Art installations: a study of the topology of collective co-located interactions

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ABSTRACT

Art installations designed for co-located collective interactions rarely call the execution of a task or a preannounced goal as a guideline for the activity. If this new configuration, which differs from those of traditional HCI, is revealed, from the perspective of aesthetic experience, to be one of the richest and most 'engaging' ones, it is by no means less complex to apprehend for both the artist and the end-user. Through a case study (with concrete examples of artistic installations), we propose in this present article to examine the topological configurations of existing co-located collective interactions by analyzing the scope of action of the systems' agents and the relations between them. To achieve this, we lay the foundations of a new graphical language (used here to describe the relations between interfaces), which we foresee to dedicate, in the near future, to the modeling, visual representation and taxonomic analysis of topologies of interaction.

CCS CONCEPTS

• **Applied computing** → **Media arts**; • **Human-centered computing** → **Collaborative interaction**; • **Software and its engineering** → *Entity relationship modeling*; *System modeling languages*;

KEYWORDS

co-located collective interaction, interactive art, relational interfaces graph, topology

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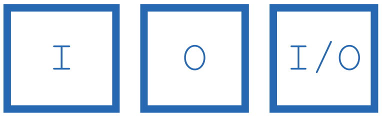
1 INTRODUCTION

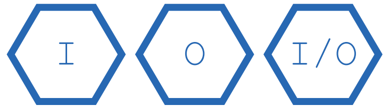
With works such as *Dialtones (A Telesymphony)* [10] by Golan Levin, Kamal Nigam and Jonathan Feinberg, *Blinkenlights* [2] by the Chaos Computer Club, and *Sky Ear* [5] by Usman Haque, the field of interactive art, notably relating to the production of digital installations, seized early on the new opportunities offered by ubiquitous computing marked by the multiplication and interoperability of computer terminals. The main objective of such installations was the deployment of original situations of collective co-located interaction capable of a profound renewal of forms of the aesthetic experience.

Based on a preliminary review of the conditions, both material and human, specific to some of today's art installations that enable co-located collective interactions, we endeavor in this article to uncover the main relational models underlying this interaction. We will also try to demonstrate that, although this research rests on the artistic field, the stakes of this work are not entirely circumscribed to that field. We in fact believe that the results of such a study are likely to contribute more broadly to the evaluation and analysis of all interactive systems in which interfaces can be alternately shared (made available on a device accessible by all), distributed (made available, and eventually personalized, on individual devices), or mutualized (both shared on devices accessible to all and, at the same time, distributed on individual terminals).

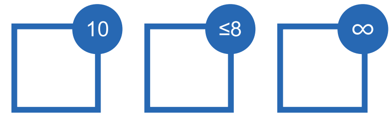
To do so, we will analyze four interactive art installations which were conceived within the framework of our research on "Large Group Interaction" at EnsadLab (the research laboratory of the *École nationale supérieure des arts décoratifs* in Paris): *Discontrol Party*, *Overexposure*, *Mobilisation* and *Collective Loops*.



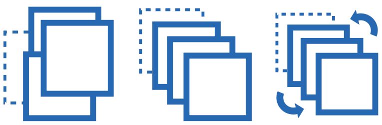
(a) individual interface type: input, output, or input/output



(b) shared interface type: input, output, or input/output



(c) interface count: precise, maximum, or unlimited


(d) interface organization: free, in a queue, in a looped queue

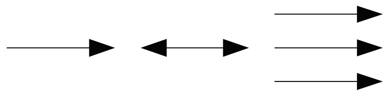

(e) data flow: unidirectional, bidirectional, symmetrical correspondence of individual and shared interfaces

Figure 1: Symbols of the interface relational graph system

2 TOPOLOGIES OF INTERACTIONS

Today's digital art installations offer diverse modalities of collective interaction in museum settings and public spaces. Several of them call for coordinated and synchronized user actions in a co-located setting, i.e. within the same unit of time and space. Those installations often invite users to access and manipulate multiple devices (sometimes simultaneously) that can be either shared (such as a large video projection) or personal (such as smartphones).

