

Design process for interactive sound installations: the designer, the interactor and the system

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ABSTRACT

In the design process of interactive sound walk art installation, the composer must think his sound design in a real or a virtual space according to the listener's promenade. For a given piece, the sound designer leaves to the interactor a certain amount of freedom and to the system, according to its level of self-sufficiency, a certain amount of autonomy. This paper presents an analysis of this fundamental composition choice between determinism, emergence and interactivity. In the first part, this problem is stated as the position of an art piece in the D.I.S. (Designer/Interactor/System) triangle. We analyze from this point of view several interactive pieces. The second part concerns mainly the design process of *The Listening Walker* scripted versions. This interactive sound walk relies on the technology and the design principle of video games. In the scripting style, the designer takes the point of view of the interactor, who becomes the narrator. We conclude by an introduction to the second version of the same piece written according to the emergent style. In this case the designer takes the point of view of Non Player Characters controlled by the system.

Keywords : interaction, sound installation, video game,

1. INTRODUCTION

One of the authors of this paper has worked as a composer on numerous sound walk art installations. During the last decade, her work has been influenced by the design methods used in video games, leading to interactive pieces. In the design process of such pieces, as compared with interactive music works, the composer think his spatial sound design in a real or a virtual space according to the listener's promenade. Such an installation shows the evolution of the composer's role from a deterministic creation to a non-deterministic one. For a given piece, the composer leaves to the interactor a certain amount of freedom and to the system, according to its level of self-sufficiency, a certain amount of autonomy. According to these two parameters each art piece can be positioned somewhere within the triangle D.I.S. (Figure 1) which vertices are the Designer, the Interactor and the System.

Our main purpose is to analyze the goals and the needs of the designer of such interactive pieces, in terms of methodology and tools. We first analyzed a set of interactive pieces designed by musicians, visual artists and game designers. From this analysis, we determined a set of classification criteria in order to position these art works in the D.I.S. triangle.

A position in this triangle can be related to a choice between two writing styles, the "scripting style" and the "emergent style". In the scripting style, the designer takes the point of view of the interactor, who becomes the narrator. In the emergent style, the designer takes the point of view of Non Player Characters (N.P.C.).

For a deeper analysis, we have designed two versions of the same interactive sound installation *The Listening Walker*.

This paper is mainly devoted to the analysis of the design process of the scripted version according to a choosen position in the triangle. The design of the emergent version is briefly introduced in the conclusion, a full description of our work can be found in [1].

2. D.I.S. TRIANGLE

2.1 Components

We have placed the protagonists concerned - namely the designer, the interactor and the computer system (i.e. the agents in the virtual world) - equidistantly in relation to one another. As a first step we outline the following aspects relating to each of these three protagonists: their knowledge of the environment, their patterns of perception, their controls and intervention rules, and their

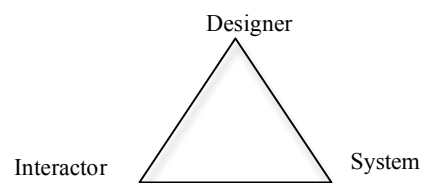


Figure 1. D.I.S. triangle

motivations.

2.1.1 The designer

We use here the word designer for an author such as a composer, a sound designer, or more generally a creator of a sound installation.

The designer in the triangle has a leadership position. He must choose the position of his work in the D.I.S triangle. Our work relies on the following hypothesis on the designer goals:

- His goal is to abandon linear writing towards a better distribution of the "narrative" between the designer, the interactor and the system.
- He wants also to maintain artistic consistency within such an open compositional proposal.
- From the designer point of view, the interactor is unpredictable. The Designer wants to let a part of the story to rely on his objectives, his decision-making, his personal perception and understanding of the sound space and, more generally, the surrounding world.

2.1.2 The interactor

Depending on the device and the interface offered, the interactor receives visual, auditory, tactile and, more rarely, olfactory information. We focus on listening and the understanding of space. We assume that the interactor discovers the environment in which he moves based principally on his auditory attention; control of the system and its rules are learnt through trial and error.

The interactor has many ways to take a decision. Decisions may be based on logic or they can be actions in response to the interactor's understanding of a situation. We start from the assumption that this is no set goal; rather the motivation is toward discovery of an "unknown", in every sense of the word.

