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A user-centered Perspective on Interactive Data Visualization. A digital flâneries into the documentation of the Historical Italian Mind Science Archive.

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Abstract. The data visualization debate is often polarized between the two dominant position of communication design and data science. A human-centered approach can introduce a third perspective putting people who'll use the information in a prominent role in the design process. According to user research methods, user personas and task-based testing, and co-design activities, the paper presents a case study developed for the Historical Italian Mind Science Archive (Aspi). The project has been focused on the experience of the users when surfing the hierarchical structure of the Aspi website looking for biographical information about the protagonists or searching for primary and original documents – such as correspondence, writings, notes – inside the digitized archives and their inventory. Interactive data visualization, on one hand, and human-centered design, on the other, are the two drivers chosen to make links and connections – otherwise embedded in the historical knowledge of experts in the field – explicit or, better to say, *visible*. The results are different conceptual and visual displays of the archives and curated contents of the website offering dynamic and interactive insights according to three different selected criteria: time, space, people. Activities of expert walk-through and user-testing, used in the research phase of the process have been used to evaluate the final results to understand and assess the overall experience of users and to validate the initial design hypothesis to extend the approach beyond the proposed case study.

Keywords: Interactive data visualization / digital archives interfaces and interactions / user-centered design

1 Introduction

The discussion – both academical and professional – on how to let people navigate information has raised in the last four decades. The massive diffusion of computers and their capabilities in generating, and analyzing data have opened the info to wider targets.

Nevertheless, the ambition to have a system or an *intelligent machine* able to catalog and connect every single fragment of knowledge is older. We already find intriguing examples in the work of Aby Warburg: the *Mnemosyne Bilderatlas* introduced in 1929 [1], or in the Shiyali Ramamrita Ranganathan faceted *Colon Classification* system [2].

In the contemporary debate, it has progressively polarized according to different disciplinary perspectives.

Firstly information architecture – the term has been introduced by Wurman in 1997 [3] – includes the problem both of information organization and of its visualization. The attention is driven not just by the conceptual structure, but also on the users' mental model [4], the cognitive map [5], and how it can be represented [6].

A year later, in the milestone book *Information Architecture* [7], Morville and Rosenfeld stated the aim and the role of IA: "Learn how to merge aesthetics and mechanics to design Web sites that 'work'. This book shows how to apply principles of architecture and library science to design cohesive Web sites and intranets that are easy to use, manage, and expand. Covers building complex sites, hierarchy design and organization, and techniques to make your site easier to search." On the other hand, authors such as Tufte [8] emphasized the visual structure displayed information as a method to understand and create meaning: the process itself in which data make sense.

Finally – but not in chronological order – visual semiotics [9] and the information graphics manipulation studies [10] started by Bertin in the late '60s tries to give scientific guidelines – cognitive [11], qualitative [12] and quantitative [13] – to data visualization disciplines.

2 Divers vs. flâneurs

Since the introduction of hyper-text and the web design era graphical user interfaces have been the tool to let people interact with digital artifacts. Metaphors, allegories and other *figures of speech* [14] – in this case – visual rhetoric figures have been adopted to let people build their mental model of a navigation system or a data structure.

In the early years two models have revealed creating what we now call the *hierarchy* model and the *hub* one [7, 15, 16].

2.1 The hierarchical model

The first pattern established in digital navigation systems – the hierarchical or *waterfall* model – has a very organized *shape*, often compared to a tree's structure. The main trunk, the different branches, and single leaves are the metaphor adopted to draw and visually represent the nested level of information. According to this approach, peoples' navigation starts from the top – the homepage – and proceeds in a

vertical descent. As the user proceeds, information become more in-depth, complete and specialized.

As underlined already by Rosenfeld and Morville, the structural model below the hierarchical navigation has a very determined organization. On the one hand, information architects approach to the tree definition adopting a top-down a decisional process in which every path have been already designed and determined.

"While a well-designed hierarchical organization scheme will reduce the likelihood that users will become lost, a complementary navigation system is often needed to provide context and to allow for greater flexibility of movement within site.

Navigation systems can be designed to support associative learning by featuring resources that are related to the content currently being displayed" [17]. Therefore, to bypass this limitation, other navigation systems are offered other than global navigation: local and contextual ones. Then the hierarchical models seems to perform well when the user already has a mental model of the whole structure, good knowledge on the field and already and an idea of the information he/she is looking for. In this case, the top-down structure is very efficient in letting people retrieving data and information in an effortless and fast way.

