How Can a User-Centered Design Bring Innovation in a Business Intelligence Platform?

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***Abstract*—We live in a world of data, in a constant flow of information. In business intelligence, data support a key role in decision-making and innovation. Digital tools are used to help business intelligence experts in research of insight. However, these tools are often difficult to use for a novice and are not fully adapted to every activity field. In this study, we propose to apply a user-centered design method for business intelligence tool redesign. We have integrated the user as a co-designer from the ideation phase to the evaluation of the solution. We present here the developed method and the mobilized tools necessary to generate a novel, efficient and generic interface for business intelligence experts.**

Keywords-user-centered design; data visualization; design method; evaluation method.

I. INTRODUCTION

With the Big Data advent, we are confronted with a huge production of digital information. Big Data is defined as: "*a new generation of technologies and architectures, designed to economically extract value from very large volumes of a wide variety of data, by enabling the high velocity capture, discovery, and/or analysis*" [1]. Therefore, it can be approached in a technical way, for instance, with algorithms, but it can also be addressed towards the end users, their operations and their needs. This represents the end-user approach that will be favored here, through the user-centered design process. End users are strategic or marketing stakeholders of companies from different fields (such as aeronautics, pharmaceuticals, transport, etc.,) but they are driven by a common aim: collecting as much data as possible on their markets to adapt their strategy and decision-making. For example, they want to visualize key information during a meeting and show them to their boss in a quick and efficient manner. We performed an intervention based on principles of user-centered design [2] and using its relevant tools and resources.

The context of the study was an intervention within a software edition company. Collaborators were using a business intelligence platform including complex functionalities from meta-analysis to news reading. This software was composed of several functionalities to share, organize, analyze, collect and search information. However, this version was restrictive, not intuitive and therefore not fully satisfying for the business intelligence expert. In this context, the company was looking for developing a new software to improve multidimensional data manipulation. We identified the following multidimensional data concerns:

- The origin of the information: type of media, of network, etc.
- The characteristics of the information: date, transmitter, linked concepts, etc.

In this study, we aimed at developing a new tool to support the daily work of the business intelligence expert and improve the decision-making by allowing an intuitive browsing within a complex network of data. To reach our goal, we used the user-centered design method.

The rest of the paper is structured as follows. In Section 2, we present a state of the art to define business intelligence and to specify the human needs and habits in this domain. We also identify the cognitive principles involved in visualization and data processing to improve those activities in an appropriate manner. Then, in Section 3, we define our method of intervention. Finally, in Sections 4 and 5, we perform a study to build a relevant solution for the end-user and to evaluate and to readjust it quickly.

II. STATE OF THE ART

A state of the art will first allow us to define the terms of business intelligence and data visualization. In the second step, we will present the research question discussed in this paper.

A. Business intelligence

Business intelligence is defined as a "*process implementing, recurring and methodical devices to collect, process and disseminate information to its operation. It is a systematic activity, equated to an active environmental monitoring*" [3]. Gathering competitive or strategic information for a company is a major challenge that provide added value, and sustains the growth of the company [4]. To this end, several software solutions: Digimind, AMI Enterprise Intelligence (Figure 1), Synthesio, etc. have been developed, offering advanced setting and information analysis of one or more topics of interest. The information is valuable for decision makers and must give insights quickly to push for action and to optimize decision-making. We extracted from the literature a first taxonomy of tasks governing information analysis. It consists of the following categories [5]: Observation, Navigation, Manipulation and Comparison to which we added one more: Restitution. We translated functionally these categories into the tasks performed by the user during the analysis [6]: Give an

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overview, Filter, Zoom, Details on demand, Associate, Provide a historical, Extract. After collecting a dataset, the user will first implement visual exploration strategies [7] and by then get new knowledge from the data by completing specific tasks. The decomposition of these strategies gave us a first insight of users' needs to analyze data and to proceed to decision-making.

