

11.1 Memory Overload

With digital memory "the past is always here and always perfect; everything can be represented, no moment be lost. Moreover, all of it is as good as new, and every copy identical to the original. What's missing is a cadence, a play of values, or a respect for the way loss informs our experience of time. Like the map that's as big as the world itself, it's useless precisely because it's too good" (Lewis 2003).

Obviously, people worry about the dilemma that if you record 24 hours a day, seven days a week, you will never have time to "watch". And indeed, you cannot watch everything. Recordings should be presented at the right time in a form that is optimally attuned to the task and context of the "owner" of the digital memory. The fact that everything is recorded does not mean that everything has to be watched or remembered. It is recorded all because the owner does not know a priori which selection will be of value in the future.

Norman (1992) says that normal brain functioning requires the right balance between two modes of functioning. The first mode is driven by our sensory data and externally controlled by signals from outside, including the signals from external forms of memory. In the second mode, called

conceptually driven processing, the mind drives itself and develops and invents new concepts and thoughts. Excesses of the sensory driven mode may cause solitary thinking to disappear, along, perhaps, with creativity and invention. More generally, perception and introspection (remembrance) should be in balance.

11.2 Organisational Content and Personal Content

Not surprisingly, individuals usually organise their stored information in a way that differs strongly from organisations. The effectiveness of dealing with personal content is optimal when its organisation is ego centred. That is, when its structure and presentation optimally serve the owner's skill, task, and context. From a person's perspective, personal content serves a lifetime, and its value is in feelings, lifelong learning, social activities, privacy, and entertaining. Professional organisations, however, are more and more project centred and aim for knowledge based value creation. High priority issues are validation, consolidation, knowledge sharing within the organisation, intellectual property rights, security, and protection.

Ego centred and project centred organisation of content conflict in many ways. In a project centred organisation, documents and correspondence are usually organised in projects with inflexible formats, quality standards, and limited lifetime. Bilateral communication is often facilitated by non-recorded information channels. Consolidated knowledge is "published" within the organisation, and its accessibility by colleagues depends on their role in the organisation and the classification of documents. For security reasons, content is usually "imprisoned" in enterprise information systems and strictly separated from personal content.

Personal content is much more oriented towards keeping memories alive and sharing them with friends. Experiences are best preserved as audiovisual representations, not documents. And, in contrast to project centred information, personal information is extremely fragmented and stored in many formats. Additionally, the value of company information usually decreases with time whereas the value of personal content increases with age. And most of all, it is all about the person's life which has a time span far beyond the duration of a project.

A person's work, however, is part of his/her life and part of his/her experiences and thus should be integrated into his/her personal archive. An interesting challenge is to relate organisational and personal content in such a way that security and property rights are respected.

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