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DIGITIZED & DIGITAL-NATIVE MEMORIES

Are Memories an Interaction Design Problem?

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Abstract
Digital transformation fosters the acceleration of the flow of information in relation to the instantaneous nature and speed of digital tools and poses a reflection on the construction of personal memory through the use of the content on digital media. They do not allow us to consolidate the memory and are neither designed around man's intrinsic need for forgetting. The lack of permanence of objects and the increasing process of emptying one's personal space generated by the inevitable digitization of contents shows how this detachment from material reality negatively affects our relationship with our memories. This research aims to understand how interaction design and cognition are tightly connected in memory-related interaction projects: on the one hand, by considering how poorly designed interfaces conspire against memory, and on the other hand, how memory processes themselves are adapting to the transformation imposed by new digital information tools.

1. Introduction

The transformation of information processes is changing in relation to the fact that the cycle of transformation of the media from analog to digital hypothesized by Nicholas Negroponte in the last century (1995) and extensively analyzed by Paul Virilio in his book *La bombe informatique* (Virilio, 1998), is taking place. In this transformation, strong accelerations in the information flow occur in relation to the instantaneousness and rapidity of digital tools that abolish the distances (Bauman, 2000). This change poses a reflection on how personal memories are built, recalled, and elaborated through the fruition of contents on digital media. Tomás Maldonado has already extensively dealt with the topic of the relationship between memory and knowledge (2005), highlighting the critical issues concerning the use of digital tools and their influence on human long-term memory in a context in which the pervasiveness of social and online tools was still at an emerging stage.

The research topic of how humans construct their memory processes is a very broad scientific field and the subject of multiple disciplines. This analysis aims to highlight how the radical change brought about by the new digital tools is reducing the time it takes to access content and, consequently, man's ability to store and organize his knowledge, which emerges from the flow of information we consume daily through the media. For example, the use of Instagram as a "memory tool" has been recently investigated in relation to the instantaneity of photo sharing (Caliandro & Graham, 2020), meaning the considered selection of images to be shared and its remembrative role in our lives.

The results show the trend to select the "best possible" photographs, but conversely, there is a notable reluctance to post intimate (especially family) images to the platform.

The increasing complexity of information systems that have evolved into many types of media has evidently diversified the range of tools, which from simple content providers have become on-demand tools and means of personal interaction. If we once owned books, movies, records, paintings, or other forms of communication, today, we are accustomed to using, renting, or downloading information and content from the web (Rifkin, 2000). Our mind uses different forms to access the information stored in our memory and helps itself by unintentionally building retrieval cues and concept maps to connect the information. Building personal maps also induce ourselves to build representations of individual experiences. As recently investigated in social science (Shannon, 2022), Facebook and Instagram posted family leisure images and narratives are intended to communicate non-normative definitions of family and clarify the family's 'real' identity. These representations help individuals resist the typical idealization of family life and offer authentic representations of family leisure.

The bookshelves in our homes and space themselves are access systems to our own information (Maldonado, 2005; Casati, 2013) and are physical maps that help visualize and find information: the books in it are extensions of the mind itself (Casati, 2013). This concept called 'extended mind' is recognized in the literature as a natural form of extending our ability to reorganize our memory (Clark & Chalmers, 1998).

Conversely, the practice of photo sharing on social media, i.e., Instagram, is changing the way people think about visual remembering. Digital photography, together with maintaining memories of the past, diffuses the sharing of visual narratives practice with the creation of "networked archives" of both personal and collective memories (Serafinelli, 2020).

As the artifacts change, the retrieval cues change as well. Far from being those tangible elements and visual traces we leave on which we anchor memory processes, the digital systems we use today becomes complex and unable to structure memory. In this contribution, we want to investigate how models of interaction with digital tools can be investigated, rethought, and designed according to strategies of content fruition that can support the stratification of personal memory, evoke memories (Hassenzhal, 2005), and increase our ability to remember. Short-term memory built on the storage of a few elements in the case of digital media is confronted with a considerable flow of information, and the process by which this becomes long-term memory is critically evolving because the possibility of reviewing and reflecting on the content is challenged (Bagnara & Pozzi, 2012).

