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Genetic Criticism and Analysis of Interface Design: A Case Study

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The paper proposes a methodology that combines theoretical and practical aspects from human-computer interaction (HCI) and genetic criticism to trace and analyse prototype evolution. A case study illustrates this type of enquiry by examining the iterations and the dynamics of change in the design and development of the Transviewer, an interface for digital editions. The initial assumption is that such an analysis can inform existing models in interface design and possibly provide new ground for discussion in humanistic HCI. For instance by fostering broader reflections on software production as a technological and cultural artefact and the gradual shaping of the principles and metaphors underlying the construction of a certain type of knowledge, argument, or interpretation through an interface.

Cet article propose une méthodologie qui combine les aspects théoriques et pratiques de l'interaction homme-machine (IHM) et la critique génétique afin de repérer et analyser l'évolution de prototypes. Une étude de cas illustre ce type d'enquête en examinant les itérations et les dynamiques du changement dans la conception et le développement de *Transviewer*, une interface pour des éditions numériques. La supposition initiale est qu'une telle analyse peut offrir des renseignements sur les modèles existants de la conception d'interface et peut potentiellement fournir de nouvelles informations à la discussion autour de l'IHM humaniste. Par exemple, cela peut faciliter de meilleures réflexions plus élargies sur la production de logiciels comme artefact technologique et culturel, ainsi que sur la formation progressive des principes et métaphores qui sont à la base de la construction d'un certain type de connaissance, d'argument, ou d'interprétation à travers une interface.

Introduction

The article approaches the evolution of a prototype from a humanistic perspective combining theoretical and practical elements from the areas of Human-Computer Interaction (HCI) and genetic criticism to analyse and model changes in the process of iterative design. The proposed methodology is applied to a case study of interface design for digital editions. It traces, in a semi-formal way, the evolution of the Transviewer prototype from the proof of concept to the open-source release of the interface. It is assumed that such a study can contribute to the interpretation of tool design, going beyond usability and utility considerations, and draw attention to the underlying principles, metaphors, or arguments not explicitly expressed or directly accessible in the final product alone.

In their paper *Humanistic HCI*, Bardzell and Bardzell define the field as "HCI research and practice that is supported by humanistic practices, theories, and methods" (Bardzell and Bardzell 2016, 22). This includes theories and conceptual systems, as well as methodologies, such as critical analysis of designs, processes, and implementations. Paralleling the fields of book history and digital tool building and elaborating on Manovich's assertion that "a prototype is a theory" (as cited in Galey and Ruecker 2010, 406), Galey and Ruecker follow a similar direction in their study of the relationship between process and artefact and their assumption that design can become "a process of critical inquiry itself" (Galey and Ruecker 2010, 406).

As a field of investigation centred on the creative process (in literature, music, film, architecture, painting, and sculpture), genetic criticism has brought into focus the "conceptual mutation" leading to innovation (De Biasi 1993, 242) and a way of thinking in terms of a new aesthetics, the aesthetics of production as suggested by Grésillon (1994) in her *Eléments de critique génétique*. From the area of HCI, studies in iterative prototyping (Buxton and Sniderman 1980; Buchenau and Suri 2000; Lucena and Astúa 2012) and user-centred design (UCD) (Shneiderman et al. 2009; Warwick et al. 2009; Gibbs and Owens 2012) have considered the importance of the iterative approach and the incorporation of users' feedback in the process of digital tool design, with particular emphasis on aspects like usefulness and usability. Other research, from the fields of the philosophy of technology, digital hermeneutics, and digital tool criticism (Fallman 2007; Capurro 2010; Bertelsen and Pold 2004; Dorofeeva 2014; Traub and Van Ossenbruggen 2015), have added a humanistic perspective to the field, moving closer to the "humanistic HCI" proposed by Bardzell and Bardzell (2016).

More specifically, the use of models in HCI and software engineering has produced a series of reference frameworks and model-based approaches applied to interface design

and development. One of the best known is the CAMELEON framework (Calvary et al. 2002; Calvary et al. 2003), which organises the development cycle of a user interface (UI) according to four levels: concepts and tasks, abstract user interface (AUI), concrete user interface (CUI), and final user interface (FUI). The transition from one level to another or from one context to another can be carried out by vertical and horizontal operations: *reification* and *abstraction*, which enable a transition from abstract to more concrete levels and vice versa, and *translation*, enabling adaptation to a different context of use and possibly applying at any of the four levels. Another influential framework (Nielsen 1984) considers the computer-human interaction as a "hierarchy of virtual protocol dialogues" structured through seven layers of communication, numbered 7 to 1, of which six are virtual (the goal, task, semantic, syntactic, lexical, and alphabetical layers) and one corresponds to the actual exchange of signals and physical communication (the physical layer). The translation of level i to level i-1 or inversely of level i-1 to level i messages is achieved respectively through the *realizer* and *analyzer* process. Whilst the first framework seems more centred on the area of UI design and development, the second offers a more general context to formally describe the interaction between the human agent and the computer. Other research inspired by these paradigms has produced various methodologies and tools. For instance, different notations (e.g., GOMS [Goals, Operators, Methods, and Selection rules]; CTT [ConcurTaskTrees]; UAN [User Action Notation]), meta-models and interactive environments (e.g., MARIAE, TERESA) have been proposed, some intended to support the CAMELEON framework and deal with the task, AUI, CUI, and FUI levels in UI development (Paternò 2001; Correani, Mori, and Paternò 2005; Paternò, Santoro, and Spano 2011; Guerrero-García and González-Calleros 2014) and others to combine the CAMELEON and Nielsen models with the goal of integrating culture-based requirements into the UI architecture (Khaddam and Vanderdonckt 2014).

Within this broader context, formalising change in UI design has sometimes been used to represent the set of transformational rules necessary for the design of user interfaces for multi-platform systems. These rules are usually applied to a single UI designed for less constrained platforms, for instance, in transforming desktop into mobile applications, a method known as "graceful degradation" (GD) (Florins and Vanderdonckt 2004; Correani, Mori, and Paternò 2005). Other models, rooted in user-centred design and focused on modelling informal strategies (prototyping, scenarios, storyboards, iteration based on user feedback, usability testing), have been developed to capture the static properties of UI design combined with dynamic UI behaviour through formalisms such as presentation models and finite state machines (FSM) (Bowen and Reeves 2007a; Bowen and Reeves 2007b; Bowen and Reeves 2008). Visual approaches

have also been considered, for instance, to transform sketches into formal diagrams that describe both the appearance and the functionality of an interface (Plimmer and Apperley 2002) or to develop visual design methods that allow existing developments of graphical UIs (GUIs) to be reused via tree algebra and logical operators supporting the decomposition, composition, and recomposition of UI elements (Lepreux, Vanderdonckt, and Michotte 2007).

Despite this variety of methods, models, and tools, little attention seems to have been paid to modelling the process of interface production itself and how a prototype evolves in terms of appearance and functionality. Versioning can provide an indication of such evolution from the coding standpoint. The methods of graceful degradation and visual design through decomposition address some aspects of this idea of evolution but in the context of target change (desktop versus mobile) or component reuse in building new UIs from existing ones. Other studies, such as the one by Roberts-Smith et al. (2012), describe the evolution in thinking within the development of a tool (e.g., designed for theatre research) but the description uses structured prose rather than formal language or representation. Rockwell et al. also delve into the history of an interface, looking at the published versions produced for the Perseus Project, and recommend that projects should "preserve their own histories" and that such "preservation should be valued as scholarly activity" (Rockwell et al. 2020, 116). However, as yet there have been few attempts to trace the transformation of the visual and functional features of an interface through successive iterations, including the pre-release forms, from a more formal perspective.

The proposed methodology is inspired by a set of operations used in genetic criticism to describe the genesis of a text by analysing the transformations discernible in the manuscripts and other related documents preceding and leading to the final product. The assumption is that such an analysis can inform existing concepts and models in UI design and lay new ground for discussion in the field of history of culture and technology. This may foster broader reflections on software production as a technological and cultural artefact and on the modalities involved in shaping its core function, namely enabling the construction of certain categories of knowledge, argument, or interpretation. As pointed out by previous research, interfaces can act as "interpretational forms" (McGann 2010, 3) and "influence our interpretation of [...] data" (Dillen 2018, 37). Therefore, a glimpse into the laboratory and the production process of such artefacts can provide insights into the underlying principles (utilitarian, technological, aesthetic, persuasive, cultural, etc.) at work while building tools of this type.

1.1. Research questions

Following the call by Galey and Ruecker (2010) for a hermeneutical and critical approach to design in digital humanities projects, and elaborating on Armaselu et al.