2.2 The explorative model

The hub structure offers a second perspective on how to move across a digital hypertext. Nodes are interconnected, but ideally at the same hierarchy level, to draw a map where all information is disposable at the same time.

Links can be explored according to a meaning associative relation, where all the opportunities are presented and exposed.

The user can move through the information in a horizontal direction– rather than vertical – discovering associations not thought before losing him/herself in a sort of cognitive labyrinth. The apparent loss of structure and control opens up, instead, to the serendipity of discovering unpredictable associations or unknown connections. Navigation itself suggests new paths and offers new insight and perspectives as masterfully told by Borges [18] creating a random discovery experience that enriches and broadened the user knowledge.

2.3 Complex digital information visualization

Furthermore, if referred to a complex information and material system – such as the exhibit or digital archive field – the hub opens big opportunities that change the nature itself of logical and physical connections: "The natural evolution of web hypertextual space has allowed the real deconstruction, not only of the physical unit of the archive […] the conceptual space of the collection and its belonging. The works become primordial cells, atoms of culture and of memory, which aggregate, disassociate and recompose in different associations with respect to the static nature of an exhibition, or their belonging to a collection corpus. The objects become nomads

and transversal, they intertwine in a continuous movement which stratifies their reading, relations and contaminations." [19]

Although the two models refer mainly information architecture e and cognitive navigation strategies they have deeply connected also with specific patterns of visual representation.

The first hierarchical one often adopts the graphical structure of the *list* – a logical form – the second one prefers spatial structure as *maps* [20].

Consequently, hierarchy representation tends to utilize ordered navigation steps based on the sequence: *home* > *list* > *card*, from general to particular, mainly displaying information according to an editorial grid system where images, texts, and contextual links are placed side by side in columns.

On the other hand hub and maps are based on a synoptic structure – both in a temporal and spatial sense – and a bi- or tridimensional visualization of the date and their connections.

If this second model has already been a field of experimentation for data visualization practices – see *Thinkmap Visual Thesaurus* [21] by Plum design based on semantic connections implemented back in 1998 to see how powerful the visual approach is – it is not always clear how to evaluate and asses the efficacy of such an approach.

However promising the adoption of the visual language, by its very nature unstable and polysemic is likely to introduce a further complexity, instead of supporting the user experience [22].

3. A human-centered approach to complex data visualization

According to a recent adoption of a usability methods also in the field of graphic design [23], an experimental project has been developed aimed to evaluate the users experience when navigating inside a complex ecosystem [24] offering both a hierarchical and an explorative navigation pattern.

The selected case study is the Aspi The historical Italian Mind Science Archive (aspi.unimib.it), established in 2004 at the University of Milano-Bicocca. The digital archive portal is part of the PAST the Historical Archive Center, and between 2014 and 2016, two funded projects has been developed to offer a dynamic data visualization aimed to present the connections among the three archives pillars: people, places and time [25]. The mission of the research center is to map and study the history of Italian mind science since XIX century, and nowadays the website presents 196 curated bios of the Italian protagonist, 23 digitized archives, and 111 registered archives. Historians and archivists, psychologist mind scientists and scholars, Ux a UI designer, computer scientists and software developers have been involved in a transdisciplinary redesign activity along with the users [26].

3.1 Method

To evaluate the different system an experimental activity has been conducted in a two phases. In an early stage, the existing hierarchical interface has been evaluated with expert users – historians, archivists, and scholars – to understand the interaction dynamics and the research strategies. Then subject has been interviewed: the analysis was focused on how experts can transfer their cultural knowledge to enable a broader audience guaranteeing cognitive accessibility to historical documentation [27]. The role of experts emerges above all in the ability to connect the protagonists just looking at a names' list, to contextualize documents – letters, manuscripts, written notes – and to read the connection between people and places – research institutes or mental hospitals – in an historical framework.

In a second phase, according to user-test task-based/personas-based method both the navigation models have been evaluated with users.