Moreover, "in media art ... goal-oriented processes are only rarely at the focus of artistically staged interactivity" [9]. Indeed, unlike traditional HCI research, which is mainly concerned by utility and usability, or projects in the CSCW community, which almost exclusively address collaboration in a working environment, interactive art installations rarely call for the execution of a task, or dictate a common objective to achieve in a predefined framework that can serve as a guideline or support for the activity. On the contrary, art installations are often more concerned about staying open to interpretations [14], and generally invite the public to participate in a relational experience with no specific purpose or precise goal. They aim above all else the emergence of a dynamic and collective aesthetic experience. Their activities mostly fall under co-emergence and cooperation methods based on intuitive and abductive reasoning principles.

Aspects that characterize co-located interactive systems have been the subject of previous research and publications, such as the work of Lundgren et al. [11], yet few appear to deal with aspects related to the *topology of interactions*, that is the configuration of the interactive space according to the actions and relations between its agents, both humans and machines. It is, however, clear that the success of a co-located collective interaction is related, among other things, to the topological layout of the system (while some of the layouts were already described in the late 90s for groupwares, new ones unfold as new possibilities are offered by emerging and disruptive technologies).

Firstly, the quality and success of a collective co-located interaction seem to depend on the relational framework, i.e the nature of the space and the context which partly determines the field of action of participants, which we denote here by the expression *collective organization*. The collective organization rises from a bottom-up process well known in social sciences as the phenomenon of emergence by an effect of aggregation "*which is not explicitly sought by the agents of a system and which results from their position of interdependence*" [1]. In other words, the collective phenomena arise from actions carried out by individuals and their mutual interactions. This approach is opposed to that of Holism, a top-down theory according to which the properties of individuals cannot exist independently from the whole, or cannot be understood separately from the properties of the set to which they belong. In art installations designed for co-located interaction, the former, bottom-up, approach seems to be the only viable one due to the nature of the interaction which is not induced, oriented, or directed towards the achievement of a task or a predefined goal.

Secondly, the quality and success of the interaction also derive from the type of the technical equipment or apparatus (e.g., the connection and synchronization modes of digital devices) and the configuration of the common interface whether it is shared or distributed, which we will designate as the *apparatus and interfaces* in this article. The chosen configuration can have an impact both on the well coordination of actions and their perceptual-cognitive "alignment" (the visual identification and/or control of an individual's actions and their correspondence or conformity with those of others), as well as the nature of the collective outcome. In fact, certain conditions (to be further elaborated) are required to move from the mere juxtaposition of actions to a collaboration.

2.1 Towards a graphical modeling language

To better understand those aspects and help analyze and design such installations, we are currently working on a new graphical modeling language.

While only at an early stage of development, the language presented herein can already help visualize the relations between the different interfaces and their arrangements. We will thus use this preliminary version of this graph system throughout the article for that very purpose.

The language is currently composed of two main symbols: (1) a square one representing individual interfaces with an indicator specifying whether they are input interfaces, output ones, or both as seen in Fig. 1a, and (2) a hexagon symbol for shared interfaces with the identical indicators for input and output as depicted in Fig. 1b. Furthermore, the number of each interface supported by the system is represented by a small "badge" icon overlaid on the top-right corner of each symbol (see Fig. 1c), the arrangement or organization of the individual interfaces can be indicated using one of the icons in Fig. 1d, and the direction or nature of the flow of interaction data between the individual and shared interfaces is illustrated by the different arrows of Fig. 1e.

Although there already exists graphical modeling languages commonly used in the HCI community such as *UML* (Unified Modeling Language) [13], *SysML* (Systems Modeling Language) [6], *SDL* (Specification and Description Language), *EXPRESS-G* and *Petri Nets* [12], the modeling of very complex systems such as the art installations dealt with here produce very large and complex graphs, hindering the readability and analysis of the most important aspects. We are, however, exploring the possibility of combining our approach with *Coloured Petri Nets* [8], to increase the expressiveness and modeling capabilities, while preserving the readability by abstracting some of the common patterns in high-level symbols similar to those described above.

