Comparing Unstructured 2D Files: An Interactive Combined Multiple Views Method

Samory Houzangbe, Chloé Morel, Alexandre Pere-Laperne, Marco Dias, Nadine Couture

Comparing Unstructured 2D Files: An Interactive Combined Multiple Views Method

Samory Houzangbe
Univ. Bordeaux, ESTIA Institute of Technology
F-64210, Bidart, France
s.houzangbe@estia.fr

Marco Dias
GLN
E.N. 356-1, Nº24, 2405-018
Maceira
Leira, Portugal
marco.dias@gln.pt

Chloé Morel-Targosz
Univ. Bordeaux, ESTIA Institute of Technology
F-64210, Bidart, France
c.morel@estia.fr

Nadine Couture
Univ. Bordeaux, ESTIA Institute of Technology
F-64210, Bidart, France
n.couture@estia.fr

Alexandre Pere-Laperne
1A3i Applications & Innovations Industrielles & Informatiques
97 Allée Théodore Monod,
Technopole Izarbel
F-64210, Bidart, France
alexandre.pere-laperne@1a3i.com

emphERGO'IA 2023, October 10–13, 2023, Bidart, France. ISBN: 979-8-4007-0910-4

Abstract

An unstructured document is made of a collection of potentially important data that are difficult to process through a computer. In the context of exponential data growth, one of the main challenges for companies is to manage, develop and use unstructured data. The collaboration of Famolde and 1A3i, two Europeans companies, has led to the development of new ways to process and compare unstructured data in Famolde's industrial manufacturing process. However, an ergonomic study identified limitations and potential improvements with the solution developed. In this context, we explored the information visualization literature to propose a new prototype designed to facilitate the comparison and classification of information. A multiple views solution based on the initial juxtaposition comparison tool is enhanced with explicit information about the identified differences. Finally we propose experimentation protocol to validate our solution.

Author Keywords

Unstructured documents; Visual comparison; Information Visualization.

CCS Concepts

•**Human-centered computing** $\rightarrow$ **Information visualization;** *HCI theory, concepts and models;* Please use the 2012 Classifiers and see this link to embed them in the text:

https://dl.acm.org/ccs/ccs_flat.cfm

Industrial context: comparing unstructured graphical 2D files

The RUD project is a two and a half year project that aims at developing and validating innovative integrated technologies capable of performing searches and comparing both unstructured and heterogeneous files, unstructured data from 2D files/3D models (see Figure 1). An unstructured document is a document that is not exploitable or difficult to exploit by a computer. Unstructured data can be displayed, printed, or exchanged. All the persons having knowledge of the domain can “understand” and exploit the content of this document once displayed. Internally the document does not contain any structured data directly processed by the machine. However, the expert can identify all the elements and understand the structure of the information.

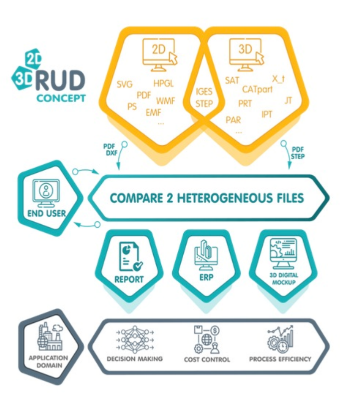

Figure 1: Diagram of the RUD project.

The volume of digital data is growing exponentially, and it is expected that in a near future, all the company’s data will be digital [10, 3]. One of the key challenges for companies is to manage, develop and use unstructured data. For the past 30 years, lots of work focused on the restructuring of graphic data from paper media. However, the problems of restructuring information from paper and digital vector media are wholly different. There is no study, apart those of 1A3i, on restructuring vector graphics files including schematics, plans, or drawings [7, 8]. The RUD project addresses all these issues for the first time to answer market needs.

In manufacturing companies, 2D and 3D files are linked to a huge amount of data. These files are created by Computer Aided Design (CAD) tools and contain a considerable amount of important information about the company (its processes, products, etc.) which, if adequately structured, could be used and could provide very valuable knowledge. However, due to the current unavailability to transfer this data from one application to another, this available data is poorly or not reused today. In fact, it is impossible nowadays to transfer directly unstructured file’s data, in a software, to use it.