(2016), it is assumed that the combination of HCI modelling and digital prototyping with genetic analysis may shed light on facets of the building process that have been less examined in tool design for digital humanities. Research from other areas, for instance combining genetic criticism with narrative theory (Bernaerts and Van Hulle 2013) or with rhetoric (Jensen 2016), have shown the potential of analysing the dynamics of production and revision in providing new insights into the studied phenomena by taking into account two important aspects of genetic methodology, the "temporal dimension" and the "space of possibility" (Jensen 2016, 268), intrinsic to any work in progress.

The questions to be addressed will, therefore, be articulated around topics such as: How do the modelling of change and the time dimension inherent to the process of tool production and the subsequent analysis of tool evolution influence our understanding of transformation and its impact on the "final" product? What types of factors related to innovation and change occur in the prototyping and post-release development of the interface (e.g., user-oriented, designer-oriented, project-oriented, technological, aesthetic and cultural factors)? To what extent does our knowledge of the space of possibility at discrete time points in the construction process foster new angles of critical reflection on tool building? Could that perspective support a humanistic HCI approach and an aesthetics of production anchored in a broader context, such as the history of culture and technology?

The paper will include a case study of interface design, the iterative development of which is described in section 2, followed by a discussion on the potential theoretical incentives of the methodology in the analysis of digital tool building (section 3), and by conclusions and future directions of study (section 4).

1.2. Theoretical starting points

The starting points of the analysis are framed within the HCI context of model-based UI design and development combined with theoretical aspects from the area of textual genetic studies. The initial setting for discussion includes a "chrono-typology" of documents pertaining to UI design and development similar to the typology of genetic documentation for a literary work proposed by De Biasi and Wassenaar (1996). This type of categorisation allows the process to be positioned within a broader background, recognising the collection of materials that contributed to the creation of the final artefact. Such a perspective may become more useful beyond the considered case study. For instance, we may imagine a field of enquiry in the history of software production investigating the history of various types of user interface and the traces of their origins as preserved by digital archiving environments and providing information not only on technical and usability-related aspects but also

on facets specific to culture, human interaction, and workflows. In this way, the development of practices in UI production over time can be documented and provide incentives for further research.

Figure 1 illustrates an interpretation and schematic representation of De Biasi and Wassenaar's (1996, 34–35, 41) "chrono-typology," considering five phases: the pre-compositional phase, the compositional and pre-publishing phases that relate to the "avant-texte" (all the documents produced before the *Pass for Press* point), and the publication and post-publication phases that refer to the different editions published and revised by the author, as well as those delivered in the public sphere after the "last edition of the author's lifetime."

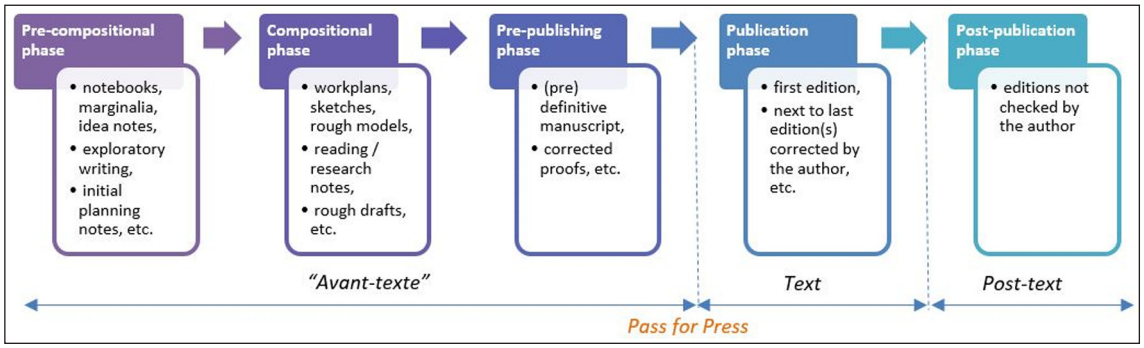


Figure 1: Chrono-typology of documents in the production of a literary work (adaptation from De Biasi and Wassenaar 1996).

Similarly, it was assumed that a chrono-typology can be applied to the process of digital tool building (including open-source technology and interfaces for digital editions), while taking into account its different stages, as a prototype before the first public release and as an open-source product susceptible to further revisions or more substantial alterations by the community (**Figure 2**).

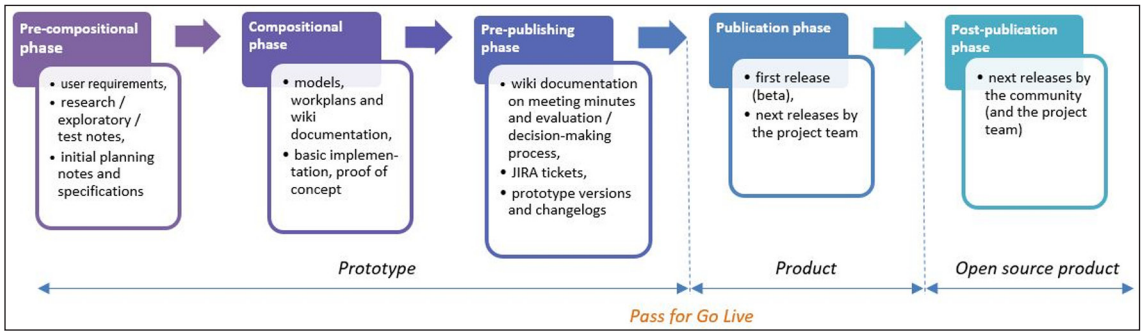


Figure 2: Chrono-typology of documents in the production of an open-source tool.

The analogy is symbolic and ignores differences between the creative process of a single author writing a literary text and UI design and development by a team or community contributions. The chrono-typology is intended to provide a broader view on the general workflow of tool building that can include modelling at different stages of the design and development process. Formal approaches such as the CAMELEON reference framework may also be supported. For instance, concept and task models can be built from user requirements, planning notes, and general design specifications in the pre-compositional phase. The AUI, CUI, and FUI may result from the compositional and pre-publishing phase, while further development of the artefact may also occur after the *Pass for Go Live* point, in the publication and post-publication stage. In this view, refinement, understood as "structured progression from some abstract version of a system towards a more concrete version" (Bowen and Reeves 2008, 129; Paternò, Santoro, and Spano 2011), may be used in a broader sense to include progression (or improvement) on the same level of abstraction (as in the case study discussed below). The life cycle of a product can also be imagined beyond the elements represented in the figure, for instance, continuing with an archiving or out-of-use phase or even completely disappearing if no preservation support is available. The representation is therefore intended to illustrate the dynamics of digital artefact production with a focus on the shift from product to process, one of the distinctive features in genetic studies applied to creative works from literature and the arts. This paradigm shift is sometimes expressed in editorial theory and practice by notions such as the "'diachronic text' of a work of literature," acknowledging the "genetic dimension of texts" and their "processual materiality" (Gabler 1999, 61).

The case study presented in this paper refers to an early form of the FUI of an interface for digital editions, the proof of concept, and its gradual transformation until the *Pass for Go Live* point.

2. Transviewer case study

The tool considered for analysis is Transviewer, an interface for digital XML-TEI-based editions (TEI 2021), developed at the CVCE (CVCE 2021), now the C²DH at the University of Luxembourg (C²DH 2021). Transviewer is an interface intended to enable the exploration of primary and secondary sources, at document level, in historical or other types of digital editions involving the digital representation of original material. Its name comes from the combination of the terms ***trans****formation* and ***view****ing*, supposing the transformation of documents to XML-TEI format (in the earliest form of the prototype directly in the browser, now by means of a server) so that they can be viewed in the browser. The tool has undergone a series of changes, from the first formal requirements and planning notes to the current online version. For comparison

purposes and to enable an analysis of its evolution, the different versions developed so far have been kept functional in an internal test environment. The goal of such enquiry is to examine, through a theoretical lens inspired by studies in model-based design and genetic criticism, the dynamics of change, and occasionally innovation, which underpin the tool-building process.

The initial idea of the interface was to provide a flexible framework for the publication of different types of documents associated with modern European history on the CVCE's website, from treaties, official declarations, and meeting reports to letters and interview recordings and their transcriptions. The concept was multi-project-oriented and based on a modular design including *core* versus *project-specific* modules, ultimately integrated into a backend-frontend architecture and making use of technologies such as JavaScript, Java, XML-TEI, XSLT, HTML, and CSS.

