Co-Design of Interactive Museographic Exhibits: the MIME case study

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Abstract
Cladistics is an abstract and counterintuitive classification of species. In the context of the Museum of Toulouse, it is one of the most important concepts presented to the visitors. To ease the understanding of this classification method and to stimulate the visitors discovering this thematic, we (museologists, designers, computer scientists ...) have envisioned new ways for supporting the exhibits explorations. We chose to explore the use of mixed interactive systems (Augmented reality, Tangible interfaces, etc.) and found that they constitute a good alternative to involve the visitors in such scientific thematic. In this paper, we present the development of MIME, a Mixed Interaction for Museum Environment: its aim is to experience the major principles of cladistics. This paper also describes and illustrates the design of this prototype: it was based on a process dedicated to the development of mixed interactive museographic exhibits. This paper then concludes with lessons learnt from the use of the design process and feedbacks about the prototype and its use into the museum.

1 Introduction
Museums play the major function of acquiring, preserving, conserving, managing and presenting collections. Usually collections take the form of galleries, showcases and panels. In such contexts, the visitors remain very lightly involved and are not real actors of their visit (Drioli, 2006). To overcome this consideration, the collaboration between museologists, designers, computer scientists, ergonomists, etc is required to develop solutions that better stimulate the visitors on a thematic and transform the visitor from a spectator to an actor of his/her visit. To reach this goal, museums and science centres add interactivity to support the exploration of their exhibits (Wakkary et al. 2009). For example, visits can be made more engaging through the use of audio multi-media or interactive guides. However, when it comes to explain a complex and abstract phenomenon such as a methodology or a scientific concept, designing such systems becomes harder.

To support the design of such interactive experiences, a dedicated process is required (Brown et al., 1998). The use of an appropriate methodology should ease the collaboration between disciplines and allow several specialists to select suitable content and museum settings for the exhibits. Following this goal, we have developed and
applied across the past years a co-design process dedicated to guide and structure the cooperation between disciplines; it is also intended to help designers identifying appropriate and innovative forms of exhibitions, especially in complex contexts. In this paper we present the structure of this co-design process through an illustration of the design of “MIME” (Mixed Interaction for Museum Environment). MIME is a prototype related to the domain of cladistics. Cladistics is a counterintuitive classification system of species and organisms and is therefore hard to transmit to the visitors. Using an interactive approach to support the mediation of this theme is therefore particularly suitable. Hereafter, we introduce the principles of cladistics, existing interactive applications in this domain and the basic principles of our prototype.

2 Interactive approaches for presenting Cladistics
2.1 Understanding Cladistics
Proposed in the 1950’s, Cladistics is the modern method for the classification of life. This classification method is based on evolution of criteria rather than similarities/differences between species (Hennig, 1950). A classification is represented with evolution trees, called cladograms (see Fig 1), in which leaves represent taxa and in which nodes represent a hypothetical ancestor characterized by an evolutionary stage of a criterion acquired during evolution. However, cladistics is still largely unknown and poorly understood by the large audience: indeed educational experts have pointed out that cladistics is really awkward to learn (Lecointre, 2004). To ease the understanding of cladistics’ principles, many pedagogical applications have been proposed. For example, (Phylogène, 2009), developed by the French National Institute in Pedagogical Research, has been deployed in schools and universities to introduce students to the process of building cladograms. However, the use of Phylogène requires extensive domain knowledge as well as a teacher’s assistance: it is thus inappropriate for museum contexts.

Other interactive tools like Arbres (Hyptique, 1998) propose a more informal vision of cladistics. The aim of Arbres is to make accessible the concept of structure and understanding that the tree semantic does not depend of its graphical depiction. 3D animations of rotating branches of cladograms bring a playful touch to the subject. Although Arbres has been developed for museum context, it does not introduce the notion of phylogenetic criteria and all its underlying concepts.

These examples illustrates two forms of existing interactive application for Cladistic: they are either complex and require the intervention of a teacher/facilitator, or they simply increase the visitors’ awareness of cladistics (Wagensberg, 2005) and are usable by the general public without the presence of any expert.
Our development of a new support for understanding cladistics aims at finding an intermediate position between these two situations. The goal is to present most of the major cladistics principles and to better involve the visitor as an actor of the exhibit. Therefore, in collaboration with curators of the Museum of Toulouse, we designed and implemented new interactive supports that provide a simple experience of cladistics in museums.