In the following sections, we will examine four of our interactive art installations designed for co-located interaction through the two indicators mentioned above; following a brief description of each installation and the motivations behind it, we will outline its *collective organization* and *apparatus and interfaces.*

3 DISCONTROL PARTY

In the context of its research on "Large Group Interaction", EnsadLab has developed, with several partners, the interactive festive installation entitled *Discontrol Party.* Uniting the two, usually opposing, worlds of state-of-the-art surveillance technologies and partying, a dance floor appears in the dual spotlight of a party and a data-driven control and surveillance system with computer vision and indoor geolocation.

Participants of the event are encouraged to carry one of the 200 available active RFID tags, allowing the system to track their every move. And 10 video surveillance cameras are installed throughout the space to perform blob and face detection. While partying, the crowd is confronted with multiple real-time visualizations of the collected and analyzed data.

Though the system does its best to track and analyze the behaviors of participants, their rapid movements and the crowd's high density makes it almost impossible to distinguish the individuals from each other.

3.1 Topology of interactions

Collective organization. Due to the festive context of *Discontrol Party* and the fact that the event can accommodate several hundred participants, the relations between the individuals are above all social. The collective organization is thus largely guided by those relations; individuals gather and act predominantly according to their social bonds. In addition, the hands-free interaction with the system via RFID tags and computer vision as well as the immersive projections allow the free movement of individuals in the space and limits the impact of mediated interactions on social ones.

Figure 2: *Discontrol Party*
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Apparatus and interfaces. In this project, the mediated interaction relies on embedded sensors attached to the bodies of participants (the active RFID tags), and surveillance cameras installed in situ. The feedback of the collected and analyzed data is done through shared data visualizations that are video-projected on the surrounding walls as illustrated in Fig. 2. Here, all participants act on the system at the same time, and the shared feedback reflect the entire set of data at a given moment.

3.2 Relational graph of interfaces

To make the relations between the individual and shared interfaces more readable and thus facilitate the comparison between different configurations, we propose to graph them according to the system described in Fig. 1 inspired by those designed for groupware such as that of Jean-Claude Courbon and Silvière Tajan [3]. The top-left symbol in the graph of Fig. 3 indicates that *Discontrol Party* supported up to 200 individual input interfaces (the RFID tags) freely positioned in the installation space, whereas the symbol at the top-right represents the 10 shared input interfaces (the surveillance cameras), and the bottom one represents the 20 shared output interfaces (the video projections).

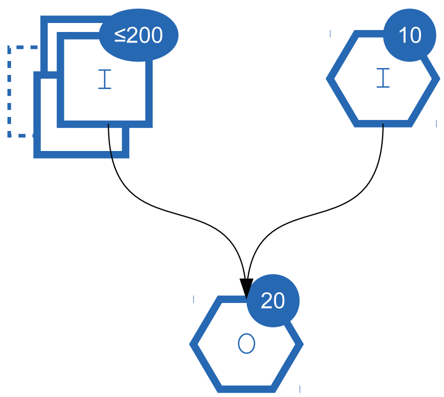

Figure 3: Relational graph of interfaces for *Discontrol Party*

4 OVEREXPOSURE

Overexposure (version 2) is an interactive work bringing together a public installation and a smartphone application.

On an urban square, white dots and dashes scroll from bottom to top on a large black monolithic structure. Each time one reaches the top of the monolith, a bright beam of white light is projected by the structure into the sky.

Visible all over the city, the light beam is transmitting short messages sent by participants using the mobile application or via SMS. The text messages are encoded into Morse code and made visible, one at a time, to everyone for a few moments, marking the installation with their rhythm.

On a completely different scale, we see the same dots and dashes scrolling across the smartphone screens of the participating public following the same rhythm. Here, it is the flash of the smartphones that synchronously releases light in accordance with the coded language.

Returning to the very essence of Morse, the messages are also transformed into a sound composition, broadcast by the monolith and the smartphones. In addition, a map of the real-time activity of the mobile phone network, is floor-projected around the monolith and available through the smartphone application, giving access to the pulse of an even larger community: that of the city.