For Famolde, nowadays, the analysis of versions of 2D drawings requires a dedicated effort, since the analysis is mostly developed in physical format. There is a visual comparison between two printed drawings, being invariably subject to human error, for various reasons and uncontrollable factors – tiredness, stress, pressure or lack of technical sensitivity to know how to look for the most minute details. Although changes between versions are mostly in the interest of those who produce them, technical knowledge and the perception of their feasibility can compromise a more agile analysis. It will compromise downstream work, when the detail should be assured in the preliminary phase. Additionally, it can cause unforeseen effort and costs, and consequently an unsustainable business model. Moreover, since it deals with industrial processes, the analysis of 2D drawings requires the participation of different technical people. Their approaches are vastly different depending on the different manufacturing steps.

Thus, for Famolde, it is imperative to improve this process and provide the 2D drawing analyst with more reliable tools and mechanisms. It facilitates not only the entire analysis process, which can take under normal circumstances 1 or 2 days for each analysis, to a few hours of effort. Moreover, the results being more faithful to expectations, and allowing the analyst to have all the information supported to present an opinion of feasibility.

The software used to produce 2D CAD models keep them structured as long as they are open in their dedicated soft-

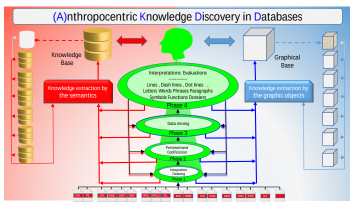

Figure 2: The four steps of the (A)KDD Method: 1)Structuring lines: Defining the type of lines and identify them based on their composition; 2) Structuring letters: Defining the font, size, style, direction and letters which associate one or several graphics; 3) Structuring words: Grouping together letters identified to create words, then text; 4)Structuring basic symbols: Defining these symbols and associating basic graphic items and text.

ware. But once they are exported the files are considered unstructured. 1A3I, leader of the RUD project, developed a method that relies on the analysis of 2D sketches to compare and find differences between two documents containing unstructured data.

It is much less expensive and more efficient to get the user to intervene throughout the process (and especially at the beginning) rather than at the end to validate or correct errors. Involving users reduces and even cancels the error rate for all the tasks [9]. In this way, a semi-automatic interface to structure unstructured data has been designed, placing the user at the heart of the extraction process and during all the restructuring phases. The solution developed by 1A3i offers to automatize that process. Indeed, by uploading two different files on the interface, the software is capable of comparing both files and highlighting the differences depending on selected parameters.

In this article we will focus on one specific innovative software tool enhancing 1A3i's solution: a tool to structure 2D data, allowing the comparison of unstructured and heterogeneous 2D files.

Existing 2D comparator

Designers and engineers who work with several versions of the same schema often need to know differences between tow versions. The prototype developed by 1A3i for the RUD project is able to find it, even through transformations (translation, rotation, scaling and elongation in one or two directions). But how to present, classify and store these differences? To ensure a comfortable use of the prototype, some ergonomic adjustments are needed.

A knowledge discovery database for destructured document
Several strategies have already been implemented in the 1A3i's prototype. One consists in displaying the 2 compared files, one next to the other, and synchronizing zooms and scrolls on the 2 views (see Figure 3). This allows viewing the details on each part of the documents at the same time. Thanks to a third view displaying the whole page in a reduced format, a flag indicates to the user the position of the zoomed part. With this "map-style view", the user keeps a global understanding of the file. Each of these views is on a different window so that it can be displayed on different screens: multiple screens environment enhances the capacity to display more information with more accuracy. 1A3i also uses several colors to underline differences between the 2 files: added elements, deleted elements, moved elements etc. Other interface dedicated to the comparison in the prototype of 1A3i displays both files in the same view, the one overlapping the other: the user can move a cursor to play with transparency ratio in order to distinguish each file and understand differences.