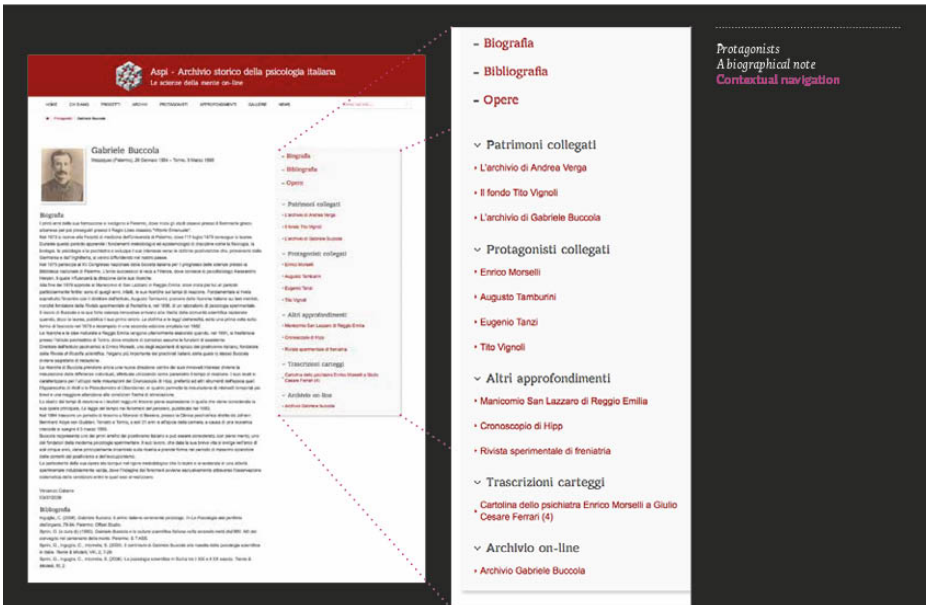

Fig. 1. Aspi: hierarchical navigation modality. Biographical card and contextual navigation system.

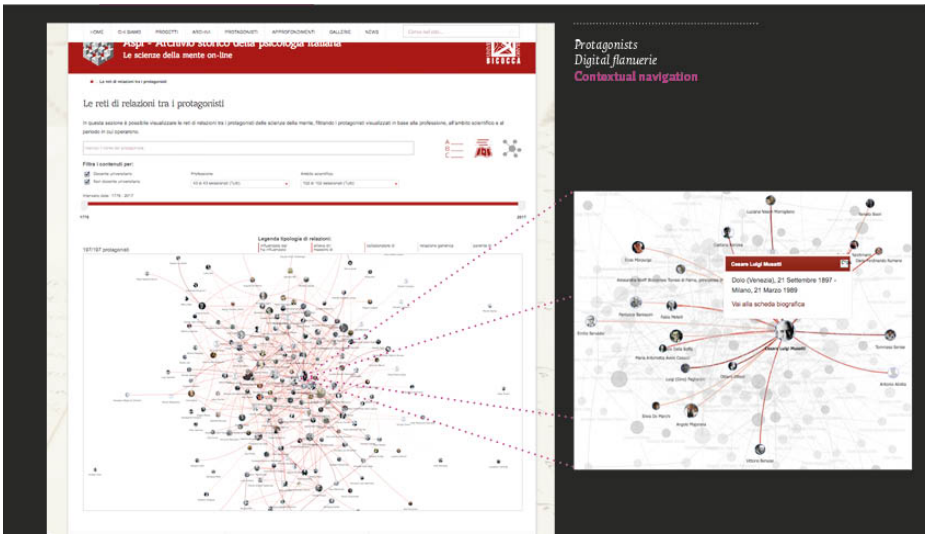

Fig. 2. Aspi: explorative navigation modality. Protagonists and associative navigation system.

The new target audience was composed of psychology students, fine arts, art history and architecture scholars and professionals.

The 25 participants according to literature – were split into two groups of respectively 5, 5 and 15 subjects and were asked to complete five tasks. One group approach firstly the hierarchical navigation model, the second the explorative one. Other subjects were free to choose which way they want to start with, and then they must complete the same tasks starting from the other modality.

They stacks were: 1) final a biography 2) find the correspondence between two protagonists 3) find an archive 4) find a place 5) find if a place was active in a specific period. Results were evaluated according three parameters: a) efficiency: execution time b) efficiency: errors or completed tasks c) satisfaction evaluated with a qualitative interview.

3.2 Results

Outcomes of the users' test have been clustered and prioritized according to the Norman's Design Principles: a) visibility b) feed-back c) constraints d) mapping e) consistency, and f) affordance.

Results have been divided and compared between the two navigation systems. The hierarchical model seems to fails mainly in the local navigation affordance of the contextual menu. A second emerged issue is the conceptual model of the place's alphabetical order organization. The exploration model has a lack of a) feedback for things and events happening under the folder, that means under the visible area of the display b) action trigger to activate the search and filter query (see fig.4) c) of visibility in the vertical scrolling of the timeline visualization.