From a individual devices the size of a hand to a shared device at the scale of the city, a momentary community forms and transforms, sharing a space and a pace, through a type of communication whose ability to bring people together by a sensory experience is more important than the meaning of the messages it transmits or their destination.

4.1 Topology of interactions

Given that we are interested in this article more precisely with the co-located interactions, we will not deal here with those that can occur at the city level, but will restrict our analysis to interactions that occur near the monolith and the floor projection.

Collective organization. Intrigued from afar by the light pulses in the sky or coincidentally passing by the installation, the public of *Overexposure* is, unlike that of *Discontrol Party*, predominantly constituted of passersby. It is thus mostly composed of small scattered groups of individuals. However, the synchronization of the light and sound emitted by the smartphones and the monolith causes the emergence of a collective organization that goes beyond social relations.

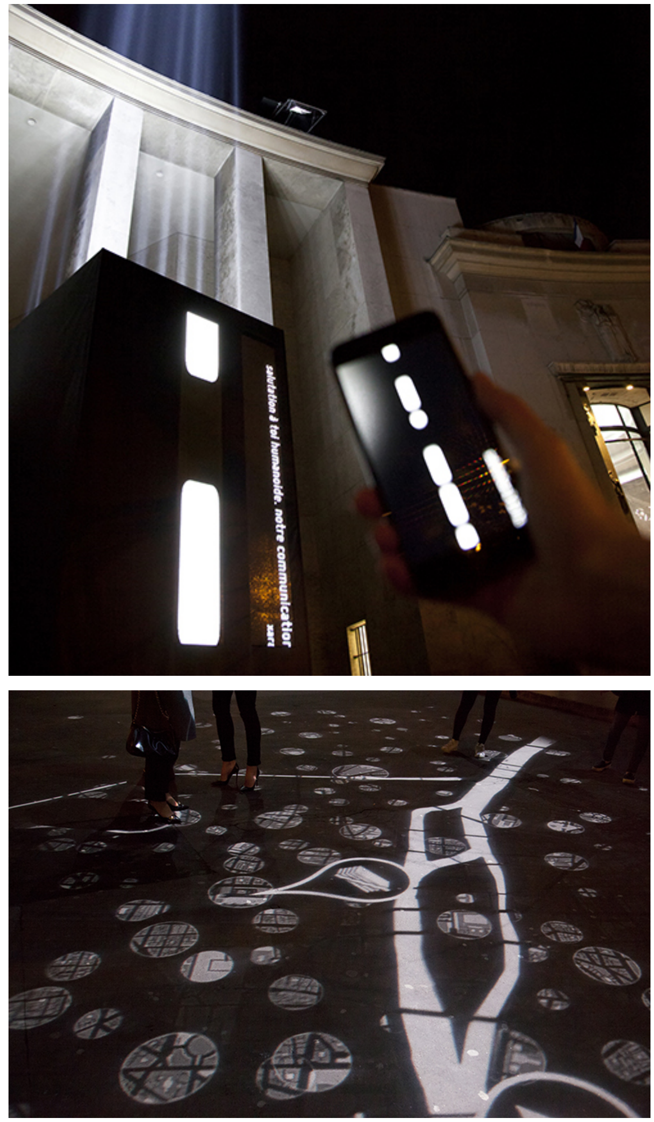

Figure 4: *Overexposure*: monolith and mobile application (above), and floor-projected map (below)
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Apparatus and interfaces. Participants of *Overexposure* have the possibility to send a text message accompanied by an optional nickname via the smartphone application. Due to the relatively slow display of each message in Morse code, the received messages are processed by a complex temporal queue, making sure that the last received message also has a possibility to be selected by the system and displayed. One after another, each selected message is made visible simultaneously and synchronously on the monolith, the floor projection and the smartphone application. The output interfaces are thus mutualized; they are both shared by the monolith and floor projection, and distributed through the smartphone application.

4.2 Relational graph of interfaces

We can represent the interface relations of *Overexposure* as in Fig. 5. The queue for the individual input/output interfaces (the smartphones) is indicated by the symbol at the top, and the two shared output interfaces (the monolith and the floor projection) are indicated by the symbols at the bottom. Since the two shared interfaces differ in nature from each other, each one is represented by its own symbol. The arrows between the individual and shared interfaces indicate that information flows back and forth, as smartphones send the messages, and the selected message is displayed on all the individual and shared interfaces.