Figure 1. Business Intelligence AMI EI Software process

B. *Business intelligence and Data visualization*

This project is at the crossroads of two subjects: Business Intelligence and Data visualization. We are already familiar with some theories about visualization and architecture information of a Human Computer Interaction (HCI), for instance with the Gestalt Theory [8], whose basic premise is: *"in front of the complexity of our environment, the brain will try to get in shape, to give a meaningful structure to what it perceives to simplify and organize"*. Therefore, it was important to ensure excellent presentation and organization of information, and to introduce visual variables in user interface design regarding the user perspective [9]. The laws proposed in Gestalt Theory guide designers to arrange information in a relevant way. In addition, the system acts as a guide for the user by intuitive interaction, involving for instance icons and labels, mostly known as "Affordance" [10]. The functions of icons and labels must be clearly represented and quickly understandable. For instance, we can switch a cursor's representation to indicate the possibility of "grabbing" an object and moving it to another. Affordance is highly attractive from the perspective of data visualization as it facilitates decision-making and thus improves usability and usefulness of the system.

To provide functional implementations based on user as a human, we investigated cognitive sciences in detail. We focused on the user's needs to interact with a dataset and to provide better performance. The Active Reading consists in transforming the "reader" into an "actor" [11]. This is possible by offering a degree of freedom in document manipulation thanks to specific enrichment such as graphic signs and text annotations. The user can actively read and produce a modified or "enhanced" version of the source document. Thus, during a second reading, important information will be easier to find and draw more attention. The main constraint of this process remains the homogenization of these signs between different operators, particularly for the purpose of sharing information. Indeed, it is important that all operators share a common understanding of the codes used. The notion of Active Reading is strongly linked to the concept of ownership defined as "*the progressive internalization of technical and cognitive skills at work, in individuals or groups who handle daily technology* "[12]. Consequently, the daily use of technology allows suitable changes by creating new uses. This concept must bring designers to think about their project in a prospective way such as we have done here. Interestingly, it is common to say "I see" when we realized something instead of "I understand" since vision is the first sense we used, that provide us valuable knowledge on how information is assimilated [13]. Graphical characteristics (orientation, color, texture and movement) are seen without effort. For this reason, it is a source of information that promotes efficiency and should not be ignored. There are many forms of presentations to be considered, particularly movement that can be used such as a dynamic information. We chose vision as a central element of our project so we will be sensitive to those pieces of information during all our intervention.

C. *Research question*

The state of the art has allowed us to promote the importance of visualization and perception in the context of business intelligence and manipulation of a large and heterogeneous amount data. As part of this work, the research question focuses on how to effectively adapt a user-centered design method to design and evaluate a business intelligence platform?

III. METHOD

To define our intervention methodology, we used the User-Centered Design (UCD) [14] [15], which is frequently used in the field of ergonomics [3] [16] [24]. The project was divided into four main stages, regarding the UCD method: 1- specify the context of use, 2- specify requirements, 3- create design solutions, 4- evaluate design.

For each step of the method, we mobilized tools that allowed us to (1) introduce the users at the beginning of the design process and (2) produce intermediate solutions on an iterative and incremental way in order to permit their evaluation by the users. The users were first introduced in the design process as informant. Then, they became the most important stakeholder during the design of solution and its validation. These two phases were built on an iterative manner. The user contribution was progressive and participated to the success and strength of our intervention (Figure 2).

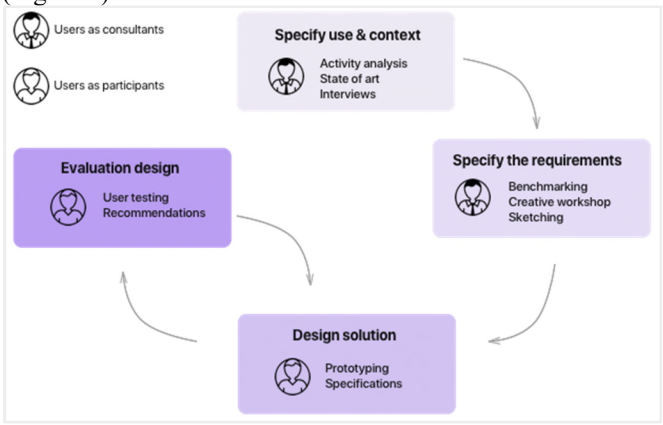

Figure 2. The methodology designed for this intervention

We opted for a method close to the MVP (Most Viable Product). This method consists of proposing a simple version of a product with basic features and allowing it to evolve using user's feedbacks. It is an agile design approach, which, if it remains close and keeps listening to users, provides very convincing results [23].

After the presentation of the general approach we will present in details the steps that bring us to the development of the final solution.