Some buttons allow to the user to sequentially iterate differences. There are several possible sort orders defined to iterate differences: depending on coordinates on the page (from left to right and top to bottom, etc.), depending on size of differences (from the biggest to the smallest, from the smallest to the largest) or depending on the contour of the drawing on which the difference appears. The user need to iterate differences because they want to inventory significant differences. Depending on their goal, the same difference can be significant or meaningless: the user are not interested in the same differences if they try to calculate a budget or if he tries to evaluate technical changes in the design. They are the only one who know how to distinguish significant and meaningless differences. This involvement of the human being in the process of restructuration comes from the (A)KDD method [7, 8] (see Figure 2). When it is identified, significant differences are flagged with a different color and the prototype of 1A3i can also build a report con-

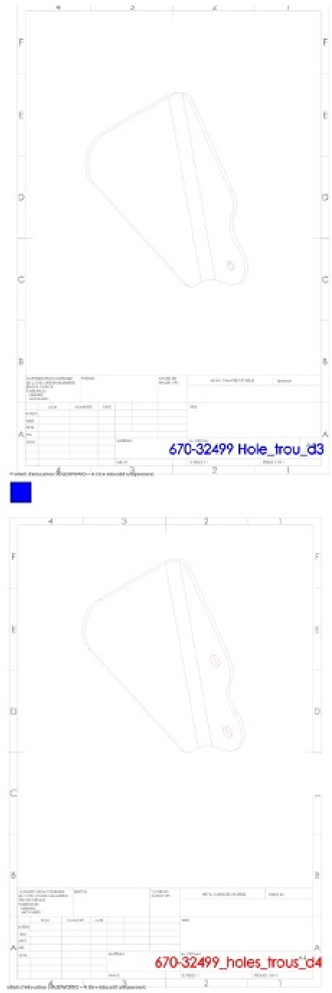

Figure 3: Example of a visualization of two files being compared.

taining significant differences with screenshots and textual comments of the user.

However, 1A3i consider that these strategies already applied in their prototype are effective but not enough to ensure a comfortable use of the prototype. One reason is that a lot of differences make the file less readable. Even with the use of colors and multiple views, a lot of differences in a small surface of the page can be confusing. Readability is essential to avoid errors.

Moreover, navigating a large list of differences can be tedious. Even if the "map-style view" indicates the position, the user must make an effort to understand it. Moreover, iteration implies an order. Even if the prototype allows choosing the contour or the difference to start the iteration, the user may not want to process differences in the sequence that the prototype proposes it. Iterate a list of differences is a repetitive task and it may be perceived as a boring task for the user. How can we represent and navigate the list of identified differences for a better and more efficient experience?

Ergonomic study

In order to develop a human centered solution to answer these concerns, an ergonomics analysis was performed to provide a diagnosis of the existing interfaces. Two methodologies were used : (1) ergonomic inspection of the software described previously (2) usability testing.

The ergonomic inspection method is the first step to identify user problems in software. It was carried out using Bastien and Scapin criterion [1]. Each interface was evaluated by comparing all the elements with the 8 criteria of Bastien and Scapin. Then, all usability problems identified was detailed in an inspection grid and illustrated with annotated screens. A total of 69 points were identified during the analysis via the Bastien and Scapin criteria after the evaluation of all the interfaces of the software: 2 were considered blocking, 25 were considered critical, 30 were considered medium and 12 were considered minor. In order to validate this first analysis and to propose concrete suggestions to build the new solution, the user testing method was used in a complementary way.

The usability test method consists of evaluating the usability[1] and user experience[2] (UX) [6]. It refers to evaluating a product or service (digital products, physical consumer, commercial products) by testing it with representative users. During a test, participants will try to complete typical tasks while observers watch, listen, and takes notes. The goal is to identify any usability problems, collect qualitative and quantitative data and determine the participant's satisfaction with the product.