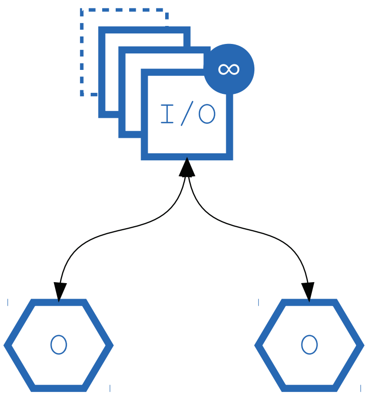

Figure 5: Relational graph of interfaces for *Overexposure*

5 MOBILISATION

A mobile sculpture, moving with the slightest breeze, is suspended from the ceiling of the lobby of Sciences Po (Paris Institute of Political Studies). The sculpture is composed of over a hundred flags, on which textual information is video projected using projection mapping. When the sculpture and the flags move, under the effect of wind, the video projection seeks to adapt to the movement in real time. It only succeeds to do so to a certain extent, especially if the movements of surrounding objects or people disrupt its environment.

Each blank white flag is initially coated by three letters representing the name of one of the countries (e.g., FRA for France) that contributed to the IPCC, the Intergovernmental Panel on Climate Change. Although a world map is not quite formed, the arrangement of the flags corresponds to the global organization of the territories.

We can perceive on certain flags, behind the three initial letters, some more or less dense texts in the background. These typographic aggregates reveal the degree of participation of each country in the various IPCC reports and indicate an information space to be explored. The public facing the sculpture can indeed act on it through a dedicated application on their mobile device. After choosing a flag, and thus a country, they explore this information by traveling in the

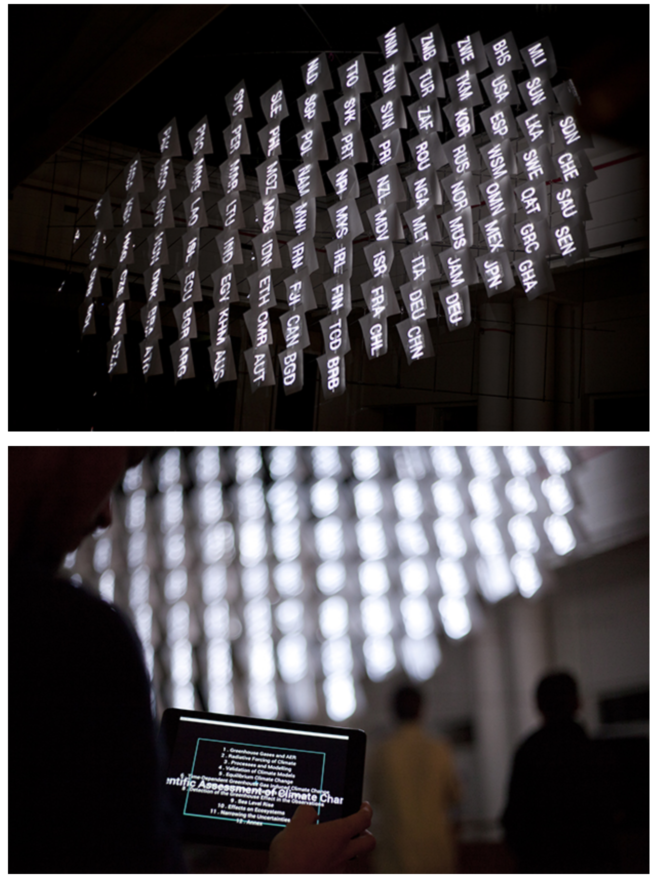

Figure 6: *Mobilisation*: flags (above), and mobile application (below)
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typography laid out in a three-dimensional space. The information revealed by the interactions varies according to the data available in the IPCC database (report, role, participation chapter, working group, etc.). By seizing this information and adopting a country's perspective, the interactions of the participant on the mobile device are reproduced in real time on the corresponding flag to be seen by all. Each participant thus momentary becomes a representative of the chosen country.