2.2 MIME: Exploring a tree of life from its inside
MIME stands for Mixed Interaction for Museum Environment and aims at teaching the major notions of cladistics. This prototype provides two views of a cladogram, i.e. a tree of species:

1. A 3D interactive egocentric representation of the cladogram
2. A 2D global representation of the cladogram

The 3D interactive representation (Fig 2. n°1) of a cladogram allows users to navigate with an egocentric view inside the branches of the cladogram. In this view, cladogram’s nodes and leaves are represented by rooms connected to each other by tunnels (Fig 2. n°2). In each room, the visitors can change their point of view from left to right and access information cartels providing details about the phylogenetic criterion or specie represented by this room (Fig 2. n°4). For example, panels summarize the list of acquired characteristics since the cladogram root and a brief definition of the current specie/criterion.

Users can also interact with two doors to access the connected rooms (Fig 2. n°5). Opening a door and moving in the tunnel to the next room means acquiring a new phylogenetic criterion and therefore making a step forward into the evolution of life.
Going a step backward in the evolution is also supported. Finally, users can also take a look through windows to get a short view on brother criterion/specie (i.e. the brother nodes in the tree). In this view, tunnels are made of bricks that correspond to the bricks constituting the walls of the Museum of Toulouse: this further links the interactive application to the Museum and contribute to the visitor’s immersion into the visit. This representation is intended to stimulate users to visit as many rooms as possible. Overall, the trajectory through the 3D rooms helps in the understanding of the characteristics that define different species (leaves).

![Fig 3. Evolution of MIME map view](image)

The 2D representation of the cladogram plays the role of a map (Fig 3). This view provides many information and feedbacks that help the visitors in the exploration of the cladogram. When the application starts, the map view of the cladogram (cladomap) is totally hidden (Fig 3 n°1) except the species. To limit user’s spatial localization difficulties in the 3D view, a green rotating arrow on the cladomap indicates the direction of the user’s point of view and position in the 3D view. In addition, when the user looks through a window in the 3D egocentric view, the current brother node is highlighted on the 2D map view (Fig 3 n°2). Finally to encourage users exploring the cladogram, a percentage indicates the exploration rate. This representation is thus intended to encourage the visitor to explore all the rooms of the 3D representation in order to discover the entire 2D map.

With MIME, the visitors are therefore encouraged to explore a 3D cladistics tree and to discover that the complexity of species (tree leaves) depends on the amount of phylogenetic criteria (tree nodes) visited from the root. As a result, the application aims at explaining one of the most important principles of cladistics: “every species in a cladogram is defined by the set of phylogenetic characters inherited from the cladogram’s root”. Having these rules and messages defined, we then focused on the design of appropriate interactive techniques.

Following Wagensberg’s prescriptions would result in the use of real objects (Wagensberg, 2005). But cladistics is an abstract phenomenon for which no real object can be identifiable. Therefore we chose to incorporate the manipulation of physical objects to support the exploration of cladistics concepts: physical objects constitute a tangible support to interact with the representation of the cladistics concepts. Such interactive situations are called mixed interactive systems (MIS) (Dubois, Nigay, and...
Troccaz, 2001) and are also called augmented/mixed reality systems or tangible user interfaces. Such interactive systems combine:

- the computer’s ability to store, retrieve and transform digital data and
- the user’s physical abilities and the physical resources surrounding him.

Using MIS to support the interaction with multimedia applications triggers the use of physical artifacts; this reinforces the semantic coherence between the manipulations and the object of the exhibit, thus guiding the visitor through the exploration of the presented information. Using appropriate alternative to traditional interaction therefore constitutes an adaptation of Wagensberg’s principles and may be useful to instrument the presentation of methodologies or abstract concepts in a museum context. We developed two different techniques to interact with this environment: each of them involve different aspects of the physicality of the interaction.

The first one is based on physical manipulation of a flashlight. As shown in Fig 4, predefined movements of the flashlight are recognized by the system. By handling the flashlight, users can change their point of view, move from one room to another, and access information panels into the egocentric view of the cladogram. The detection of the flashlight’s orientation is based on video detection allowing six degrees of freedom to users. As a result, the visitors just have to handle the flashlight and move it to start interacting with the system.