The memorization process is based on the fact that an element is repeated and, above all, acquires value in being revised. The taste for reviewing (Morpurgo, 1985), consolidated by the domination of the photographic image for almost a century, comes into crisis with the proliferation of public and personal digital visual information, and the fragmentation of attention brought by mobile devices also increases these issues (Oulasvirta, 2005).

The time people have devoted to this process of learning and appreciating their experience is gradually becoming more and more limited and bounded by the features of the artifacts. With respect to these considerations by Maldonado and Flusser, it is also important to emphasize how the difference between 'network time' and 'real time' (Virilio, 1998; Thackara, 2005) and the awareness that the digital dimension may bear no relation to the real flow of events (Rushkoff, 2012) opens up a necessary reflection on how the gradual loss of moments of personal reflection (Bagnara & Pozzi, 2012) does not help to build one's own relationship with memory.

In this article, the relationship between memory, reflection, and interaction design has been investigated with Norman and Nielsen's principles for the design of digital artifacts in mind (Nielsen, 1994; Norman, 1988). In particular, the visibility, mapping, control, consistency, recall, and time heuristics have guided the authors in approaching good and bad design examples and verifying the quality of the memory experience. Memories are remembered thanks to the memory spaces allowing to store traces of significant moments. Quality memory experiences also contribute to raise awareness about visual pollution's importance (Evecen & Gudekli, 2019). As the number of shared images increases, people need to start to be concerned about leaving a digital visual trace.

2. Interfaces and Interaction Design for Memory

This research aims to understand how interaction design and cognition are tightly connected in interaction design for memory: on the one hand, by considering how bad interfaces conspire against memory and, on the other hand, how mem-

ory processes themselves are adapting to the transformation imposed by new digital information tools.

In most cases, social networks provide a model of interaction with content that takes the form of a long timeline that ideally begins with the date of the user's first registration. Such a continuous scrolling model of information affects memory organization, clustering, and management (Zannoni, 2018). The social network flow of information has many similarities with a continuous television broadcast, with the exception that its fruition starts from the last content posted and goes backward in time until the user is willing to explore the content.

The impossibility of organizing content and being able to fix it with bookmarks that can be more or less organized into lists is the contemporary limitation of most of the modern tools we use on a daily basis. The linearity proposed by a blog or a timeline of posts on a social network does not correspond to a traditional reading model for a few simple principles, such as for example: their sequence is predominantly backward because they always foster reading from the most recent content. In that way, readers are never aware of where the flow of content begins because they always see a limited part of it, the most recent one. In fact, our mind cannot linearly map information and memories as the timelines interface models are proposing. They do not allow for the consolidation of memory and, above all, in agreement with Liam Bannon (2006) and Victor Mayer-Schönberger (2009), they are not designed on the basis of the intrinsic human needs for remembering and forgetting.

However, the concept of linear visualization of information does not represent the problem in itself because we have al-

ways lived with the sequential structure of our libraries (Casati, 2013; Ferrari, 2014), but it is the interactive, instantaneous nature of digital technologies that impacts and undermines the strategies humans enact toward reality (Virilio, 1998). Differently from the book, which represents knowledge in itself and constitutes a physical retrieval cue for its contents, the hypertext has completely innovated the structure of access to information, making it necessary for users to construct non-linear concept maps involving logical choices in which the tree of information is far from reaching completeness and does not help to construct a unitary vision.

2.1. Bad Interfaces

What is the explanation of this possible crisis that, in addition to transform the way we use content, not necessarily for the worse, is bringing transformations to the processes of personal and collective memory (Zannoni & Formia, 2018)?
If we take inspiration from Clark and Chalmers' concept of the extended mind and try to extend it to digital artifacts. In that case, we are faced with the need to allow people to construct concept maps of their memories thanks to these new intangible objects that need a device to be enjoyed due to their digital nature. Today, our images are taken and stored in a huge continuous camera roll that we can organize into albums, but people hardly do so. The two prevailing operating systems for smartphone devices have gained the upper hand in the management of this content and dictate the rules in management logic. Third-party competitors are nowhere near able to meet this challenge and disappear little by little, such as Flickr and other forerunners of online cataloging systems.