2.1.3 The system

The interactor is not the only source of indeterminism in the execution of the piece. The computer system - by combinatorial developments, the use of hazards or any other generative technique - can make the execution of the sound piece to some degree unpredictable. Usually in generative artistic creation, such as in video game, the goal of artificial intelligence - and more broadly generative mechanisms - is to generate credible perceptive behavior. The Designer who is, in general, neither a specialist in artificial intelligence, nor a trained psychologist defines this role. It therefore seems reasonable to consider that the description of these components is mainly behavioral.

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2.2 Interactive art works analysis

2.2.1 Analysis criteria

We have selected a set of interactive art pieces in order to understand the position chosen by their designers within our D.I.S. triangle. To do this we have established a set of analysis criteria:

- Interactive or not: either the spectator is an interactor, his actions have a real impact on the piece execution or not.
- Endogenous or exogenous: in endogenous pieces the indeterminism is internal to the computer program while exogenous pieces behavior is, at least partly controlled by the interactor..
- Exploratory or ontological: in exploratory mode, the only ability of the interactor is to control his perception of the virtual world (camera and listening point) without influencing the simulation whereas in ontological mode, he interferes with the very existence of this world and can change its evolution.
- Emergent: evolution of a system from the interaction between agents in ways that are not completely controlled nor fully provided by the designer.
- Awareness or engagment: a conscious interactivity does not need the interactor to control rendering while engagment requires interactor control in learning the rules of interaction as in the case of video game. [14].

2.2.2 Selection criteria

The common point between all the presented pieces is the will of the designer to create an open form that can be perceived in many ways. They are all digital works. Some are based around navigation proposed to the public both with or without the opportunity to interact with the device. Some, due to autonomy granted by the designer to the computer system, are generative pieces. Others allow communication between the system and the public.

The privileged form is the installation, in the sense of a specific device proposed to the public. Technical and spatial complexity of these devices are variable, ranging from a computer screen with a keyboard to a system deploying in space several screens and a complex system of sound diffusion, or else to a soundwalk with headphones and sensors. A work in this form can be experienced either online or in real space. Some works can be considered as interactive writing systems or video games, others as sound installations taking after the world of video games. Some of them are sound pieces other are "silent" pieces.

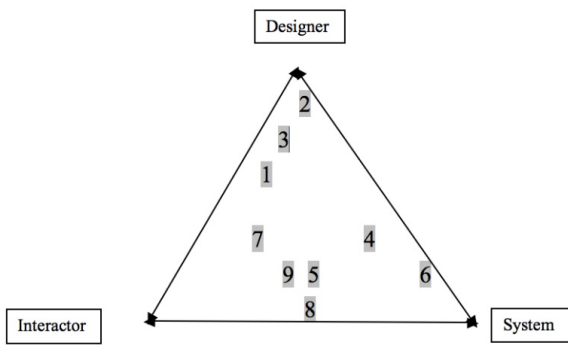


Figure 2. Positioning pieces in the triangle D.I.S. (1.*Portrait N°1*, L.Courchesne; 2.*Le passeur*, C. Le Prado; 3. *Vocatifs*, C.Le Prado; 4.*Le Jardin des hasards "Mutations"*, B. Gortais, G. Hutzler,Y. Orlarey; 5.*Le Jardin des hasards "Diversity"*, B.Gortais,G.Hutzler, T. Delor, M. Broilliar; 6.*Khorwa*, M. Malt; 7.*Listen Lisboa*, C. Le Prado; 8.*Façade*, M.Mateas, A.Stern, J.Grieve; 9. *Bandonéon*, X. Boissarie, R.Cahen, A.Schmitt)

From available informations in exhibition catalogs, scientific papers and other data from the web, in certain case our personal experience of the pieces, we deduced a value for each analysis criteria. We positioned each Art works within our D.I.S. triangle. This translates to a position on each of two axes (designer / interactor and designer / system) and, by deduction, a possible communication between interactor and system.

The art works, within which the designer gave both the interactor and the system a high degree of autonomy, are at the bottom of the triangle and equidistant between interactor and system.

Works with exogenous interactivity may solicit different types of attitude and consciousness from the interactor. For example, *Le passeur* [2] and *Mutations* [3], both require a limited awareness of the actions of the interactor. The first piece does not solicit the system during its exhibition, while the second piece focuses on it. *Listen Lisboa* [4] and *Bandonéon* [5] share the fact that they both invite visitors to engage in interactive exploration, being aware of their actions on the evolution of audio and visuals, but with no real need to control it.