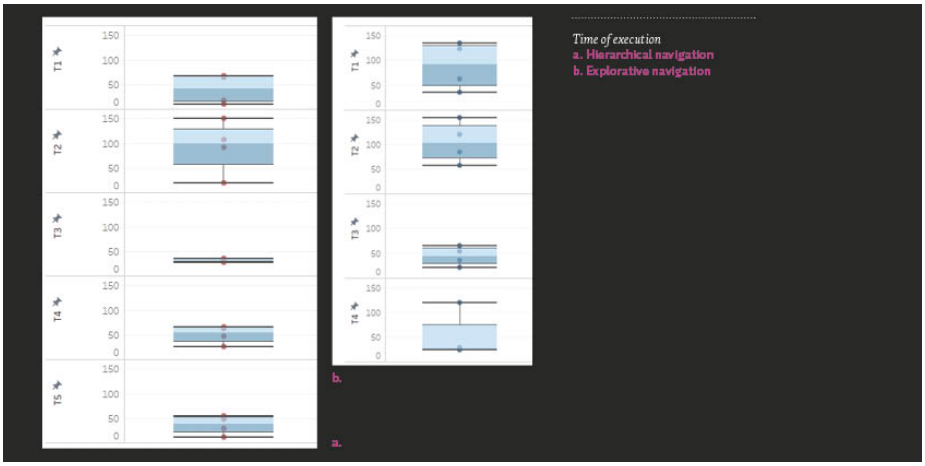

Fig. 3. Efficiency: time of execution a) the hierarchical b) explorative model.

3.3 Discussion

From the qualitative interviews emerge, probably the most interesting aspects of the two models comparison.

It seems that *experts* prefer the hierarchical navigation: they are able to manage historical documents so they directly dive inside the digital archive able to locate and contextualize the retrieved informations. On the other hand, generic public prefers to be guided by the visual system and the *cloud* of connections that offers an associative navigation when the scope or the *destination* is not yet known or clear.

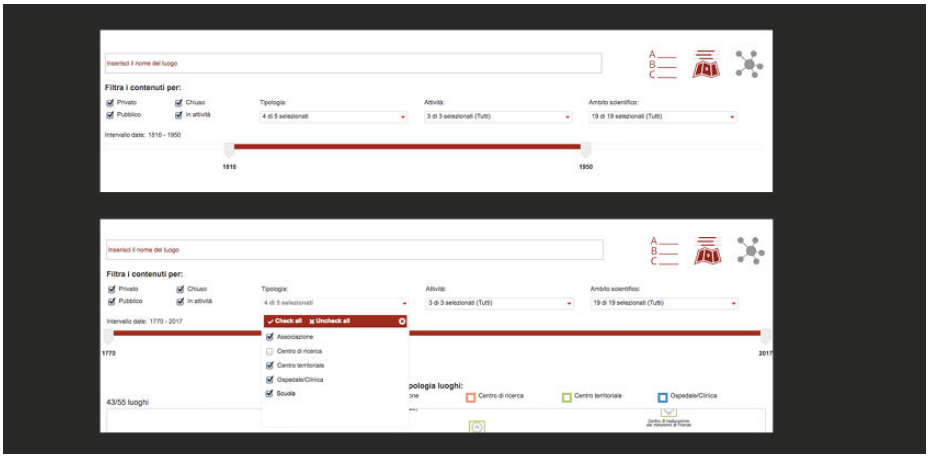

Fig. 4. Efficacy: filter and search action triggers.

4 Conclusions

The lesson learned in this experimental approach to a data visualization digital dynamic system seems to be that visualization facilitate accessibility both to data and embedded knowledge.

The graphical form of the interface – as happened since the introduction of GUI in 1984 – is a way to enable and empower users in complex information ecosystems. Furthermore, the visual language, the spatial and synchronic representation of data is a way to create and communicate context and to visualize significant connections.

The results of this first experimental phase could be developed in further design activities such as an iterative cycle to redesign and test again the problematic issues emerged by the study.

Furthermore a topic to be foster understand and implemented is a possible integration between the two models trying to offer a more connected and rich user experience mainly for non-experts.