To carry out these tests, 5 participants were recruited, 3 research engineers in additive manufacturing and 2 engineering school students. In total, 19 points were noted by the participants during the user tests. This number is much lower than the evaluation performed using the Bastien and Scapin criteria (69 points), because the scenario proposed for the usability test was not intended to evaluate all the interfaces of the software. Indeed, the tests focused only on the following workflow: the creation of a project with the synchronization of documents, the realization of a comparison (direct, transformation and by point) and the realization of a report. During the user tests, the participants were able to answer the System Usability Scale [2]. This scale aims

[1]Usability: the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". ISO 9241-11

[2]User experience : a person's perceptions and responses that result from the use or anticipated use of a product, system or service" international standard on ergonomics of human system interaction, ISO 9241-210

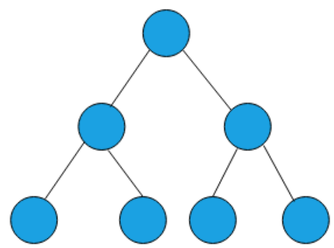

Figure 4: Example of a tree graph.

Table 1: Areas of improvement and comments from the user study.

Not intuitive	Lack of guidance in the type of comparison
No history	“it is sad that there is no history of the comparison”
No trust in the point translation	“this resize bothers me since it is dependent on mouse precision”

to measure the perceived usability and general appreciation of a system. The score is between 0 and 100, but it is not a percentage. The average score obtained for the initial solution was 57/100. The interfaces were therefore evaluated as acceptable. This score is consistent with the feedback, knowing that the software is still in the prototype stage. To significantly improve the interfaces, modifications are to be expected

The most critical usability issue was a lack of guidance when making comparisons. Users had real difficulty navigating through comparisons (see Table 1). Comparisons were not archived or classified according to their type (between direct comparison, transformation and point transformation). In order to guide the user, several suggestions were made including creating a tree structure to navigate through the comparisons and creating an annotation system to allow the user to identify each comparison.

We aim to establish the specifications for a functional interface for upstream efficiency. How can we efficiently browse a list of identified differences on a graphical files in order to correctly classify the major, minor and wrongly classified differences in two 2D graphical files?

Proposed prototype for visualization and exploration

A large body of visual tools have been used to facilitate comparison of multiple sets of data and information. They are essential to understanding, analyzing, and communicating data. The information visualization community has explored different solutions and proposed three main comparative designs: juxtaposition (showing different objects separately), superposition (overlaying objects in the same space) and explicit encoding of relationships [4]. The 2D comparator developed by 1A3i already implement the juxtaposition design to facilitate the comparison between tow files. They also analyze the documents and produce a list of identified differences between the two. To have a visual representation of the differences we want to propose the addition of a explicit encoding of relationships. This combination helps the user connect the juxtaposed views with the necessary additional information that will facilitate comparison. One interesting solution in this context consists in highlighting the explicit relationships on the juxtaposed views (for example zooming on the corresponding part of the juxtaposed views when selecting an explicit relation). To limit decontextualization, an explicit encoding of the representation may be shown next to a visualization of the objects.

The solution developed by 1A3i allows for the transformation of unstructured 2D graphical data to be restructured into tagged information. 1A3i’s software produce a hierarchical representation in the form of marked-up files with groups, sub-groups and details in an XML-like format: SVG. XML schemas are hierarchical and as such can be represented as tree graph. Tree representation have been studied a lot in the field of information visualization [5]. The node-link layout is the most widespread, parent-child relations being represented by lines drawn between nodes,

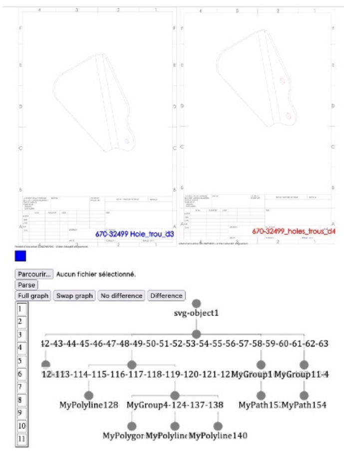

Figure 5: Tentative design of the prototype proposed. The top images represent the 2D files to be compared, the bottom tree is the hierarchy of the different parts in which differences have been identified.

they usually follow a top-down orientation (see Figure 4). This type of representation is easily understandable and communicates structure immediately. The addition of explicit encodings can help the user link the juxtaposed information and gives context for the relations [4].