From 2017 onwards, Apple and Android online systems began to build algorithms based on the metadata contained in images to create a logical organization for this flow of information. Periodically this artificial intelligence re-proposes images chosen over time, but the logics behind are not typically clear to users: this process, called "cued recall", acts by constructing engagements to resurface past episodes (Fawns, 2022), e.g., they create fictitious albums that correspond to places and temporal moments indicated by tags and metadata but fail to interpret the content from a semantic point of view, and remains sterile and cold if compared to the life emotions they could represent.

Photos content interpretation mechanisms have drastically improved, see Google Lens for example, and the same for online archives search systems able to analyse the content of images (Ben-Yair, 2021), but we are still far from imagining a scenario in which this intelligent interpretation might results truly valuable for constructing a structured personal memory. Another recent study on the impact of interface type on long-term memory showed that browsing sequential images within galleries does not facilitate the reminiscence of memories (Broekhuijsen et al., 2017; Axtell et al., 2022).

Considering the general audience of such intelligent services, these people are unlikely to bridge these digital contents to physical artifacts such as prints or photo albums. Although there are many solutions on the market, printed copies of photo memories are no longer as widespread as they once were.

In the past, there were very interesting tools that developed shared memory processes, one of which was the del.icio.us

platform, which made it possible with a very simple action to create bookmarks of web pages by organizing and disseminating them in one's own community. Del.icio.us counted about 5.3 million users before being sold to Yahoo, and 180 million bookmarks get lost after many changes in company ownership: a full heritage of collective memory and the representation of the interests of individuals who shared contents and forms of memory of facts and events in the network. The loss of this content was not a form of oblivion of web information but an example of the bad design of a system. Indeed, every individual should have the right to preserve their data and to be able to store, export, and reorganize them in different memories. But the policy of open and user-owned data does not always match with the web companies' policies. If one day Meta will decide to close down Facebook, what has been our online social life for over twenty years would vanish. The relevance of Facebook Photo Memories as memory artifacts has been discussed in relation to novel memory scenarios (Schwarz, 2014).

If social networks can be considered primitive interfaces for viewing content and building an organization of one's interests so that they constitute memory for people, what could the most suitable tools for supporting individual and collective memory be?
At present, personal data management systems are proprietary, and personal archives do not migrate between one platform and another in case of acquisition. There are open platforms based on textual tags markup systems which are often hostile to ordinary users.

We are probably at the beginning of a change in the management of personal data, and this, in the long run, will be a possible problem in which large archives of knowledge will exist on the net. However, due to the obsolescence of systems, many personal memories will also vanish several times in an individual's lifetime. However, this information, even if in some home or networked storage that is properly preserved, will, in any case, be submerged under an exponential amount of data.

2.2. Digital Artefacts and Memory

As already described by Sebastiano Bagnara (2006) at the beginning of the popularization of digital technologies, the gap between the availability and supply of information and the human capacity to process it has exponentially widened. One of the key mechanisms in memory is filtering, which allows some memories to be deliberately retained and others to be deleted. The ability to filter information is inherent to a mature mind; children and adolescents have not yet had sufficient time to build an intelligent, personal cognitive filter. The Net Generation, i.e., those born at the turn of the year 2000, who have lived almost their entire childhood and adolescence with the availability of the Net, exhibit memory navigation styles that are driven by the relative intensity of the information they are exposed to rather than by their own personal interest or choice.

As analysed by Maldonado, the increasing process of emptying one's personal space generated by the inevitable digitization of content led to the lack of permanence of things and enforced detachment from our memory (2005). It is also plausible to argue that the act of delegating human memory

to machines exponentially expands the amount of accessible data but at the expense of man's ability to construct a real memory (Flusser, 1990).

We are surrounded by ambivalent technologies that if, on the one hand, relieve us of the burden of remembering because they allow us to retrieve memories, especially visual ones. On the other hand, force us to remember and lead us to distrust external memory aids. In fact, in recent research on the role of human factors in cybersecurity (Pollini et al., 2022), the authors noted how memories of a visual nature are commonly shared in professional activities through taking and exchanging clippings, screenshots, photographs, videos sent in conversations and groups via messaging and online collaboration apps, e.g., Whatsapp and Slack.