Figure 3 shows the types of configurations intended to be supported by the tool, of which 1 to 3, except for audio/video, have been implemented (the elements included in the initial architecture but not yet implemented are represented in light grey). Five configuration schemes were devised according to the various documents to be visualised via the interface. The first and second correspond to a single panel layout including either a digital representation of the original (digital facsimile or audio/video recording) or just the transcription of the original content. The third type allows side-by-side visualisation of the original and its transcription, while the fourth and fifth make use of a multi-panel layout to represent, for instance, multi-version or multi-language alignments, potentially associated with a digital facsimile view.

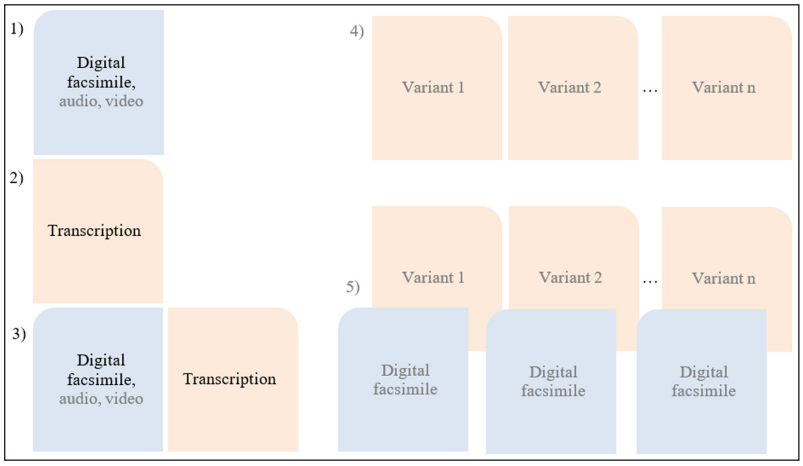


Figure 3: Transviewer configuration schemes. The light blue squares with a rounded top-left corner represent digitised forms of the original (image facsimile, digitised audio or video footage), while the light orange squares with a rounded top-right corner represent transcriptions or different variants of the original in textual form.

As previously pointed out, a prototype can be the embodiment of an argument (Galey and Ruecker 2010). In particular, an interface for digital editions may have a twofold function: it allows the editor to set up an argument about the edition and provides users with the opportunity to "view the text through an expert's lens" (Bleeker and Kelly 2018, 197). Moreover, the interface can be considered as a "second layer of editorial interpretation," the first being offered by the transcription of the edition's documents, visualisation and transcription representing two important aspects in conveying the editor's interpretation of the edition (Dillen 2018, 42).

The "argument" in designing the edition and the Transviewer interface was based on two simple assumptions: the historians or researchers in European integration studies (the main category of users of the CVCE website) are always interested in comparing a transcription with the original (when available) and in searching documents for key entities (e.g., people or organisations). Further analysis of the prototype development and usability testing revealed (as showed in section 2.2) that these assumptions were actually related by the users to two important notions in historical research: trust concerning the source of the documents and contextualisation of the topic.

The transcription and XML-TEI encoding of the collection implied a selection of features to be encoded and rendered via the interface. The selection was mainly guided by the goal of providing diplomatic (intended to represent the appearance of the original document as closely as possible) and linear transcriptions of the historical material, to support both document- and text-centred exploration. For instance, the encoding involved the following types of features (terminology adapted from Pierazzo 2011, 467): *documentary* (ink colour of stamps, e.g., red or black); *topological* (document layout, e.g., position and alignment of headers, footers, and headings); *writing*-related (capitalisation and punctuation); *structural* (sections, paragraphs, and tables); *semantic* (names of people, organisations, locations, events, dates, etc.).

Regarding the two basic interface design principles for digital editions, defined in terms of attractiveness and intuitiveness (Bleeker and Kelly 2018; Dillen 2018), the early experimental stage focused on the functional aspects and the implementation of the initial assumptions in a simple proof of concept which progressively evolved together with aesthetics- and intuitiveness-related properties. The following subsections present the main elements in the evolution of the prototype, paying particular attention to this dynamic of change.

2.1. Proof of concept

After a series of experiments with existing open-source XML-based platforms (e.g., EVT 1 Digital Vercelli Book [DVB] (EVT 2013), TEIBoilerplate 1.0.2 (TEIBoilerplate

2012), TEIViewer 1.0 (TEIViewer 2008), Kiln 1.0 (Kiln 2012), XTF 3.1 (XTF 2012), Versioning Machine 4.0 (Versioning Machine 2010)), the early form of the Transviewer was inspired by the EVT model, which proposed a "client-only architecture" based on XSLT transformation, HTML, CSS, and JavaScript, and allowed side-by-side view of manuscript images and related transcriptions (Del Turco et al. 2014). The first phase also involved the digitisation, OCR and XML-TEI P5 encoding of a selection of 56 documents (in French) on armament production, standardisation and control within Western European Union (WEU), in the context of a larger project, *Jeux et enjeux diplomatiques franco-britanniques au sein de l'UEO (1954–1982)* (Franco-British diplomatic games and issues within WEU [1954–1982]) (Jeux et enjeux 2011). The aim was to use the digital collection and the tool as a testbed for a new CVCE publication workflow based on XML-TEI format.

Although the direct adaptation of EVT was considered from the beginning, different requirements for EVT 1 [DVB] (1) and Transviewer (2) were identified, for instance page-oriented (one HTML file per page/manuscript image) (1) versus document-oriented (one HTML file per XML document) (2); support for structural elements of medieval documents (divisions, verse, etc.), annotations for editorial changes (e.g., additions, deletions, correct/incorrect forms) and image-text linking (1) versus support for the basic structure of modern prose (divisions, paragraphs, tables) with semantic annotations (named entities) and project-specific structural and semantic elements (e.g., particular header and footer layouts for WEU administrative documents, speech encoding) (2); and one-by-one image loading (1) versus images loaded for a whole document (2). Given these differences, a hybrid solution was adopted for the implementation of the proof of concept: a combination of the EVT 1 [DVB] side-by-side model with the integration of third-party open-source libraries (BookReader 1 (BookReader 2008) and Saxon-CE 1.1 (Saxon-CE 2013)) and in-house development (**Figure 4**).

One of the reasons BookReader, a tool for the online visualisation of scanned books, was chosen was its ability to load images on the fly. However, since this tool was designed to work only with images (not with image and text) and to flip right/left page navigation, it needed to be adapted to accommodate the transcription view and vertical scrolling. Saxon-CE was selected for direct XML transformation via XSLT 2.0 in the browser. However, technical issues, such as non-uniform support for Saxon-CE in different browsers, determined the adoption later on in the prototype iterations process of a server-based solution for the transformation of XML documents to HTML without the need for this processor. (Nevertheless, the open-source release offers the option of a direct XML transformation in the browser using Saxon-CE.)

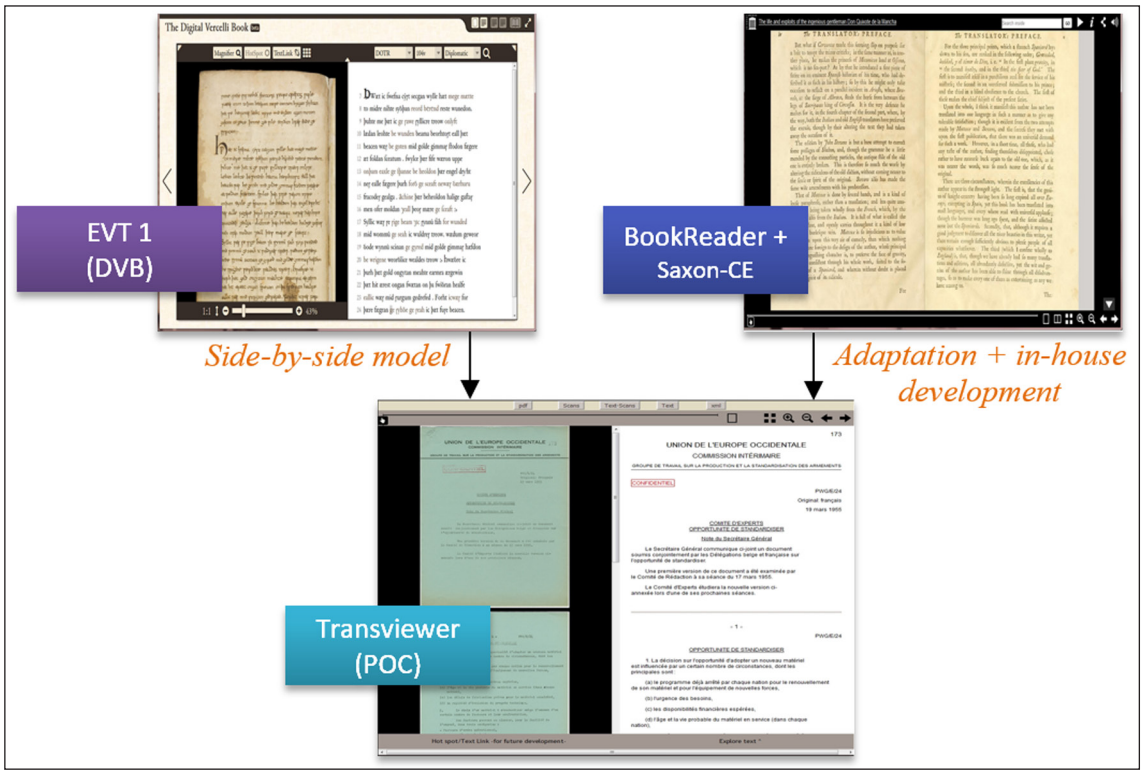


Figure 4: Transviewer Proof of Concept (POC).