References

[1] Warburg, A. (1929). *Bilderatlas Mnemosyne. Einleitung.* Retrieved from: http://www.engramma.it/eOS/index.php?id_articolo=2334
[2] Garfield, E. (1984, February). A Tribute to S. R. Ranganathan, the father of Indian library science. *Essays of an Information Scientist*, 7, 37-44.
[3] Wurman, R. S. (1997). *Information Architects*. New York: Graphis Inc
[4] Bollini, L., & Palma, G. (2004). *Cognitive maps: New paradigms in information architecture and interface design for the web. The Opsis identifier descriptive model for web information architecture based on cognitive maps: Designing-x a case study*. In A. J. Canas, J. D. Novak & F. M. Gonzalez (Eds.), *Concept maps: Theory, methodology, technology*. (2), pp. 95-98. Navarra: Nova Text
[5] Bollini, L., & Palma, G. (2003). *Web interface design based on cognitive maps: Generative dynamics in information architecture*. In C. Soddu (Ed.), *6th Generative Art, Conference Proceedings* (pp. 66-71). Milano: Politecnico di Milano
[6] Bollini, L., & Palma, G. (2006). Un approccio visivo all'architettura dell'informazione per il web: Le mappe cognitive. *Progetto Grafico*(7), 48-55
[7] Rosenfeld, L.; Morville, P. & Arango, J. (2015). *Information Architecture: For the Web and Beyond*. 4th Ed. Sebastopol: CA: O'Reilly Media
[8] Tufte E. R. (1990). *Envisioning information*. Cheshire, CT: Graphic Press
[9] Bertin , J. (1967). *Sémiologie graphique. Les diagrammes, les réseaux, les cartes.* Paris: La Haye, Mouton, Gauthier-Villars

[10] Bertin , J. & S. Bonin (1977). *La graphique et le traitement graphique de l'information.* Paris: Flammarion
[11] Blackwell A. F., Britton C., Cox A., Green T. R. G., Gurr C., Kadoda G., Young R. M. (2001). *Cognitive dimensions of notations: Design tools for cognitive technology.* In Beynon M., Nehaniv C. L., Dautenhahn K. (Eds.), *Cognitive technology* (pp. 325-341). Berlin, Germany: Springer.
[12] Ware C. (2004). *Information visualization* . San Francisco CA: Morgan Kaufmann
[13] Tufte E. R. (1997). *Visual Explanations: Images and Quantities, Evidence and Narrative*. Birmingham: Graphics Pr.
[14] Eppler M. (2006). A comparison between concept maps, mind maps, conceptual diagrams, and visual metaphors as complementary tools for knowledge construction and sharing. *Information Visualization,* 5, 202-210
[15]Resmini, A. & Rosati, L. (2011). *Pervasive Information Architecture. Designing Cross-Channel User Experiences*. Morgan Kaufman
[16] Bollini, L. (2004). *Registica multimodale: Il design dei new media*. Milano: CLUP
[17] Rosenfeld, L.; Morville, P. (1998, February 20). *Designing Navigation Systems* https://people.apache.org/~jim/NewArchitect/webrevu/1998/02_20/webauthors/02_20_98_10.html
[18] Borges, JL. (1964). *Labyrinths. Selected Stories & Other Writings*. New York: New Directions.
[19] Bollini, L. (2013). *Lo spazio digitale del sapere: dalla forma archivio alle knowledge-base culturali. Aggregazioni, narrazioni e migrazioni.* In R. Trocchianesi & E. Lupo (Eds.), *Progetto e memoria del temporaneo* (Vol. 3, pp. 53-67). Milano: Electa
[20] Bollini, L., & Cerletti, V. (2009). *Knowledge sharing and management for local community: Logical and visual georeferenced information access.* In B. Granville, Z. Majkic & L. Chunping (Eds.), *EISWT-09 conference proceedings* (pp. 92-99). Orlando: IRST
[21] www.visualthesaurus.com
[22] Karjaluoto E. (2014). *The design Method, A philosophy and process for functional visual communication.* San Francisco: New Riders
[23] Schlatter T., Levinson D. (2013). *Visual Usability: Principles and Practices for Designing Digital Applications.* San Francisco: Morgan Kaufmann
[24] Bollini, L. (2016). *Large, small, medium. Progettare la comunicazione nell'ecosistema digitale.* Rimini: Maggioli
[25] Bollini, L.; De Santis, D.; Radice, S. & Zocchi, P. (2016). Le trame invisibili. Nuove modalità di esplorazione online dell'Archivio storico della psicologia italiana. *Umanistica Digitale*, 1(1), pp.59-84
[26] Bollini, L. (2009). *From paper to bytes: Digital knowledge sharing. A multi-level approach to document digitalization. A case history in Italian historical studies*. In Filipe, J; Cordeiro, J. (Eds.), *Proceedings of the fifth international conference on Web Information Systems and Technologies* (pp. 567-571). Lisbona
[27] Bollini, L. (2016). *The open heritage of digital archives. Preservation, sustainability and accessibility of historical documentation to map the field of Italian Mind Science* (pp. 773-782). In R. Amoêda, S. Lira & C. Pinheiro (Eds.). *HERITAGE 2016.* Lisbona: Green Lines Institute