The second interactive technique is based on the use of the Cubtile™ (de la Rivière et al, 2009), a five faces multitouch interactive cube. As shown in Fig 5, we have associated each face of the cube to a defined action in the MIME environment. Left and right faces are used for changing user point of view respectively to the left and to the right, top face is used to access information cartels, and front face is used to open doors in the environment. The back face remains unused.

The design and the evaluation of the two interactive techniques of MIME have been supported by a co-design process dedicated to mixed interactive museographic exhibits (Dubois et al. 2011). In the next section, we show how this process led us to consider all the specificities related to the pedagogical principles, the mixed interaction and ecological integration in the museum.
3 Co-Design Process for Mixed Interaction Applications in Museums

From the identification of the thematic, the deciphering of museographic expectations and the definition of the pedagogical message, the design of our system has been fully performed in collaboration with museum experts. However, to identify the appropriate requirements and find the “appropriate design”, we have followed a specific co-design process dedicated to mixed interactive museographic exhibits (Dubois et al. 2011). This one aims to:

1. Facilitate the communication between involved disciplines (musicologists, ergonomist, computer scientists, designers, etc.),
2. Guide the design team throughout the development and
3. Support the exploration of initial expectations rather than just users’ requirements.

This process is composed of a set of four major phases (Fig 6), each one covering a different aspect of the design:

1. The “preliminary analysis” phase is devoted to the analysis of the domain, i.e. the identification of a theme, relevant goals and messages, position in the exhibit path and finally, constraints and user profile in the considered domain.
2. The “analysis of interactive principles” phase involves the definition of how to produce an interactive context that will support the expression of the previously identified goals and messages.
3. The “optimization” phase is an iterative design phase that aims at successively improving aspects of the prototype’s design, such as (but not limited to) its interaction, integration and social dimensions.
4. The “production” phase finalizes the prototype, possibly leading to an industrialization of the solution.

These four phases define the global structure of the process, separating design issues linked to the museum itself, requirements analysis of the interactive application, design and implementation, and finally its diffusion. Each phase requires the implication of different disciplines, but the weight of the role of each varies from one phase to another.

![Fig 6. The co-design process](image)

In the following section, we report the use of this design process for the MIME case study and detail for each phase how it has been instantiated and which specificities of the final prototype have been considered.
3.1 Preliminary analysis
This phase aims at identifying, with the museum experts, thematic and activities into the museum that may benefit from an interactive application. Before designing MIME, we have identified several such situations. For example, activities that require to handle abstract entities (e.g. energy of two different molecules, classification of life), to manipulate huge elements (e.g. a lake, a volcano), or even situation for which the object of interest cannot be brought into the museum (e.g. a planet, fragile artifacts) constitute relevant thematic to be computerized. In the case of MIME, after many discussions and co-design sessions with the museum curators, we have identified the classification of life (i.e. cladistics) to be an appropriate concept to computerize. For this thematic, we identified with curators a first generic activity: “the exploration of a complex structure”. To understand cladistics it is important to focus on the structure of the tree rather than on the leaves (i.e. the concretization of the living, the species). This step of the design is crucial because it guides all the requirements specified in the following steps of the process. In addition, this phase is also the place to specify the visitors’ profiles. For MIME, we have extracted from museum’s statistics that public from 15 to 40 years old, with some basic knowledge in science were the most interested in the chosen thematic (i.e. cladistics).

At this step of the co-design process, no interactive considerations have been explored yet. But this phase led us to investigate the thematic field and to understand the museum objectives and the visitors’ profiles. The next phase focuses on more specific aspects of the interactive application itself.

3.2 Analysis of interactive principles
This second phase aims at defining the overall design of an interactive system which could support the generic activity identified in the previous phase. In this phase, HCI specialists and ergonomists are the main actors and collaborate with domain experts, which are the only ones able to express domain constraints and recommendations. This phase includes three major steps.

First, the boundaries of the generic activity have to be defined. It aims at defining the minimal elements required in an interactive context to support the generic activity. When designing MIME the concretization of the generic activity (i.e. the exploration of a complex structure) becomes: “to become acquainted with a complex structure, a user needs path from a starting point to a target”. Based on this instantiated activity, additional specifications of the interaction are required: it includes the definition of Guiding rules and Phasing.