IV. EXPERIMENTATION

To reach a pertinent solution for the interface users, we first worked with them on the usage context.

A. *Phases 1 and 2: Specify the context of use and the requirements*

In this step of the design process, we drew from the literature all relevant information to specify better users' needs, such as the vision process, the active reading process [11], the preference for dynamic information, etc. We also gathered complementary and specific information during users' interviews, about their preferences on the composition of the modules, the importance of the analysis page, the difficulties to use some features such as key concepts, etc. Then, we realized a benchmark to determine the add value that we can propose on this market.

Creativity workshops were integrated in our intervention. We settled up a brainstorming with 4 developers, 3 managers and 3 designers with the following lead question: "How to improve the manipulation and the interaction with Big Data?"

We focused on the two working axis that emerged from this work: elements about the representation of information and elements about the interface interaction. Recommendations were associated to these two axis and are presented in the table below:

TABLE I. 2 AXIS RECOMMENDATIONS

	Recommendations
Interface interactions	- Save, export and share data - Drag / drop of a value from a chart to another, allowing zooming to obtain more details - Ability to lock the widget filters to keep a scope unchanged, as a context of the analyze - Comments on data
Representing information	- Multiplicity of graphics - Filter display - Widget layout

For the interface redesign, we focused on the analysis mode because it represents the most difficult part for the users but also because it covers the highest number of interaction elements and information representation. Indeed, interviews with users allowed us to identify difficulties linked to the analysis mode as it is not interactive and it does not allow the reading of several graphics at the same time to compare and study the interaction between several criteria (Figure 3).

During the analysis configuration, the expert has to use 3 tab pages to set up one analysis (Figure 4). Once again, the presence of these 3 tab pages prevents the expert to have a synthetic and global vision of the elements of the analysis. Moreover, the language used is not adapted to random users but only to experts.

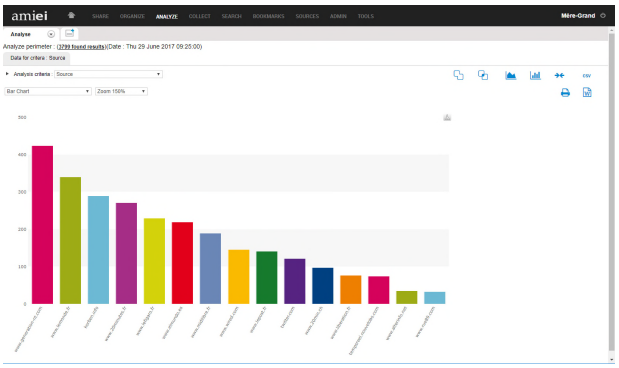

Figure 3. Screenshot of the current page of Analysis

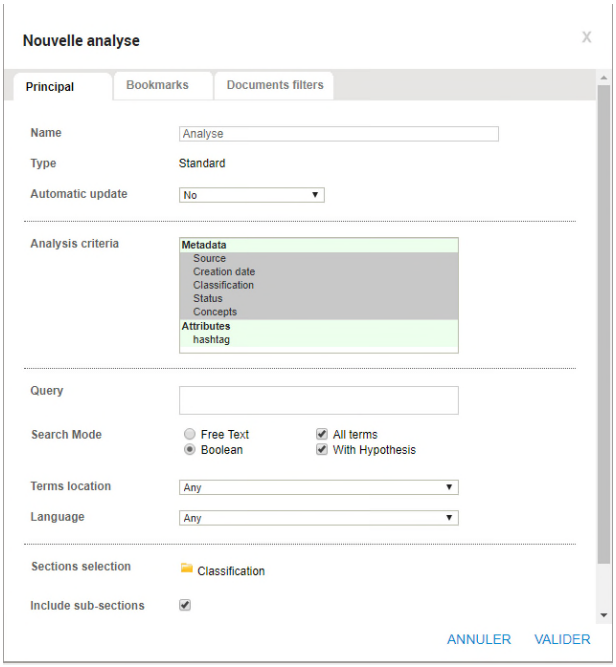

Figure 4. Screenshot of the setting of Analysis

A work of synthesis brought us to the first functional prototype that combine insight from the literature and users' interviews [17][18]. To start the experimentation, we developed an interactive prototype with a dedicated software: Axure, and implemented our solution on the Analyze module of AMI EI software.