Caught between the actions of the participants and the slightest air movements, the information attempts to mobilize us through an uncommon and collective aesthetic experience.

5.1 Topology of interactions

Collective organization. The individual interface on the mobile device of *Mobilization* is very rich, and the interaction requires a lot of perceptual-cognitive effort from the participant. Hence, when a person passes from the state of spectator to that of actor, her attention also shift from the shared interfaces to the individual interface. As a result, the active participants seem to act for the others, and are thus pushed to the fringes of the collective.

Apparatus and interfaces. This installation reveals a configuration that seems uncommon in co-located interactive systems: it maps each individual interface to a shared one. Consequently, the number of simultaneous participants is limited by the number of shared interfaces, the flags. In addition, the visual output of each shared interface is a replica of the corresponding individual interface's output.

5.2 Relational graph of interfaces

Fig. 7 outlines, by the parallel arrows, the direct correspondence between the individual and shared interfaces. It also indicates that the individual interfaces are input and output ones freely distributed in space and limited in number to 103, corresponding to the total number of shared output interfaces.

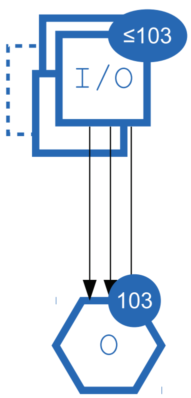

Figure 7: Relational graph of interfaces for *Mobilisation*

6 COLLECTIVE LOOPS

Collective Loops is a real-time collaborative musical 8-step loop sequencer developed as a prototype project for the *CoSiMa* [7] (Collaborative Situated Media) platform, in which several institutions and agencies are combining efforts to develop a software platform easing the creation of co-located collective interaction projects.

The loop sequencer is comprised of two user interfaces as illustrated in Fig. 8: (1) an individual interface used by each participant through their smartphone allowing them to alter the sound emitted from it, and (2) a shared, floor-projected, circular visualization (of approx. 3m in diameter) showing all participants' choices as well as the current position of the sequencer's reading head represented by a bright moving sector.

The latest version of this project supports up to 8 participants, one per time slot. A first touch interface on smartphones allows each newcomer to manually choose his time slot from the available ones. A second touch interface is then made accessible allowing the participant to alter the sound emitted from the smartphone by choosing notes from three instruments (percussion, bass, and melody). Multiple notes from each instrument can be activated by the same participant within certain predefined limits (3 out of 12 melody notes, 1 out 6 bass notes, and 3 out of 3 percussion notes). In addition, the intensity of the emitted sound can be controlled by inclining the device back or forth.

Figure 8: *Collective Loops*: floor projection (above), and mobile application (below)
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Through the specially distributed sounds and the floor-projected interface that makes participants' choices visible by all, the installation aims to promote the emergence of a collective and collaborative audio-visual experience.

6.1 Topology of interactions

Collective organization. Here, the collective organization is largely governed by the arrangement of the shared interface on the floor. Indeed, it predefines, to a large extent, the positions of the participants in the interactive space, and establishes the tempo of the mediated interactions. Additionally, the tight-loop arrangement encourages each participant to focus more on the choices and actions of his peers (especially the preceding one), and incites participants to work closely together to try to produce a coherent collective outcome.

Apparatus and interfaces. In contrast to *Mobilization*, the interfaces of *Collective Loops* were designed to set the focus of attention on the shared interface and encourage collaboration. This was achieved by minimizing the cognitive load needed for interacting with the individual interface on the mobile phones by making it as intuitive as possible, and displaying the user's selections on the shared floor projection in a manner that closely resembles the visual interface on the mobile devices. Thus, once a user becomes familiar enough with the individual interface, he can switch most of his attention to the shared display and the other users around him.

6.2 Relational graph of interfaces

The diagram in Fig. 9 indicates, by the upper symbol, that the individual input/output interfaces are in a looped queue, and that the system supports a maximum of 8 of those interfaces. It also specifies that there is only one shared interface, and that it is an output-only one. The one-way arrow signifies that the interaction data are not returned to the individual interfaces, and therefore the choices of the other participants are only visible on the collective floor projection.