Guiding rules provides general recommendations related to the content setting. When designing MIME, we relied on ergonomic criteria (Bach and Scapin, 2010) to support the decision making process. Two guiding rules have been identified:

1. A first person view will be used to navigate into the cladogram in order to reinforce user’s presence (Heeter, 1992)
2. The whole structure will be provided through a second view in order to always have a view of all reachable species
3. Mixed interaction will be used to increase visitor’s immersion and fun and to constitute a tangible support to interact with this representation of the cladistics concepts.

Phasing is intended to structure the user’s activity with the interactive application into a hierarchical set of sub-activities. For MIME design, we used the MAD task model (Gamboa-Rodriguez & Scapin, 1997) to reflect about action sequence and associated feedbacks.

Finally, based on all the identified requirements since the beginning of the process, this phase ends with the elaboration of an initial proposal. This proposal represents a satisfecit (Simon, 1996) reached by the design group. It should compile all the design decisions in a unique artifact to serve as a means of communication understood by every stakeholder, and to reveal aspects that will need further design refinement. It can take any sufficiently representative form of the functional requirement, guiding rules and phasing of the application: a story board, a paper mock-up, low-fi prototype, etc.

For MIME, we chose to build a low-fidelity prototype showing the navigation into the tree through a PowerPoint and a paper mock-up representing the external view of the cladogram (Fig 7). At this step, design decisions related to the interaction were limited to the interaction in output. About input interaction, we only chose at this stage the use Mixed Interactive System, so the design had to be considered more deeply. After a collaborative validation of all the design choices, the design process enters into an iterative cycle.

![Fig 7. Initial proposal of the MIME application](image)

3.3 Optimization
This phase is dedicated to improvements of an interactive experience in a museum. During this phase dimensions such as interactivity, usability, nature and content of the experience, socio-cognitive considerations as well as the museum setting must be taken into account. Considering all these dimensions necessarily requires an iterative and incremental approach. To optimize the design of MIME, we relied on participatory design techniques (Mackay, 2003) which are commonly adopted in the field of HCI. Participatory design has also proven to well address social considerations, as well as other contexts in which decision making and co-design play a central role (Schuler et al., 1993), which match perfectly our design context. This includes four major steps:

- “Analysis” of the situation to identify remaining problems,
- “Design” to generate ideas solving the identified problems,
• “Prototyping” to concretely represent the generated idea, and finally
• “Evaluation” to study the adequacy of this solution with end-users

When designing MIME, we have iterated many times over this optimization cycle, however in this paper we focus on the optimization related to the interactive dimensions. However, designing mixed interactive techniques requires more than just a participatory and iterative cycle. To better handle the multidisciplinary design group, to reinforce the exploration of the design space of mixed interactive techniques and to take the opportunity of finding an original and appropriate interactive technique, we relied on a model assisted creative session: MACS (Bortolaso et al, 2011). During this session participants representing all the involved stakeholders, generate ideas to find a mixed interaction solution for a defined problem. Their creative activity is supported by the manipulation of a design model of mixed interaction (Gauffre and Dubois, 2011), i.e. a model allowing to represent and to specify different mixed interaction possibilities: participants thus explore the space of possibilities and produce alternative solutions. For MIME, the design space was opened to various input devices, tangible objects, and interactive metaphors. From this MACS, we extracted several solutions, each one related to a different interactive metaphor, using different physical/digital artifacts. Among them, we selected the flashlight solution because of its adequacy between the proposed solutions, the technical limitations and the museum constraints. We also retain the tactile based interaction, because it seems to better attract the visitors to the place where the interaction takes place. It has been further materialized through the use of the Cubtile™. In the next section we present the evaluation of these two prototypes. The evaluations are based on a combined use of lab and field activities (see Dubois et al, 2011 for more details), thus constituting a form of evaluation continuum. We report in the next sections solely the main qualitative results of field evaluations.

3.4 Evaluations
The evaluation of prototypes in museums involves many research questions about methods, tools, equipment, metrics, planning, ecological level... We report here some results and feedbacks about the evaluations of the two versions of MIME in the Museum of Toulouse using the FoldI platform (Dubois et al, 2011). The FoldI (i.e. foldable incubator) is a nomad user lab dedicated to field experiments in Museums (see Fig 8), which can be deployed in the museum for short periods.