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B. Phases 3 and 4: Create and evaluate design solution

During all prototyping, we confronted the solution to our research findings to readjust the conception. The first version was composed of functionalities such as save, export, share, filter, widgets addition and also new interaction such as drag and drop. Although we made an important research on users' needs, we also included the specificity of AMI EI to accomplish the business goal. The evaluation phase started with a presentation of the prototype to expert clients to gather feedbacks and advices about the functional architecture. We decided to include "Recommended analysis", working such as an analysis template, to reach user of different expertise level. We also included a rapid and simple way to access to the filters of the analyze (Figure 5).

For the evaluation, we made two different tests with different users: expert evaluation and end users testing.

Figure 5. Screenshot of recommended Analysis page

1) Experts evaluation

The evaluation was realized in two steps: a demonstration of the prototype and a test scenario. First, we performed a demonstration of the prototype to five AMI expert customers. During the recorded interview, the experts guided us to a more fluent architecture. For instance, instead of dissociating the family of criteria with their children, the experts proposed a simpler way to present criteria all together. They particularly enjoyed multiples widgets on a same page, the use of a shortcut to add widgets and the direct manipulation offered by the drag and drop interaction. They also raised the importance of text document's consultation during analyze. Following this, we conducted iterations and established a test scenario composed of tasks such as starting an analysis, adding criteria to it, filter with these criteria, dragging and dropping a value from a widget to another. We engaged a second expert's review and received positive feedbacks and validated the overall behavior with a second phase of iteration before user testing. Each iteration phase took about a week.

2) End users testing

Prior to the user testing, a protocol was written and included:

- The objective of the test: improve the navigation and manipulation of a large dataset
- The scope: the analyze module
- The context: 1h of testing by ConfCall with recording
- Several scenarii, based on the information analysis tasks: starting an analysis, adding criteria to it, filter with these criteria, dragging and dropping a value from a widget to another.
- Material and human resources: AMI EI customers
- Final questionnaire

The testing sessions began with a presentation of the scope project and the objective. Then, the participants could performed the scenario of tasks. In line with the low number of users of the current Analysis module, we could only meet five testers. However, their profiles were varied by their level of expertise and by their work field (Aviation, Defense and Security, Automobile, University Research). Moreover, according to Nielsen, 80% of usability problems can be observed with a panel of five users [19].

3) Results

Two tasks, adding a widget and locking a graphic, required a demonstration to three out of five testers before the functionality can be well understood. However, all features were considered useful and relevant. The more popular ones were: plurality of widgets on a same a page, preprogrammed analysis models, drag / drop, sharing, annotation and export tools. All users also highlighted a better usability compared to the current model and suggested some improvements to pass the next step with a even more intuitive interface. At the end of each task, we asked them whether the interface met their needs in day-to-day job and all participants answered positively. Finally, they had to evaluate the global interaction on a scale of 10 (10 meaning the highest score for the best interaction). These feedbacks and score were formalized through the final questionnaire (Table II).

TABLE II. SYNTHESIS OF FINAL QUESTIONNAIRES

	CURRENT Analyze Module	**TESTED Analyze module**
Evaluation	4.6/10	7/10
Strengths	Advanced settings Capacity to provide the source statistics, subjects, etc.	Clear language Solves the main defect of the current module, the visual creation is more natural and accessible
Weaknesses	Difficulties to use some features such as key concepts	Filtering a graph from another one is not intuitive but training helps

A third phase of iteration was performed taking into accounts the result of user testing. The page was redesigned to increase relevance and customization possibilities (Figure 6).

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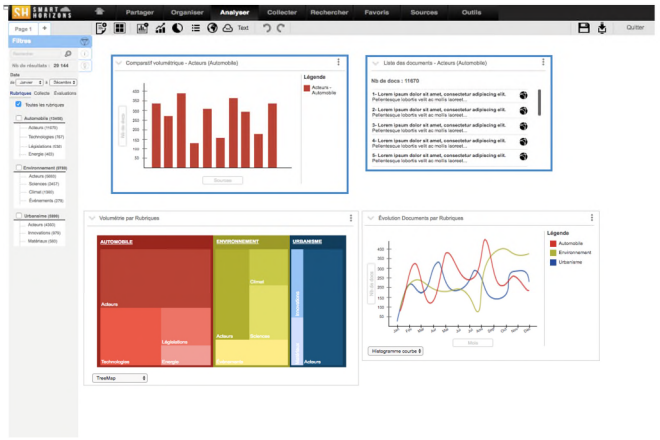