The immediacy of visual memory in these forms has overtaken the importance of textual exchange in personal and professional communications. In this scenario, the visual recognition of content, e.g., photos of shifts between colleagues, or images of project boards, plays a dominant role. The main *hook* for memory retrieval becomes the conversation and people taking part in the dialogue. There are working tools, such as the search function, searching for content in the conversation, or the filters for the types of media exchanged in the conversation, which are also connected to the conversation.

In contrast to the growing confidence we have in exchanging visual memories, we are now witnessing situations where a new capacity for remembering is required. For instance, the mnemonic keys to access systems: current authentication mechanisms in computer systems, especially those related to

valuable data in the professional sphere, such as two-factor authentication, the use of customizable queries for information retrieval, PIN codes in payment systems, eight to sixteen character passwords... all of which are asking for a mnemonic demand also combined with not leaving any digital traces.

New memory aids are wide spreading in the cybersecurity sector; they are automated software, such as Google's Authenticator, which generates random codes to be used for the 2FA verification method in approximately 30 seconds time intervals. These are random codes that are automatically generated by the app without the need to use the data connection that is coupled with personal accounts. There the main issue for users is to understand the model of the system and completely rely on it.
Both memory-enhancing systems, through multi-media social sharing, and memory loading technologies, like those for data protection and cybersecurity, are not explicitly designed for memory, nor with a human-centred design mindset focusing on extending and reinforcing cognition and memory.

2.3. Digital Artefacts and Oblivion

In dealing with technologies that require us to commit to memory, such as the security systems described above, memory can represent a real burden, an unnecessary weight due to the accumulation of access keys, credentials, and contact numbers that, although in disuse, linger in our memory. As Bagnara (2006, p. 195) states, "one has a distinct feeling that it would be better to 'clean out' our memory".
But our memory is also made up of and fed by the memories

that digital systems and social networks offer us here. Unlimited retention of personal information on the web might not only affect individual forgetting needs. However, it may harm individuals by keeping shared and collective memories alive, such as youthful indiscretions on employees or low credit scores that may haunt individuals for a lifetime. Currently, Europe revives the "right to erasure" as the first step towards a forgetting web: a "right to be forgotten" (Mayer-Schönberger, 2009). Ideally, online services should "intelligently" support users with the oblivion of disclosed personal information.

As Liam J. Bannon states, "forgetting is not some unfortunate limitation of the human, but is rather a necessary mental activity that helps us later the incoming sensory flood and thus allows us to act in the world" (2006, p. 7). In particular, the cognitive processes responsible for forgetting are decay (i.e., forgetting implies not using knowledge for a long time) and interference (i.e., newly required knowledge interferes or inhibits already possessed knowledge).

Interference is what we continuously experience with the real-time overflow of contents and data and what we retain in memory is mainly represented by our reflective activity (Bagnara & Pozzi, 2012): what we think more deeply about and elaborate into personal concepts is what we remember and recover well. And cases where remembering everything had detrimental effects on a person's cognition are also well documented, both in the pianistic work of Alexander Luria (1968) on memory and in the more recent Viktor Mayer-Schönberger *Delete* (2009). The positive impact of forgetting has been recognized in organizations as well, be it intentional or unintentional (Bagnara et al., 2004).

We might state with Sebastiano Bagnara and Simone Pozzi (2012, p. 1109) that

> We are facing the paradoxical situation where we need to voluntarily "erase" skills and competencies in which we invested time and effort. We need to forget in order to achieve the optimal flow with the new technologies, in order to be able to quickly learn new skills. Our memory lives in a fast-moving present, where technologies do not give us any indication to consciously choose what to remember and what to forget.

The paradox is true that we might lose memories of contents we invested more attention and effort into. We might involuntarily keep other memories because they have been better described with web metadata, and search engines might efficacy retrieve them. Personal choice and control over memory and learning depend not only on our will but also on the opportunities for action and reflection we find in life and work contexts: if the artifacts we use are designed to support memory or oblivion.