Portrait # 1 [6] or *Vocatives*[7] lie on the boundary between exploratory or ontological invitations for the interactor.

Khorwa [8], through the autonomy and internal interaction between agents of the system, has points in common with *Façade*[9], *Mutations* and *Diversity* [10]. However *Khorwa* is the only piece that does not require any interaction from the listener. *Façade* is a narrative piece; *Diversity* is more formal. In *Façade*, the designers began by giving a great autonomy to the interactor and agents. Then to control the drama while retaining autonomy, they added a Drama Manager. For *Diversity*, the process was the reverse. Designers, after several art works in which the role of the interactor was almost nonexistent alongside a very autonomous system ("*Quel temps fait-il au Caplan*", "*Le jardin des hasards*"), added the ability for the interactor to communicate with

autonomous agents. An interactive mat allows the interactor to influence the behaviour of the system and the audio-visual evolution.

Through this analysis we observe the difficulty in defining a unique position for each piece while at the same time the value of this ambiguity. Indeed, between the intentions of the designer on an open, scalable implementation, the possible autonomy given to the system or the interactor, and the shape of the resulting work (the type of interactivity on offer, the awareness or commitment sought from the interactor), there are many possible branches half-way between control and autonomy. In the next paragraph, we express this problem in terms of writing style.

2.3 Two writing styles

"A form is aesthetically valid precisely to the extent that it can be seen and understood from multiple perspectives, when it exhibits a wide variety of aspects and resonances without ever ceasing to be itself." Umberto Eco [11]

It seems to us important to comprehend the implications upon design and realization that result from choosing a position within this triangle. To analyze this, we designed and developed two versions of the same piece (*The listening walker*). These two versions are distinguished by their writing style. One is written in a style we are calling "scripted": an interactive narrative structure in a controlled in space and time. The other is written in the style we are calling "emergent": in this case, the meaning of the play and its narration emerge from multiple possible interactions between the interactor and the system.

This work relies on the two following concepts:

- To let this unpredictability meaningful for both the interactor and the designer, we assume that the emergent property is beared by characters, which behaviors are defined by the designer and can be understood by the interactor. According to the game terminology, we call thereafter Non Player Characters (N.P.C.). According to the AI terminology, they also can be considered as agent. Their decisions and actions abilities can be purely reactive but also depend on a memory of previous steps [Wo02]. The spatial extent of knowledge, perception and memory of their environment is not fixed a priori.
- Then, in order to design the two versions of the "Listening Walker", we stated, as a working hypothesis, that the designer can take the place of one of the two other protagonists in the DIS triangle. He may take the point of view of the interactor to build all the possible itineraries and stories that can be experienced by the interactor. In the opposite, he can also write his piece from the perspective of N.P.C., and describe a virtual world in which the interactor will evolve.

2.3.1 The Scripting Style

An interactive narration is written according to the scripting style if the designer takes the interactor's point of view. He is the narrator of an interactive scenario, written using a procedural form. The rules are contextual and related to a relative chronological order determined by the path the interactor follows. In other words, any variability inside the narration is linked to the interactor's previous experience, and in particular, his trajectory. Each N.P.C.'s behavior is described in relation to this experience at a given point and time of the interactor's path. The scripted design writes the story from the interactor's point of view. It is the method used for most action adventure games. The universe and the events exist only when they have been or are perceived by the interactor. The interactor is the narrator and he holds in his memory the events involved in his narration.

2.3.2 The Emergent Style

An interactive narration is written according to the emergent style if the designer takes the point of view of the system through each N.P.C. An N.P.C. is a potential narrator. He has his own perception and memory, which influence his behavior, described in a generic (non contextual) way.

In the emergent approach, each N.P.C. has its own memories as a result of their perception system. The story is described with respect to what has been perceived and remembered by each actor (interactor and N.P.C.).

In both cases, it is possible, from a narrative point of view, to simulate a universal narrator who has the knowledge of events that no character has seen or heard.

3. THE LISTENING WALKER SCRIPTED STYLE VERSION

The Listening Walker is an art piece produced as part of the Terra Dynamica project, funded by the French Government. The purpose of this three years project, begun in 2010 and developed by a dozen of academic and industrial partners, is to bring life to Terra Numerica, a static virtual city. This virtual city (Paris in the experiment) is used for numerous applications from safety simulation to art installation [12].