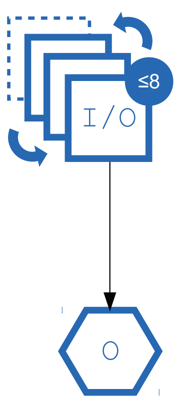

Figure 9: Relational graph of interfaces for *Collective Loops*

7 DISCUSSION

The topological diagrams, for which we have given here a first graphical attempt, can serve multiple purposes. Firstly, as a design tool and graphical programming language to help artists and designers in the development of installations that support co-located interaction and, hopefully, inspire the emergence of new and unexplored topological layouts. Secondly, as a visual taxonomic model that can allow the identification and classification of the topological layouts engaged in co-located interactive systems in order to expose and compare their properties, user experience peculiarities, and structural or design characteristics. And finally, as a visualization system, in a more simplified form, to offer the interacting public a real-time view of the system's state, and thus enabling them to construct a better mental image of the interactive environment, allowing them to more easily locate their own field of action within the collective.

With those reasons in mind, we are currently taking on the project of the development of those diagrams into a graphical modeling language (with a vocabulary, grammar and combinations) for the representation and analysis of the topologies of co-located collective interactions. We are, for example, considering extending the vocabulary of the language to include more precise information such as the interfaces' "attentional weight" (or the amount of perceptual-cognitive effort required from the user) as this aspect of interfaces can have an important impact on the collective organization as we could see with *Mobilisation*. We are also working on making the language more flexible to allow the representation of more peculiar setups such as the project *SMSlingshot* by Fischer et al. [4] in which the individual interface (a hand-held digital slingshot) is passed from hand to hand.

This work is being build on top of the authoring environment *Mobilizing.js* [1] developed by EnsadLab as a framework to create interactive artworks for mobile devices.

8 CONCLUSION

In this article, we have mainly tried to demonstrate that any artistic installation involving a co-located collective interaction essentially belongs to a dual configuration: on the one hand, *relational* in reference to what we call the *collective organization* relating to the structure of social and human relations invested in the interaction, and *material* on the other hand, relating to the *apparatus and interfaces* employed in the interactive system. Those two, undoubtedly complementary, axes form what we propose to call the *topological configuration of the interactions* (or simply the *topology of the interaction*); on the understanding that the quality and nature of the interaction (in conjunction with the nature and quality of the space itself) is equally determined by the type of relations of interest (pooling and convergence) guiding cooperation and collaboration between the participants, as well as the type of digital interfaces available to them.

Therefore, we hypothesize that art installations must be studied (in their design, implementation, and user experience) according to those two combined notions. In other words, approaching, analyzing or viewing the works from a *topological structure of interaction* standpoint would enable us to read and understand, with greater acuity, what governs, determines and conditions the engagement of the public in a situation of cooperation, and what is played out from the point of view of the aesthetic experience.

Building on the analysis of some of our recent achievements (in the form of a case study), we could see that such installations generally involve simultaneously three modes of attention for the public: H/M via the individualized interfaces, H/H in allusion to the inter-individual relations, and H/M/H through shared digital mediation bringing people together. As we have recalled in this article, the participation and cooperation of the public in an artistic context is often not "directed" or, more precisely, not subject to the achievement of a preannounced objective, other than that of sharing an aesthetic experience that is to be constructed by the public and experienced collectively and in which individual action (by way of the individual devices) must be thought of at the same

[1] http://www.mobilizing-js.net/

time as an initiator, an accelerator and a catalyst of the collective interaction.

Consequently, there cannot and should not be designed a modeling system for such installations that is based on a specific pre-assignment of tasks to participants. It can also hardly be drafted, a scenario of predicted "agreements" of collaboration between the public; such an undertaking would be just as futile as that of an architect who tries to foresee all plausible collective uses in a domestic environment. Thus, in order to take a global, objective and exhaustive view of the complex relational systems which emerge in such art installations, we argue that it is necessary to design topological diagrams of the interaction by crossing actions and interfaces.

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