Figure 6. Screenshot of optimized Analysis page after final questionnaires

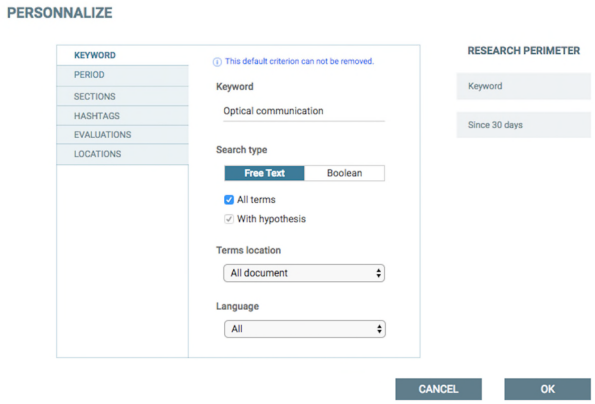

Figure 7. Screenshot "Personalized my research perimeter"

The different areas of improvement were specified in a document restoring observations during user testing and their recommendations and requests. This document was accompanied by own specifications for the development of the solution. Using "checklists", we described each feature and each section of the interface [20][21]. We collected rich feedback from users and the overall behavior can be validated and new iterations implemented. The solution continued to evolve until the presentation to the development team. We interviewed five more users, experts in Business Intelligence analysis, and developed solids use cases helpful to determine *"who (actor) does what (interaction) with the system, for what purpose (goal), without dealing with system internals"* [22].

The stakeholders decided to integrate this module in the new platform of consultation developed by AMI Software. Therefore, with an input of his choice, the user can visualize the following information:

- its change over time in the collection of data
- the set of documents associated to it within all the documents collected
- the set of the most relevant concepts lies to it

In addition, with all evolutions of the solution (after a fourth phase of iterations) the user can:

- Add a widget: the navigation bar was transformed into a floating button that follows the user throughout his scrolling on the page without being too visually ubiquitous.
- Analysis criteria are gathering on "Perimeter of research" and personalized according to users' needs. The selection is quite free and sub-criteria of a family can be chosen. The content is more distinguishable too (Figure 7). The comparison with the figure 4 and the settings of the actual analysis show clearly the progress made on an individual widget filters is also available and manageable for customizable views.

We decided to include "Share" and "Save" on a second phase of development. Preprogrammed models will also be included later, as we want to build them with the help of the daily use and a better knowledge on this need.

We defined an included analysis interface in an existing product and offered a simple interface with innovative interaction and meaningful representation. This design allows users (and even those who are far to be experts on Business Intelligence) to manipulate information to prepare a reunion with an important client or to make advanced market analysis and to spot a trend.

V. CONCLUSION AND FUTURE WORK

The "user-centered" approach established in this project gave an effective response to the problem "How to effectively adapt a user-centered design method to design and evaluate a business intelligence platform?"

The combination of a scientific and technological research, multidisciplinary team and an iterative process leads to a prototype that respects the model of ergonomic Graphical User Interface:

- meets ergonomic criteria (usability),
- innovates in line with needs and goals of end users (relevance and usefulness),
- Supports technical constraints of IT developers.

Our project is also influenced by contributions of data visualization and manipulation fields. The motion was introduced as a vehicle for information first, but also as a facilitator for handling this information (drag/drop). The crucial aspect of information architecture was enhanced by providing smooth navigation with clear design. This categorization allows the user to adapt quickly to the interface and to identify interactions. Through an analysis of the professional activity of end users, we have implemented innovative features and provided a relevant and intuitive solution.

Ongoing features on the prototype assert the stakeholders' satisfaction toward UX Designer's work. Those features included more Social Media Analysis, which is increasingly used in market analysis. Based on the work of Wu, Rosen & Schaefer [24], it will be interesting to determine how to detect communities or influencers in such networks. Indeed, it is important to involve all resources necessary to make the product evolve. During the presentation to the development teams, it will be crucial to make sense and to attach a clear goal in each feature [25].

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