The production of an Art Piece, the scripted version of *The Listening Walker*, using the Terra Dynamica technology, was one of the tasks assigned to the CNAM. The title comes from a book by Michel Chion [13]. The installation was created in Paris during the "Futur en Seine" festival in June 2013.

The goal of this sound walk is to discover a virtual district of Paris around the Pantheon. The interactor walks around this part of the city wearing headphones. The experimentation takes about ten minutes. This installation is designed as a video game with different levels of exploration. The interactor's reward is the discovery of the city mainly via sound. Success depends on his listening behavior: N.P.C. are moving around him, interpreting his moves, the direction he takes and the time spend listening particular sounds. Depending upon the listener's attitude, each N.P.C. has his own reaction such

as running away, getting closer to the listener, ignoring him or helping him to discover secret areas.

3.1 Sound design choices

The starting point of this project is the dynamic behavior of sound in space and the importance of the auditory attention that is aroused in the virtual city. In this first experiment, we classified the sounds according to the following roles:

- Landscape sounds: These are ambient sounds that contribute to the interactor's sense of immersion and the credibility of the scene in the case of some sounds. For example, the sounds of wind or traffic reposition the interactor in a familiar situation, physically experienced in a real city. Other sounds, more akin to urban drones, contribute to this immersion but in a way that is more abstract and perhaps less conscious.
- Clue sounds: These are very localized, with the goal of attracting the attention of the interactor's avatar and to induce him to move to a specific point in the city. These clue sounds disappear as soon as the avatar leaves a zone in which they are located. Clue Sounds are not tied to any fixed or animated visual entity. They exist only in the auditory space of the city map.
- Object sounds: These are attached to a visual object, generally also to its behavior (eg, the appearance of a building, speaking of a character). The object sounds show that the interactor's avatar has triggered an event such as the appearance of a building, a character or a sound - even while outside of the interactor's field of view - and draws his attention towards them.

At the beginning of the piece, the interactor starts almost in an empty black and white landscape. The city is revealed by way of outlines traced by its streets and buildings. The challenge to its quasi non-existence at the start of the interactor's experience is essential. The loss of visual cues encourages hearing acuity, and the gradual emergence of streets and buildings at once bolsters the walker in a known domain and spatially confines him in a way that is almost maze-like. This city, while at first invisible to the interactor, bears all of the spatial constraints that the interactor will meet thereafter. Although the streets and buildings are invisible, the locations of sounds, for example, are closely related to the city map.

3.2 Development process aspects of the scripted version

The scripted version was designed using a methodology strongly inspired by the level design of adventure games and the maze principle [14]. The interactor's avatar appears at a given initial point of an empty map. Invisible barriers and the associated triggers are placed according to possible paths of the interactor's avatar. The paths and the triggers are partially ordered to create sound events and the revelation of roads and buildings. Triggers are

also used to guide the interactor: they lead to sound events located in the space. N.P.C., according to scripted behavior, try to seduce or intrigue the interactor. As the city is progressively revealed, the path of the avatar becomes more and more constraint by the walls of the building. The story ends when the last trigger is activated, revealing the Pantheon.

The mapping between triggers, events and N.P.C.'s behavior is written using the graphical programming language of the CryEngine, the Flowgraph.