Design for oblivion has been investigated in relation to intelligent oblivion mechanisms, able to discern different degrees of information importance, embed decision support for meaningful data deletion, and possibly commence forgetting automatically (Novotny & Spiekermann, 2014), and in relation to socio-technical systems, where work is conceived as an activity taking place within a system where knowledge is distributed (Hutchins, 1995) among four main components: the worker, the cognitive artifacts, the community of practice, and the end-users (Bagnara et al., 2004).

3. Discussion: Design for a Memory of Quality

From the above considerations, we want to propose formulating design guidelines that take into account the following critical issues: firstly, many people suffer from digital tools and let the systems manage their digital content, and secondly, the proper features of the devices that do not allow the personal elaboration of information.

In fact, algorithms of the systems that facilitate the process of remembering an event act as surrogates for our memory but are not yet sufficiently refined and qualitatively relevant to be truly integrated with our memory evocation processes. The second critical issue is that digital devices such as smartphones have a very small interface that does not allow much information to be displayed simultaneously. The physical limits smartphones have, prevent the human eye from being able to get an overview of the whole information "at a glance". In the example of the library of books, we can visually perceive a multitude of information at the same time, recall many memories and integrate them within our cultural background in a few moments. These 'visual cues' and 'physical cues' are the elements of a visual mapping system that people construct for themselves in their personal spaces. They represent retrieval cues from the physical environment but are widely studied in the social environment (community of practice and customers) and, more interestingly for us, in cognitive artifacts. In interface design, visual cues might be removed to erect barriers to block no more useful knowledge (Bowker, 2000) or might be emphasized to provide the users with opportunities to organize the information personally. These actions, together with similar modifications in the physical environment, would need to

be configured, either to cancel or enforce the cues to recall, but always on purpose, in order to design for decay or active organization of memories (Bagnara et al., 2004).

These information structures can be elaborated into conceptual maps that help people to recall personal knowledge and experiences in long-term memory. Any of the interactive tools on our devices have been designed with an immersive, interactive, engaging, and constructive approach in mind, apart from the operating system desktop that was conceived in the 1970s at the Xerox Palo Alto Research Center (PARC) and still remains an effective and efficient metaphor which proposes a set of unifying concepts used by graphical user interfaces to help users interact more easily with the computer.

In summary, we can consider that in order to be able to develop memory processes, the human being must be able to perform the following actions: to manipulate content in a natural way, to export, i.e., to be able to share, to plan and manage the information about one's own time, to organize and find hierarchies between the individual elements, and finally to materialize and trace larger information systems back to individual visualizations.

With this in mind, in proposing some principles for outlining guidelines for action, we referred to Jakob Nielsen's heuristics and Donald Norman's principles for the design of digital artifacts.

To summarize, in designing systems to suit the human action of constructing and evoking memory regarding our analysis, we would like to propose these six heuristics:

1. **Visibility** – The information must always be within people's reach and be enjoyed through overviews and not in linear form.
2. **Enhance the mapping** – Facilitate the association of visual cues to personal content.
3. **Natural and free control** – Make it as direct and immediate as possible to organize the elements between them, allowing them to be freely differentiated visually, and giving great relevance to the images.
4. **Consistency and hierarchies** – Give people the possibility to build hierarchies and coherent organizations of their information.
5. **No dependence on algorithms** – Develop memory recall aid systems that can facilitate choices but do not imply a passive use of the automatic process by users.
6. **Time** – Give people back the ability to spend time organizing their content through tools that facilitate this process.

These principles would represent a guidance framework for interaction design processes involving personal memories and allowing people to become the main actors in this process again.

4. Conclusion

Through the analysis of the current context of use, the aim of this contribution was to consider critical issues and opportunities in several interface designs to access one's own digital content. In order to tackle the challenges that memories bring to interaction design, it is necessary to open a real debate about the limits of the tools we are used to adopting, the

faster and faster processes in the fruition of information, and how they are incompatible with personal reflection.

In order to shape and validate quality memory interface design guidelines, experimental research is required with the possibility to investigate and document this area of design, leading to the application of the heuristics proposed in this contribution. A short-term goal could be to define a set of rules and checklists for designers to assess digital tools and services massively used to construct their memories through intentional and unintentional content management practices.

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