As a result of the pre-compositional stage and the main outcome of the compositional phase, the Transviewer Proof of Concept (POC) offered transformation and visualisation in the browser and a set of functionalities such as: switch between transcription-only, digital facsimile-only, side-by-side view of facsimile and transcription; page-by-page navigation; zoom in and out on the facsimile and transcription; thumbnail view and page selection; vertical (synchronised) scrolling; highlighting names of people, places, organisations, events, products, and dates previously encoded in the XML-TEI transcriptions.

Although the design was based on existing models and interfaces, the proof-of-concept incorporated elements from these interfaces, as is or adapted, together with new features not available in the initial tools (e.g., vertical scrolling, named entities highlighting) to create a new platform implementing new technical and functional facilities in order to support the primary requirements of the project. The need for solutions to technical issues, as well as the user feedback collected during a usability test campaign and the periodic evaluation by the CVCE design and development team, determined a series of new iterations of the prototype in the pre-publication phase, as illustrated in the next sub-section.

2.2. Prototype iterations

The pre-publication phase was framed by theoretical notions on iterative prototyping and user-centred design. This approach involved usability testing and result analysis, as well as recurring evaluation and development reassessment (on an Agile-Scrum basis) by the project team.

The usability test (Nielsen 2000; Lund 2001) consisted of a single round, after the release of the POC and before the first iteration (I_1). It involved a small user group of CVCE researchers: 4 male, 4 female; age range 25–39 (7) and 40–64 (1); and research background in history (5), language (2), and political studies (1). The participants were invited to complete a list of tasks via the Transviewer POC, and their feedback was collected by means of a questionnaire filled in at the end of the experiment and by think-aloud and screen-capture recording during the sessions. The goal was to enquire about ease of use, ease of learning, usefulness, and user satisfaction (on a Likert scale from 1 to 5), and suggestions for potential improvement (Armaselu 2021).

Both the periodic evaluation and the analysis of the usability test results determined the progression of the prototype by helping the team to: (1) identify and amend technical and design issues (e.g., functionalities not quickly accessible and requiring extra effort, unclear terminology or functionality hierarchy, need for simplification); (2) better understand and support the needs of users as they dealt with historical documents (e.g., "trust" and "contextualisation" seemed to play an important role as related to the possibility of comparing the transcription with the digitised original and the ability to search for key entities in the text). An overview of the Transviewer versions (V_1-V_4) (**Figure 5**), which have been kept functional in an internal test environment, can foster insights into the prototype evolution and the factors determining it.

For the prototype evolution analysis, Grésillon's work (1994) was considered and provided incentives for a semi-formal representation of change during the process of design and redesign of the interface inspired by writing and rewriting operations applied to the analysis of literary text genesis. Grésillon's study of manuscripts through a "linguistic theory of the act of writing" (in the original French, *théorie linguistique des actes d'écriture*) summarises the dynamic character of the act of writing by asserting that "writing is doing" (French: écrire *c'est faire*) (Grésillon 1994, 150). According to Grésillon, this dynamic of "doing" is conveyed by a series of traces on the manuscript page that bear witness to specific operations of "rewriting," such as substitution, deletion, addition, and transposition. To formally describe these operations and their succession, it is necessary to: (1) delimit the "rewriting units" (French: *unités de réécriture*) (Grésillon 1994, 150); (2) consider the units' relationships and order in the process of writing.

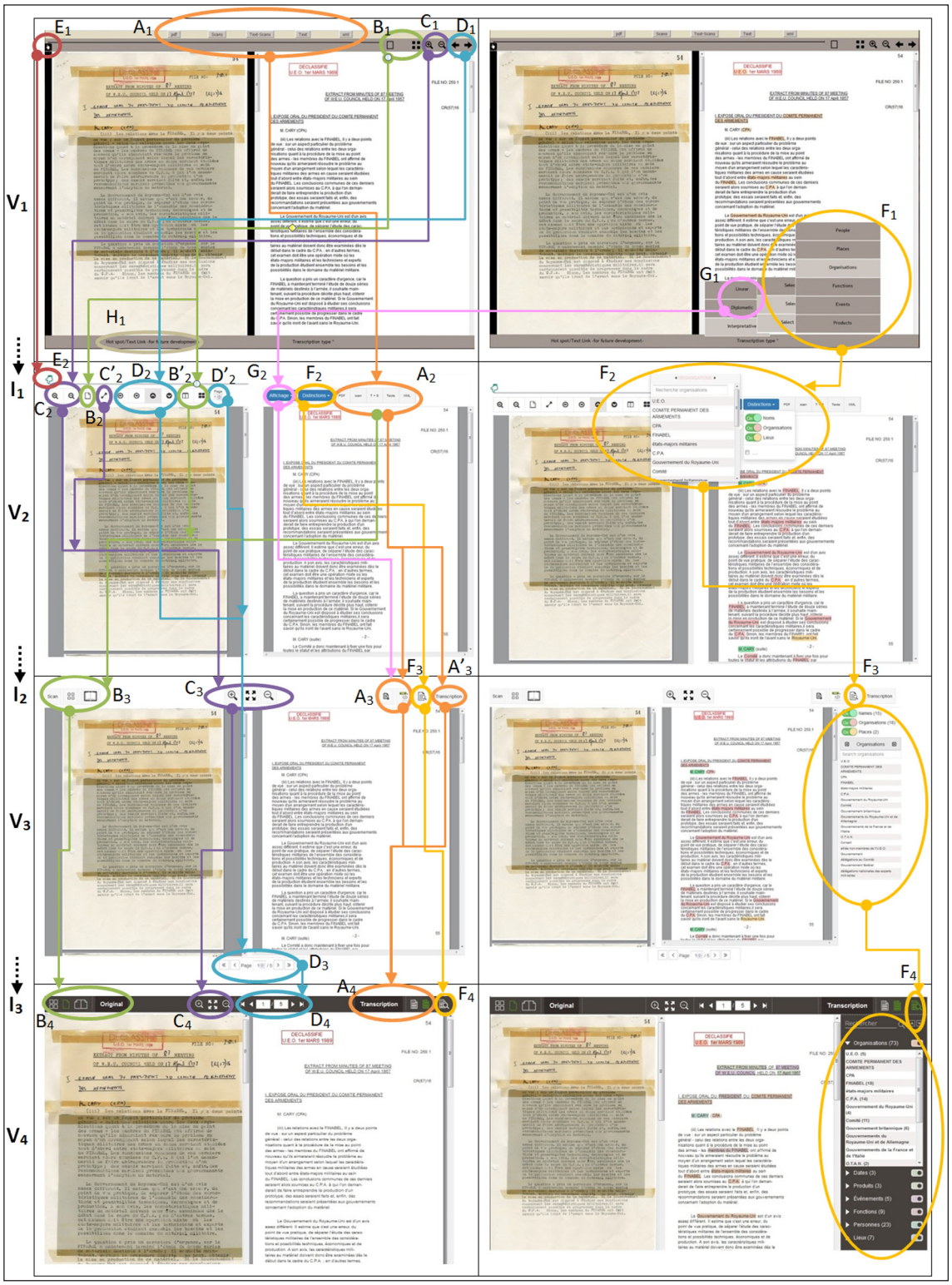


Figure 5: Transviewer versions (V_1–V_4), iterations (I_1–I_3), *comparing* (left), *searching* (right).

While a rewriting unit can be composed of a word, a syntactic group, a phrase or a paragraph, Grésillon (1994) proposes the notion of substitution, borrowed from structural linguistics and adapted to genetic criticism, to express all the other operations of rewriting:

- Substitution: A → B
- Deletion: A → zero
- Addition: zero → A
- Transposition: AXY → XAY (or XYA).