The flashlight based MIME version has been tested by 14 individual volunteers who had previously visited the museum. The other visitors could freely observe the experiment and on their request take part in it. We observed that participants used the flashlight between 10 to 15 minutes and explored between 80 to 100% of the cladogram. During these field experiments, we identified and fixed several unexpected technical issues. For instance, we did not have any control on the ambient light in this space, which caused troubles to our vision-based object detection. Another relevant example of technical problem is related to the height of the participants: we had to regularly adjust the position of the camera used to detect the flashlight’s position. Indeed, there is a significant difference between an eight-year-old child and a tall young man. These feedbacks led us
to change the video based sensing for a more permissive sensor, such as the use of magnetic detection.

From a museographic perspective, participants were satisfied with the prototype and we observed interesting behaviors. For example, during a session, more than 20 free visitors requested to be involved into the session or asked the test monitor about the design/test process or just suggested improvements for the prototype. We also observed after the use of MIME and during the post-session interviews, surprising reminds and insights of the museum cladistics exhibit. Indeed, part of the first floor of the Museum of Toulouse is architecturally organized as a cladogram. However, the single visitors almost never notice it. After the use of MIME flashlight, we got from several participants feedbacks highlighting that MIME took its place into the physical exhibit and helps the visitors to better catch the museographic message: “this game reminds me of the first floor of the museum ... it’s a kind of species classification, I understand now...”.

Regarding to the visitor experience, we extracted interesting social behaviors. For example, during the tests, we observed formation of visitors groups looking at the interaction user/prototype (sometimes around 40 visitors). The participants to the experiment played the role of magnet to visitors. Additionally, during those sessions, the docents took time to concretely experiment the prototype and envision how they could take advantage of this tool to create new entertainments with and for visitors.

The Cubtile based MIME version was evaluated in a slightly different way. First, this prototype version was evaluated by groups of 3 to 5 real visitors (i.e. not by invited participants) and second it was performed in an isolated room of the museum. We chose this study configuration to closely observe social interactions inside groups using the MIME Cubtile version. Technically the 3D view was retro-projected (size 230 cm) and the 2D representation of the cladogram (cladomap) was available on a computer screen close to the Cubtile (Fig 9). We did not observed unexpected technical problems in this configuration.

20 visitors took part to the test (7 groups). Through these tests, we observed a great efficiency of the Cubtile in the 3D cladogram exploration task. Indeed, the Cubtile’s materialization of the physical space seems to constitute a real advantage to quickly handle the interactive exhibit. We also observed a deep exploration of the cladogram. Some visitors explore 100% of it; none were under 50%. Users experienced the prototype from 10 to 20 minutes.

Regarding the social interaction, we observed some new interesting behaviors, especially with the teenagers. For example, we noticed the apparition of:
• co-interaction behaviors (several visitors using one or two faces of the Cubtile at the same time),
• alternating roles (a visitor plays the guide by using the cladomap, and another one plays the driver by using the Cubtile) and
• distributed roles (one participant plays the driver and the rest of the group guide him/her).

This prototype was a real good experience for the teenagers and for families (parents with one or two children) but was perceived as really monotonous and repetitive for couples between 30 and 40 years old.

From these two experiments we also extracted some interesting suggestions for improvements of the MIME application itself (i.e. independently of the interaction technique). For example, several visitors suggested the adding of graphics, animations, sounds and/or textures in adequacy with species (for now the texture is in adequacy with the museum architecture). They also suggested implementing an animated virtual guide. This kind of suggestions is typically the costly improvements candidate to the last phase of the process: Production (Fig 6). In terms of bad feelings, two participants reported light cases of cyber sickness due to the velocity of movements and the size of the 3D screen.

4 Discussion and lessons learnt
To successfully design and implement those advanced interactive exhibits, a multidisciplinary approach was unavoidable. However, establishing a synergy between different experts, in order to take advantage of new technologies in the museum, remains a real challenge. The described and illustrated co-design process in this paper is intended to provide a structure:

1. To organize the multiple resources relevant for the design of interactive experiences in complex contexts
2. To federate the different stakeholders

In this section, we report a set of lessons learnt from the use of this co-design process: they partially illustrate how the co-design process answers these two goals. These results have been extracted from the design of MIME and seven other interactive prototypes produced in collaboration with the museum. In the next sections, we first briefly position
our approach with regards to existing design processes and then we develop lesson learnt from our experience with the Museum of Toulouse and its curators.