The goal is to study new ways for the user to exploit the results of the comparison tool in order to conduct their own comparison and refine the results. Taking into account the (A)KDD method, 1A3i's solution lets the operator decide for themselves if a difference is important or negligible. Providing new ways to quickly manipulate the data to highlight what the user is looking for will enhance the ability of the operator to compare and extract pertinent information. Following recommendation from the information visualization community, the multiple views solution already developed by 1A3i will be complemented with an explicit encoding of the identified differences between the juxtaposed views. The solution will consist in proposing a new way to select and manipulate sets of 2D subparts.

Conclusion and perspective

We want to propose to the users a new layer of information and new interactive ways to navigate and discriminate the differences. Adding an explicit encoding view, displaying the identified differences through a tree visualization could help the user navigate and visualize the construction of the document (see Figure 5). The nodes will be foldable to limit the complexity of the representation. When hovering a specific node, the corresponding data on the image will be highlighted. Each node will display if it contains differences that have been treated or not by the user. When a node is selected the users will be able to mark if the differences found in the node are significant or if they are to be discarded (in the same fashion the original 1A3i software).

We plan on realizing short experiences with different participants. The experiences will consist in comparing the solution developed by 1A3i to the one with extra layer of information we are developing. We'll get feedback from the users and measure experience and efficiency. We plan on measuring different data regarding the experience:

- Usability: is the system usable enough for the participants? Are they getting what they need from it and in what fashion?
- Accessibility: is the system accessible and understandable enough to be used without extensive training?
- Efficiency: is the system doing what it is supposed to do efficiently?

A combination of external users and Famolde engineer will be recruited to test this prototype. The tests will be conducted in a within-subject design study with the initial 1A3i tool to identify the enhancements provided by the addition of the new view.

Acknowledgements

We thank the Eureka Network for co-funding this project through the Eurostars-2 joint program and the European Union Horizon 2020 research and innovation program (2021-2023). We would also like to thank Patrick Reuters for his contribution during the conception of the tree visualization tool. We extend our thanks to all the partners that participated in this project, staff and users that participated in the study, who provided helpful comments. This research project was undertaken with the assistance of resources and services from the PEPSS platform, Human Factors for Interactive Technology.

REFERENCES

[1] Christian Bastien and Dominique Scapin. 1993. *Ergonomic criteria for the evaluation of human-computer interfaces*. Ph.D. Dissertation. Inria.

[2] John Brooke and others. 1996. SUS-A quick and dirty usability scale. *Usability evaluation in industry* 189, 194 (1996), 4–7.

[3] IDG Consulting. 2018. *IDG 2018 Annual White Paper*. Technical Report. IDG Consulting.

[4] Michael Gleicher, Danielle Albers, Rick Walker, Ilir Jusufi, Charles D. Hansen, and Jonathan C. Roberts. 2011. Visual comparison for information visualization. *Information Visualization* 10, 4 (2011), 289–309. DOI: http://dx.doi.org/10.1177/1473871611416549

[5] Martin Graham and Jessie Kennedy. 2010. A Survey of Multiple Tree Visualisation. *Information Visualization* 9, 4 (2010), 235–252. DOI: http://dx.doi.org/10.1057/ivs.2009.29

[6] Carine Lallemand and Guillaume Gronier. 2015. *Méthodes de design UX: 30 méthodes fondamentales pour concevoir et évaluer les systèmes interactifs*. Editions Eyrolles.

[7] Jacques Pere-Laperne. 2018. (A)KDD for Structuring Destrured Documents. In *2018 International Conference on Artificial Intelligence ICAI'18 (Proceedings of the 2018 International Conference on Artificial Intelligence ICAI'18)*. Las Vegas, NV. 89, United States. https://hal.science/hal-01883868

[8] Jacques Pere-Laperne. 2019. *La restructuration des documents graphiques destructurés*. Theses. Université de Bordeaux. https://theses.hal.science/tel-02453457

[9] Jacques Péré-Laperne and Nadine Couture. 2017. Restructuring Unstructured Documents. In *SMART INTERFACES 2017, The Symposium for Empowering and Smart Interfaces in Engineering*. Berntzen, L. et al., 60–65.

[10] David Reinsel, John Gantz, and John Rydning. 2017. Data age 2025: The evolution of data to life-critical. *Don't Focus on Big Data* 2 (2017).