Therefore, in the context of manuscript analysis, substitution acquires a temporal dimension that also exhibits orientation (A becomes B and not the reverse). Starting from this theoretical framework, the transformation of the Transviewer interface was interpreted through a genetic lens as a dynamic process of design and redesign. **Figure 5** illustrates the mechanics of change in the implementation of two basic functions, or "scholarly primitives" (Unsworth 2000): *comparing* (left column) and *searching* (right column). Details of these changes are depicted in the following sections (2.2.1, 2.2.2), which refer back to this figure. A table describing the groups of features in terms of type, content, and position is provided in the Appendix.

In the case of Transviewer, the units of "rewriting" consisted of units of "redesign," containing a single feature or a group of features, and their evolution was defined by a succession of operations of substitution, deletion, addition, or transposition. To describe the merging/splitting of two groups of features or a direction of movement, or to precisely point to one or more elements of a given group, the following notations were added to the set:

- Merging: A + B → C
- Splitting: A → B + C
- Element: A(*x*)
- Element enumeration: A(*x, y, z*)
- Displacement: [Hdir, Vdir]

where the symbols A_i, B_i, C_i, ... refer to groups of features in the implementation of the comparing and searching primitives; i indicates the number of the iteration in the succession symbolised I_1, I_2, I_3, where I_1 had as an input the Transviewer POC (V_1), the starting point of the analysis (for concision purposes, two intermediate versions, between V_1, V_2, and V_3, V_4, were omitted from the discussion), and I_3 had as a result the *Pass for Go Live* version (V_4); Hdir, Vdir represent a horizontal and/or vertical movement

along four directions: left-right, right-left, up-down, down-up, referred to as L-R, R-L, U-D, D-U.

2.2.1. Comparing

To illustrate the evolution in the implementation of the comparing primitive, eight groups of features, placed on separate toolbars, were considered (**Figure 5**, top left, right). After the first iteration, the group of functions labelled A_1, allowing users to switch between different modes, was placed in a less central position, to the right. The buttons were given similar labels (sometimes with a change of language from English to French, e.g., *Texte*) but a more compact layout, minimising visual clutter.

I_1: $A_1 \rightarrow A_2$ [L-R]

The changes to group A involved a reorganisation of features combining mode switch and transcription style together with repositioning from top centre to top right (**Figure 5**, Appendix). This progression pattern draws attention to a certain logic in the development of the interface that led to a concentration of the transcription-related elements on the right half of the application window, where the transcribed text is displayed in the side-by-side view of the document.

Group B_1, containing features related to the one-/two-page view (toggle button) of the facsimile and the multi-page view (thumbnails), was split into 2 separate groups, the first including the one-page view (B_2) and the second the two-page and multi-page views (B'_2). The initial position was changed by a movement from the right to the left side.

I_1: $B_1 \rightarrow B_2 + B'_2$ [R-L]

Group B evolved in a similar way to group A but in the opposite direction, connected to the second main pole of the interface, the digitised facsimile. **Figure 5** and the Appendix table show a recombination of page view and mode switch elements and a stabilised position on the left half of the application window, corresponding to the scanned image of the original document in the side-by-side view.

The zoom group (C_1) changed its position (from right to left), as well as its appearance. A new group was added (C'_2), allowing users to reset the size and position of the scanned image to the initial values after zooming in/out or repositioning the image.

I_1: C_1 → C_2 [R-L]
I_1: zero → C'_2 (*reset size/position*)

zero → 

The evolution of group C represents a movement from right to left, centre and top centre left (**Figure 5**, Appendix). Considered in correlation with group D below, this iterative relocation can be interpreted as a gradual orientation towards a central position for the zoom tools that apply both to the transcription and to the scanned image but with a slight attraction towards the latter, since it is expected to be more often used with this type of object.

More changes affected group D_1. While the flip left/right page buttons preserved a similar look, three new features for page navigation were added: go to first and last page and go to page (group D'_2).

I_1: D_1 → D_2 (*previous, next*) [R-L]
I_1: zero → D_2 (*first*)
I_1: zero → D_2 (*last*)
I_1: zero → D'_2 (*go to page*)

zero → 

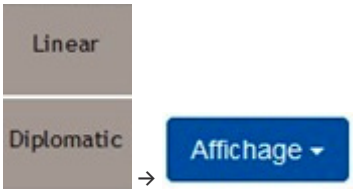
As noted for A and B, a certain symmetry operated for groups C and D, which ended up occupying the top-centre position, one slightly to the left and the other slightly to the right (**Figure 5**, Appendix). Although the functions of these groups are synchronised and apply to both the digital facsimile and the transcription, their relative positioning presumably reflects an "attraction" towards one pole or the other. While for the zoom group C an image-related usage is assumed to prevail, D's alignment towards the right may indicate a more text-oriented purpose for its page-based exploration features.

The page slider (E_1) moved to an upper position, on the top toolbar, and slightly changed its appearance. This is because users failed to notice it when it was placed below.

I_1: E_1 → E_2 [D-U]

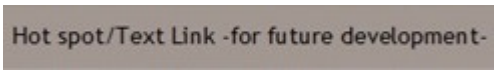
The two options for the diplomatic and linear transcription style, from the *Transcription type* menu on the bottom-right toolbar (G_1), were grouped under G_2, top right. This transitory solution prepared the way for the subsequent integration of G_2 into A_3 during the second iteration, and the final merging of the mode switch and transcription style features into group A, which provided a more coherent content-related layout.

I_1: G_1 → G_2 [D-U]



The *Hot spot/Text link* group (H_1), on the bottom-left toolbar, derived from the EVT implementation, was deleted and will be considered for future, more advanced development.

I_1: H_1 → zero



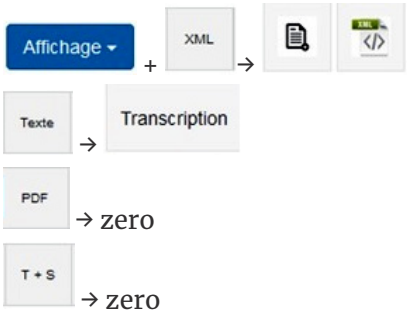
→ zero

One can note that the first iteration determined a number of changes in position and appearance, as well as a mix of French and English as the language of the interface, and additions of new groups of features, providing a different look as compared with the initial BookReader-like proof of concept. However, at this stage, focusing more on functional than structural aspects, it seems that the logic behind the organisation of the different groups and their mutual positioning was still unclear, and it is only after the second iteration that a more meaningful separation of the groups of functionalities may be discerned.

From ten groups after the first iteration, only six remained after the second, four placed on the far left and right and the others in a central position at the top and bottom. Regrouping, deletion, and merging of the two top toolbars may also be observed.

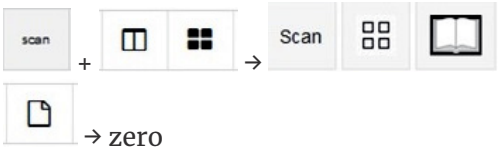
Elements from group A_2 (switching modes) were therefore permuted and combined with group G_2 (transcription style) to create group A_3, while the *Texte* feature became *Transcription* in group A'_3. The option to generate and visualise the document in PDF format was eliminated, as was the *T+S* feature made available via the *Transcription* toggle button.

I_2: G_2 + A_2(*XML*) → A_3 [L-R]
I_2: A_2(*Texte*) → A'_3 [L-R]
I_2: A_2(*PDF*) → zero
I_2: A_2(*T+S*) → zero



The *scan* element from A_2 joined the two elements for one- and multiple-page visualisation (B'_2). Group B_2 disappeared, while the two-page toggle button in the new group B_3 again incorporated the two functionalities. The resulting group moved to the leftmost position.

I_2: A_2(*scan*) + B'_2 → B_3 [R-L]
I_2: B_2 → zero



The zoom group (C_2) joined the reset size/position (C'_2) and moved to the right, to the top-centre position.

I_2: C_2 + C'_2 → C_3 [L-R]

Changing their place from top to floating bottom, the groups for page navigation (D_2 and D'_2) merged. To aid cognition, all the interface elements that were associated with page interactions were grouped together.

I_2: $D_2 + D'_2 \rightarrow D_3$[U-D]

The page slider group (E_2) was deleted. It was ultimately considered superfluous.

I_2: $E_2 \rightarrow$ zero

→ zero

As a result of the second iteration, a more coherent organisation of features emerged, correlating the position of each group with the type of content to which it applied: A_3, A'_3 on the right side, to the transcription; B_3 on the left side, to the scanned facsimile; C_3 and D_3 in a central position, to both transcription and facsimile. The idea was to help users quickly build up an understanding of the interface based on the grouping of similar functionalities.