4.1 Existing design approaches
Design approaches of interactive systems have clearly been derived from software design methods. Software cascading (Pressman, 92) or spiral (Boehm, 87) cycles are well established and focus on the structuring of steps that are important for the implementation of the systems. More recently Agile approaches tends to better involve the end-user through very brief cycle and frequent feedback from the end-user (Armitage, 2004). But on overall, the goal of these approaches is to finalize a software system rather than to properly answer to users’ requirements.

In contrast, HCI design processes primarily focuses on users’ needs and tasks (Dix, 2004). Standards have been developed (ISO, 2002) and used in multimedia and professional contexts. Additional approaches have been proposed to complement the global approaches with specific considerations such as children (Kelly, 2006), disabilities (Sears, 2008) or usability specification and measurement (Scapin and Law, 2007). Alternatively, when users’ needs are not easily understood and identifiable in the earliest steps of the system design, participatory design is often used (Muller, 1992) even in museum context (Koleva, 2009). However, such approaches reach their limit when the initial requirements cannot be directly translated into or related to interactive considerations: in museum contexts, the identification of the knowledge to transfer must be integrated in the global design process but will not find any answer in a traditional visitor centered approach.

For that reason, collaborative design has been quite widely adopted in museum contexts: these approaches tend to ensure that different but complementary considerations such as educational consideration for example will not be left apart. Although it is not easy to perform (Taxen, 2004), it has been successfully applied in different cases (Ciolfi, 2008). As mentioned in (Taxen, 2004) further explanations and clarifications of such approach are nevertheless still required to better involve the different stakeholders and better take advantage of their participation.

Our co-design process thus appears to be in line with the most recent evolutions of design processes to be used in museum contexts: it structures and documents the steps, stakeholders and tools available to cover complementary considerations of the design of interactive experiments in museums. From its application by different design groups, we collected substantial hindsight to identify the major benefits of this process.

4.2 Lesson learnt
First, the process really appears to support the design activity. Indeed, we have observed that it facilitates the communication among the different experts and guide them through the different considerations to deal with. Multi disciplinary participants have been involved as well as their different design resources: ergonomic criteria have been combined with task tree, museographic requirements have been taken into account during interaction design, etc.
In addition, it helps the design group to stay focused on design questions before thinking in terms of technologies. It has been possible to base the design process on requirements that were not limited to user’s needs but that also included museographical expectations in terms of knowledge transfer. This process was also found helpful for designing museographic content and application. Through the generic activities, it supports the homogeneity over the exhibition path and opens a structured and controlled avenue to the insertion of advanced technologies in museum exhibits. Furthermore, we observed that the process is transferable to other design teams. Indeed, four different design teams have successfully applied it for other prototypes intended to deal with different thematic of the Museum (e.g. eutrophication of lakes).

Finally, the use of the co-design process confirmed its ability to support an improved form of participatory design approach. Indeed it confers to the users a certain duality: they are first observed and then actors of the design. This is similar to what Boedker (2000) observed. Of course all these observations needs to be further analyzed thorough a more longitudinal study of the benefit of such a process. Further work will also be required to transfer its daily use to museum staff.

5 Conclusions
In this paper, we focused on rethinking the design of interactive experiences in Museums and particularly emphasized the case of complex and abstract concepts such as cladistics. We have introduced MIME, a prototype which aimed at experiencing some principles of cladistics. To do so, we relied on mixed interactive systems. These interactive technologies are in line with a modern stream which aims at replacing physical objects into exhibits. As a result, MIME supports the introduction of major concepts of cladistics while avoiding the involvement of teachers and thanks to mixed interaction, MIME deeper engages visitors and transforms their visits into interactive experiences.

Other abstract and complex themes of the museum have also benefited from such forms of interactive experiences: we have already designed systems dealing with other aspects of cladistics or eutrophication (i.e. filling of ponds phenomenon). Along our design experiences, multiple considerations, perspectives and expertise have been considered and articulated. As a substitute to actual approaches mainly based on ad hoc and technological explorations, we relied on a co-design process dedicated to museographic exhibits.

Our co-design process constitutes a scaffolding for selecting and interleaving the set of design resources which are the most appropriate to the multiple expertise involved. Furthermore, requirements definition, museum exhibit and interaction design, implementation and evaluation phases are covered by this co-design process: our co-design process is therefore guiding the whole development from the earliest analysis phase until the final concrete installation.

The use of this co-design process has been illustrated on the MIME case study and revealed its major benefits and limits. Further experiments in terms of transfer to curators, and other museographic theme will be studied in future work.
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