Further refinement was carried out in the third iteration. The transitions from A_3, A'_3, B_3 to A_4, B_4 involved the transposition of elements, with the more important ones (in relation with the corresponding content area, i.e., *Original* and *Transcription*) placed towards the centre of the left and right half respectively. After several hesitations between toggles and separate buttons, the latter alternative was chosen, as it was considered to be more intelligible when icons were used instead of labels. The linear/diplomatic (A_3) and one-/two-page (B_3) toggles were replaced by different buttons corresponding to each feature (linear, diplomatic, one-page and two-page, respectively). A feedback mechanism was also provided by tooltips and changing of the foreground colour of the icons, from white to green, to indicate when a button is activated. The *Scan* label was replaced by *Original,* as this was considered more generic and suggestive. The toggle function was preserved for the only two labelled buttons of the interface, *Original* and *Transcription*, intended to highlight the main functionality of the interface, allowing users to switch from the single to the side-by-side view. At this stage, the XML view was deleted; it will be considered for later development.

I_3: A_3(*linear/diplomatic*) +A'_3(*Transcription*) → A_4
I_3: A_3(*XML*) → zero;

→ zero

I_3: B_3 → B_4

The transformation of C_3 (zoom) and D_3 (page navigation) groups involved changes in position (slightly to the left, for the first; bottom to top and slightly to the right, for the second) and, like the other groups, changes in background/foreground colour and icon style.

I_3: C_3 → C_4 [R-L]

I_3: D_3 → D_4 [L-R, D-U]

With the third iteration, the prototype acquired a new identity with a particular colour palette and a set of icons specially designed for its functionalities (in a relatively "conventional" style). This transformation may be explained by the allocation of more resources (including a graphic designer), the integration into the backend-frontend architecture of the CVCE website (and involvement of the corresponding development team), and the widening in scope to encompass not only the functional but also the expressive properties of the interface. The result of this iteration may therefore be characterised by a simplified layout (all the features being placed on a single toolbar on the top), more clear-cut and logical grouping of functionalities (left, centre, right) according to the target content (image-only, image and text, text-only), as well as more attention paid to the feedback and aesthetic properties, in line with the environment into which the tool was to be integrated.

2.2.2. Searching

While the refinement of the comparing primitive required the transformation/ reorganisation of several groups, the development of the searching primitive involved changes to a single group (**Figure 5**, top right). As a result, the first iteration saw the

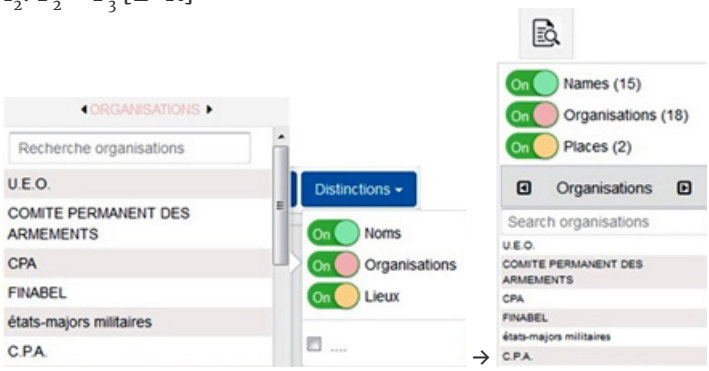
repositioning of group F_1 (containing options for highlighting different categories of named entities, people, places, organisations, etc. in the text), from bottom right to top right, under the drop-down menu item *Distinctions* (F_2). In the initial POC, F1 was part of the *Interpretative* option in the *Transcription type* group (the other two options were *Linear* and *Diplomatic*, presented as group G in section 2.2). The *Interpretative* path referred to "interpreted" dates, speaker utterances, and named entities via XML-TEI annotations. The access to F1 features (**Figure 5**, top right bottom) implied a three-layered selection allowing users to choose the type of query they were interested in, that is, dates, speakers, or entities (*People*, *Places*, *Organisations*, etc.) appearing in the texts. In the subsequent iterations, the dates were added to the entity list and the speech-related option was dropped as intended for later development. The transformation also involved an improvement of the features to provide the list of occurrences in the text once an entity category was selected. At this stage, only the search for three types of names—people, organisations and places (labelled by French nouns *Noms, Organisations, Lieux*)—was implemented. As shown in **Figure 5** and the Appendix, the evolution of group F mainly consisted in gradually merging entity highlighting with new features for textual search, as well as deriving more economical solutions for space organisation and visualisation of results.

I_1: $F_1 \rightarrow F_2$ [D-U]

Since the unfolding of F_2 led to the obstruction of part of the content area, the second iteration determined a displacement of this group to a right sidebar displayed and hidden on request via the search option, as a progressive reveal.

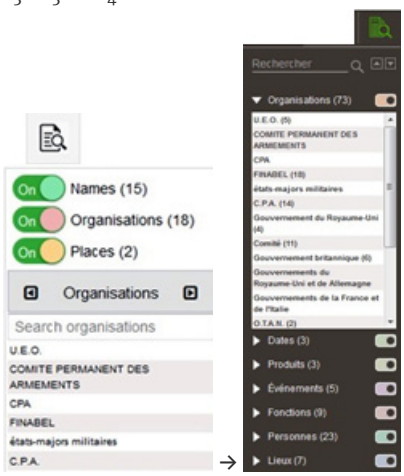
A more compact layout was also achieved by vertically grouping the selection buttons for entity categories (including counts), the previous/next navigation feature, the free-text search field, and the list of results.

I_2: $F_2 \rightarrow F_3$ [L-R]



As already observed for the comparing primitive, the third iteration gave rise to a more consistent and concise organisation of the feature space and a more individualised appearance. For instance, in the transformation from F_3 to F_4, in order to save space, an accordion list was implemented for searching in the six categories of entities and dates. Occurrence counts were included in the list of results. The left/right arrows for navigating from one instance of an entity/word found in the document to the next were replaced by up/down arrows (next to the Search field) to better reflect the direction of movement in the document itself. At this stage, close to the *Pass for Go Live* point, the default correlation between the language of the document and that of the interface was available in full (since the document was in French, the labels in the search menu displayed below were also in French).

I_3: $F_3 \rightarrow F_4$



Although less complex and untidy than the progression of the comparing function, the development of the searching primitive involved a series of adjustments to address the basic requirements of this type of functionality: a dedicated space and mechanism for the visualisation of results, without impeding the main content area, and a more coherent implementation and representation of the search criteria. Aesthetic refinement was also implied, with the harmonisation of the colour palette and icon design and a simpler and more intuitive mechanism for feedback and interaction.

2.3. Online version and future development

Compared with the outcome of the third iteration (pre-publishing phase), the current online version of the Transviewer, in the form that resulted from the publication phase (Armaselu et al. 2018), includes two additional features: a contextual help and an option for structural navigation that provides an overview of the document structure (chapters, sections, subsections, etc.) and direct access to the different structural elements. For symmetry purposes and consistent with the previously devised rule that the position of the features varies from the extremities toward the centre according to their connection with the two main content areas, the additional functionalities are placed on the rightmost and leftmost positions on the top toolbar. The panels containing related information are displayed on demand underneath the corresponding buttons on the right and left sidebars, in a similar way to the search panel described above. The interface labels and tooltips are available in three languages (French, English, and German), with the possibility of switching from one language to another depending on the language of the document or by means of a separate functionality for choosing the interface language. Given the description of the possible configurations in the *teiHeader* and a *@decls* attribute of the *text* element indicating the case (facsimile-only, transcription-only, transcription and facsimile) applying to each XML-TEI document published on the backend-frontend, the interface is able to automatically "detect" the type of configuration applying to the document to be displayed (**Figure 3**). The entire CVCE (CVCE 2021) collection of documents encoded in XML-TEI and visualised via the Transviewer may be accessed via the search engine facet Format (tei+xml) and the link (CVCE-XML 2021). By checking the box *Jeux et enjeux diplomatiques* it is possible to select only the 56 documents providing side-by-side view of original and transcription. The other parts of the collection offer a facsimile-only layout.

Although not currently included in the implementation roadmap, new development could involve extensions of the interface facilities to support configurations for audio and video material and different textual variants, as specified in the initial architecture design (**Figure 3**) or linking of the encoded entities with online repositories and

authority lists. An open-source adaptation has been released (Armaselu and Reis 2018), which may foster exchanges with the community and possibly further development.

3. Discussion

Going back to the initial assumption that a humanistic HCI perspective including elements from the field of genetic criticism may provide new insights into the process of digital artefact production, what are the main insights that came out from such an approach? Are these insights general enough to be applicable to other studies or to define a broader area of enquiry in humanistic HCI? The present case study is of course too limited to allow wide generalisations. A number of initial standpoints can however be formulated at this stage, to be confirmed or disconfirmed by further experiments in interface design applying the proposed methodology. The aim of this section is to summarise these points by following two threads of discussion: one highlighting the salient categories of transformation traits and factors that emerged from the analysis of the prototype evolution in the case of the Transviewer, and the other pointing towards possible directions of research for an aesthetics of production in tool design and humanistic HCI.

3.1. Tracing prototype evolution

Looking for traces of previous readings when studying the genesis of a literary work has often been considered in conjunction with the close examination of the internal mechanisms that determine the transformation of a text in the creative process. Combined exo- and endogenesis enquiry and the analysis of epigenesis (the development of a text after its publication) have proved their utility in documenting and designing printed and digital genetic editions, such as *Corpus flaubertianum* (Bonaccorso 1991; Bonaccorso 1995), *Beckett Digital Manuscript Project* (BDMP 2021) (Sichani 2017; Van Hulle 2016) and *Brulez Digital Exhibit* (BDE) (Bleeker and Kelly 2018).

In the context of interface design, trailing exo-, endo-, and epigenetic aspects can also be considered as part of the analysis of a digital artefact's evolution. Initial requirements and the availability of other tools with similar functionalities seem to play a significant role in the early phases of a prototype (pre-compositional and compositional). Much like the traces of previous readings observable in textual genesis, the influence of other models or interfaces can be traced back in prototype development. For the Transviewer, these traces were still visible in the POC (functionalities with the same appearance, position or name as in BookReader or EVT). Literary genetic studies have shown that these traces, first "reproduced literally," tend to vanish in the later phases of evolution and to be assimilated into newly emerging forms (Grésillon 1994,

173–174). This tendency may also be observed in the gradual transformation of the Transviewer POC from the initial "no identity" layout to the formal and logical footprint of the later phases of its development.

While exogenesis elements can sometimes be identified in the upstream stages of the creative process through traces of contact or influences from other sources, endogenesis analysis may often require the consideration of less clear-cut evidence on the aspects involved in the creation of the studied artefact. Bonaccorso (1995, XLV, XLVI) refers to a mechanism determined not entirely by chance or by the author's deliberate choice, but by a combination of both together with the internal logic of the text itself manifested in the process of writing.

An analogy may be drawn by a closer look at the mutations affecting the space of possibility in the development of the Transviewer, in line with the reflections of Galey and Ruecker (2010, 407) on digital prototyping as a "thinking through making" pursuit. Although the general architecture and set of functionalities (the *what*) to be implemented in the Transviewer were already defined at the end of the compositional phase, the concrete form in which they were materialised (the *how*) in the pre-publishing phase implied a series of transformations not completely shaped by predefined schemas. This process involved a more complex intermingling of fixed requirements, testing, feedback collection and analysis, and reflection, in correlation with the evolving space of possibility. Rockwell et al. (2020) also showed that internal and external factors, related to technological aspects, user interaction, and the evolution of the ontological discourse, can guide the "layout, features, imagery, and content of a website or program" and influence the "visual identity" of the digital artefact made available to the public (Rockwell et al. 2020, 115).

In the case of the Transviewer, the factors that determined the changes listed in the transitions from one iteration to another can be grouped into the following five categories: (1) interface design specifications; (2) user response (e.g., remarks on the hierarchy of functionalities or some labels considered confusing, the inadequate use of the bottom toolbar requiring an extra scroll to access the features, the emphasis on comparing and entity detection as main functionalities when dealing with historical documents); (3) technical constraints (e.g., lack of cross-browser support, limited space imposed by the portal framework to display documents via Transviewer on the website); (4) resources allocated to the project (starting with a small design and management team working with an intern then a freelance developer, and in the later phases acquiring additional support for IT development and backend-frontend integration, as well as graphic and linguistic assistance); (5) inter-conditioning of all these factors at different stages of development of the interface, including space and time dimensions (**Figure 6**).

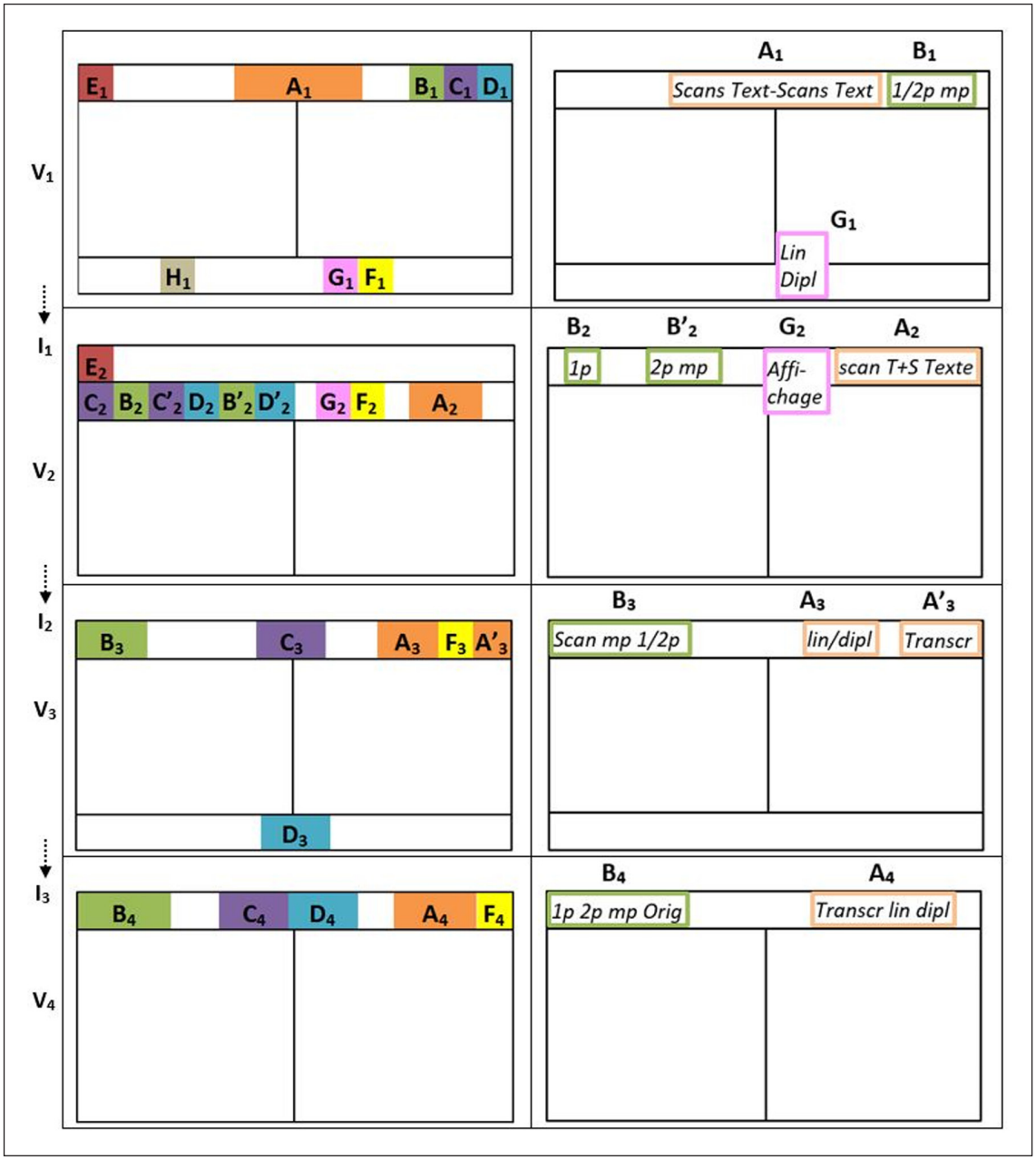


Figure 6: Transviewer mutations of the groups of features (left) and detail of main features from groups A, B (right), V_1–V_4, I_1–I_3 (Abbreviations and symbols: *1p* – one-page; *2p* – two-page; *1/2p* – one/two-page toggle button; *mp* – multi-page; *lin* – linear, *dipl* – diplomatic, *lin/dipl* – toggle button; *Orig* – Original; *Transcr* – Transcription [capitals for labels, lowercase for icons]).

Figure 6 presents an overview of the evolution of different groups and features from version 1 (POC) to 4 (*Pass for Go Live*). Their dynamics of change seem to be determined not only by controlled factors but also by an inner logic of the interface itself, a process that is neither completely random nor fully conditioned by the pre-defined design framework.

The diagram shows a gradual optimisation of the space of possibility (left), involving group fragmentation after the first iteration, then a more compact layout and relative stabilisation of the group components and position, both in relation with each other and with the relevant content areas, for iterations 2 and 3. The visualisation of feature evolution, for instance from groups A and B (right), highlights the changes of position that resulted in a layout with two focal points. The main features *Original* and *Transcription,* placed at the top centre of the two content areas to be compared, indicate the main feature of the interface.

3.2. Towards an aesthetics of production in humanistic HCI

If at first sight the demonstration may appear as a truism (i.e., proving that an iterative approach leads to a gradual refinement of the interface components and organisation with a view to coherence and comprehensibility), it may be argued that it is not the only rationale. The perspective pertaining to exo-, endo-, and epigenesis (i.e., development after the *Pass for Go Live* point) may bring about insights into the dynamics of movement and change in the prototype evolution, and, in retrospect, foster awareness at a more theoretical level of the design principles at play in the process. Moreover, the formalisation of the features and group evolution by means of a set of basic operations (substitution, addition, deletion, transposition, merging, splitting, displacement) could eventually pave the way to a digital approach for the analysis of tool building, possibly connected with existing research in model-based UI design, with a particular interpretative, humanistic touch.

In this sense, two categories of traits were identified when analysing the evolution of the prototype: *functional* and *expressive*. The first category denotes aspects generally related to the tasks to be carried out via the interface. The second refers to aesthetics- and intuitiveness-related design principles that can be further divided into *layout* and *object appearance* facets. Both categories can be the focus of an evolution analysis, either as part of existing frameworks and environments for model-based design or as incentives for new dedicated approaches and tools for studying digital artefact production.

The functional aspects, such as the different actions to be supported by the interactive objects in the implementation of primitives (e.g., comparing and searching), may be formalised at different levels of abstraction together with their evolution within extant models (e.g., CAMELEON, the hierarchy of "virtual protocol dialogues" or other schemas either derived from them or completely different). These models may include transformation operations such as substitution, addition, and deletion. On the other hand, as assumed for graceful degradation in multi-platform system design (Florins and Vanderdonckt 2004), the transformation of layout can involve a set of actions such as resizing, reorientation, and moving, while the transformation of graphical objects may imply changes related to their appearance. For instance, in the case of

Transviewer, layout transformations comprised displacement (left-right, down-up) and group splitting/merging. Transformation of object appearance included changes in representation (label/icon, toggle/individual button), colour and style (graphic charter, active/inactive feedback), while functional changes implied modification of object behaviour (search results displaying occurrence counts by category and/or entity, deletion or addition of features).

While functional transformation can be outlined through different types of formalisms in model-based interface design (which can also be connected to code versioning for a more complete picture), the transformation of expressive traits may include, in addition to formal operations (substitution, merging, splitting, and transposition), a visual component and indicators of repositioning and movement, as illustrated in the Transviewer case study. These elements are particularly valuable when tracing the evolution of certain traits of an interface, which are perceived by the user through aesthetic sensitivity and intuition rather than usability assessment only. Aesthetics and usability perception have actually been proved to be related, to a certain degree (Kurosu and Kashimura 1995). It is also possible to trace factors leading to these transformations, for instance by analysing other materials included in the genetic documentation of the product. These factors may often be associated with precise elements in the production process, technical constraints and specifications, user feedback, resource allocation, etc., as already mentioned in the previous section. Sometimes, however, these aspects are not entirely determined by specific circumstances but may be related to mechanisms inherent to the dynamics of the development itself, such as a progressive tendency towards simplification, symmetry, harmonisation of space and colour, intuitiveness, metaphorical representation, or dissimulated intentionality, which are less discernible as not always explicitly expressed in the design descriptions and related documents.

Digital genetic studies of literary text production provide examples of various ways of capturing this type of dynamics. For instance, the Beckett Digital Manuscript Project (BDMP) incorporated visualisation and animation techniques for the emulation of writing sequences and statistics of change (Sichani 2017). Scholger (2019) investigated the use of TEI encoding for hybrid primary sources (containing text and graphical components like author's sketches) and applied it to the reconstruction of the artistic creative process. Other enquiries pointed to the area of "computer forensics" for the genetic analysis of born-digital literary material (Lebrave 2011; Vauthier 2016) or the application of methods such as the Levenshtein distance for the automatic recognition of hand-drawn sketches (Coyette et al. 2007). By "aestheticizing" computer software and metaphorically understanding it as a form of conceptual art, as Cramer suggests

(2005), various modes of representing prototype evolution inspired by these digital genetic approaches may be imagined—in particular, the combination of different types of encoding with visual means to capture the dynamics of change in interface design. A simple example in this direction can consist of a collection of screenshots capturing successive iterations enriched with genetic annotations and possibly with mechanisms to highlight differences among graphic versions of the interface.

4. Conclusion and future work

Starting from the hypothesis that digital interfaces are cultural objects like other artefacts from the arts and sciences, the paper proposes a methodology for the analysis of tool building inspired by the study of literary manuscripts in genetic criticism. The analogy is symbolic and a case of interface design for digital editions is presented in a semi-formal manner in order to illustrate this type of enquiry based on the dynamics and aesthetics of production rather than on the study of the final product alone. The analysis uses a temporal dimension and a view of the evolving space of possibility leading to the product.

The study provides starting points for investigation, and further formalisation and testing of the possibilities of the genetic approach for interface design in other cases will be needed. One option may be to combine encoding and visual representations of functional and expressive traits in a prototype to trace the gradual transformation of a sample of interfaces during the design and development process. More general reflections on the creative process of tool building, beyond the traditional designer- and user-centred paradigms, may possibly emerge, as related to various fields of research such as humanistic HCI, history of culture and technology, and history of design practices in software production.

A genetic perspective may also bring to light the influence of previous tools and models in the development of new interfaces. Other aspects can be hinted at as well, such as the cultural origins of the scholarly primitives implemented by the artefacts. This pursuit may go back in time to early works pioneering scholarship and hermeneutics in Western tradition, like Origen's Hexapla and its parallel columns for critical comparisons of biblical texts (Grafton and Williams 2006). Other trails may lead to aesthetic codes and metaphoric embodiments in the interface, like Ariadne or Dante's Virgil, with figurative representations of the editor as a guide in a digital scholarly edition (Dillen 2018). This quest for cultural roots and symbolic forms of expression would need to be the focus of another study.

Appendix

Description of the feature groups by iteration and comparing/searching primitive (see section 2.2). The sub-groups of features are separated by semicolon.

Comparing			
Group	*Type*	*Features*	*Position*
A_1	Mode switch	pdf, Scans, Text-Scans, Text, xml	top centre
A_2	Mode switch	PDF, scan, T+S, Texte, XML	top right
A_3	Transcription style and mode switch	linear/diplomatic toggle; XML	top right
A'_3	Mode switch	Transcription	top right
A_4	Mode switch and transcription style	Transcription; linear, diplomatic	top right
B_1	Page view	one-/two-page toggle, multi-page	top right
B_2	Page view	one-page	top left
B'_2	Page view	two-page, multi-page	top left
B_3	Mode switch and page view	Scan; multi-page, one/two-page toggle	top left
B_4	Page view and mode switch	multi-page, one-page, two-page; Original	top left
C_1	Zoom	zoom in, zoom out	top right
C_2	Zoom	zoom in, zoom out	top left
C'_2	Zoom	reset size/position	top left
C_3	Zoom	zoom in, reset size/position, zoom out	top centre
C_4	Zoom	zoom in, reset size/position, zoom out	top centre left
D_1	Page navigation	flip left, flip right	top right
D_2	Page navigation	previous, next, first, last	top left
D'_2	Page navigation	go to page	top left centre
D_3	Page navigation	first, previous, go to page, next, last	bottom centre
D_4	Page navigation	first, previous, go to page, total pages, next, last	top centre right
E_1	Page sliding	Slider	top left
E_2	Page sliding	Slider	above top left
G_1	Transcription style	Linear, Diplomatic	bottom left
G_2	Transcription style	Affichage	top centre right
H_1	Linking	Hot spot, Text Link	bottom left

(Contd.)

Searching			
Group	*Type*	*Features*	*Position*
F_1	Entity highlighting	People, Places, Organisations, Functions, Events, Products	bottom right
F_2	Text search and entity highlighting	text search field, list of results; Noms, Organisations, Lieux	top right centre
F_3	Text search and entity highlighting	text search field, list of results with occurrence count by category, left-right navigation; Names, Organisations, Places	top right with results grouped by entity category and displayed on request via the right sidebar
F_4	Text search and entity highlighting	text search field, list of results with occurrence count by category and by entity, up-down navigation; Organisations, Dates, Produits, Évènements, Fonctions, Personnes, Lieux	top right with results grouped by entity category and displayed on request via an accordion list on the right sidebar

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The author has no competing interests to declare.

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