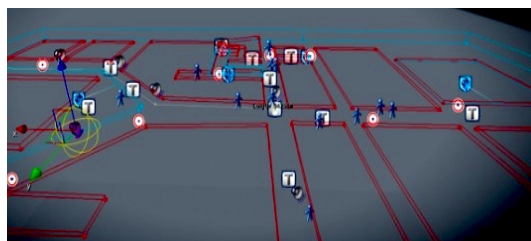


Figure 3. City 4 map in the CryEngine editor

Let us illustrate this method through the City 4 version of *The Listening Walker*. City 4 is a constrained itinerary in which the interactor, hearing a sound, starts from an empty space and gradually built the city. Invisible barriers are set up on the space, as interaction spots. They set off events when the interactor enters in their influence area. A trigger can set off a sound, create a new road or a new building. These triggers are also logically ordered. Some of them can only be activated if the interactor came across the previous ones. This logical scripting ensures that the events occur in a non-anarchic way and the consistency of the itinerary.

```
As the player appears at the intersection of rue Saint-Jacques
and rue Soufflot,
A sound hidden in rue Saint-Jacques 2 is activated;
When the player arrives over there,
A part of the urban outline of a district becomes visible;
(see FlowGraph/entities/FloorAppear:FloorSoufflotPantheon).
The sound of rue Saint-Jacques 2 deactivated
and a bass tone comes up rue d'Ulm;
An NPC - Le Chevalier - appears visually, read a text and
heads towards the back of the Pantheon following a given path;
If the player follows him, he triggers a sound moving around him;
If the player stays longer enough listening the moving sound,
two more sound entities are triggered;
If the player tries to catch them at the intersection
of rue Clotaire and place du Pantheon, they vanish;
NPC Bakal appears place du Pantheon, talking to himself.
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Figure 4. Example of City 4 map scripting

For each sound rendering entity (e.g. Fond vent.ogg), we have listed its trigger conditions (e.g. triggered at start-up), its playback mode (e.g. once), the stop conditions (e.g. "when the avatar passes through the St. Jacques trigger"), name of the associated flowgraph (e.g. "SoundDisappear: ZoneVentVille4"), geographic location of activation (e.g. the entire map), activity and attenuation zone (e.g. 0-150 meters), its spatial behavior (e.g. none), the noise level (e.g. constant) and the name of the entity in the CryEngine (eg Ambient volume + area shape).

Sound objects can either be linked either to a virtual actor, an area of the city, or a building behavior. They can also serve as a clue for the interactor's progress in the city.

The following is an example of a sound object's area of influence (Fig. 5). Within, the sound is audible with a possible attenuation cone from the center of the sphere, relative to the distance between the interactor and the position of the source of the sound.

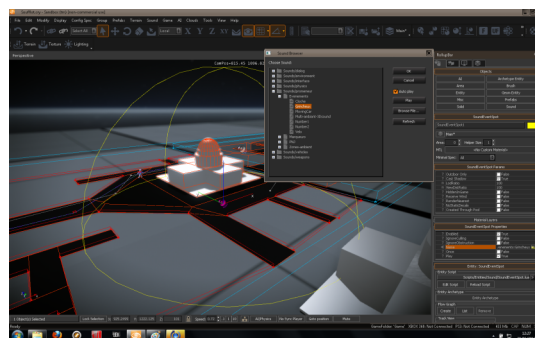


Figure 5. Ambient sound

Figure 6 shows the trajectory of a sound event triggered by the collision of the interactor with the trigger for this event. The sound is then activated in the space and follows a path between the red points positioned with the designer on the map.

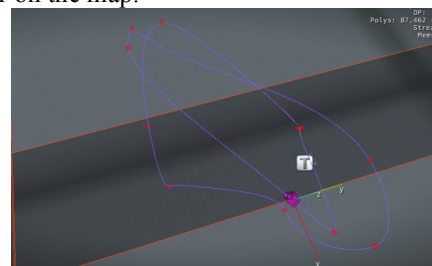


Figure 6. Ambient sound

4. CONCLUSIONS AND FUTURE WORKS

In this paper we set out, through the analysis of interactive art works, the different choices to set interactivity within the D.I.S. triangle. These give rise to more or less autonomy to interactor or to Non Player Characters. A design choice relates to two writing styles. The design and the development of the scripted writing style is illustrated by the first version of *The Listening Walker* installation. In this conclusion, we present first the design-in-progress of the aforementioned piece according to the emergent style. We then tie our observations to interviews we conducted with designers mainly about the role they want to assume in their art works. Finally we present our steps in our study on the design process of interactive sound walk installations.

4.1 Emergent version of The Listening Walker

Even if we used the same story, the same universe and the same technology as in its scripted version, the design of the emergent version of *The Listening Walker* is based on a completely different approach to the scripted one. The main principle used is that any action is decided and executed by an agent of the system, a Non Player Character. Every N.P.C. therefore has his own

perception, decision making and action system. His behavior relies only on those events that he has been able to observe and memorize. Each N.P.C. is the narrator of its own version of the story. The narration relies on a partition of the space into areas. An area is controlled by an invisible stationary N.P.C. Moving N.P.C.s are permitted to act within defined sectors of the map. These moving N.P.C.s have the same names and the same personalities as in the scripted version. Moreover, the empathy relationship between the interactor and a moving N.P.C. relies on the same ideas. The corresponding actions and rules, however, are non contextual. In the emergent writing style, the designer describes what N.P.C.s perceive and how they are perceived by other N.P.C.s and by the interactor. Rather than positioning triggers as an ordered sequence of steps, writing here involves the development of a decision-making system for agents.

The emergent version of *The Listening Walker* leads us to the use of automata in the CryEngine. The exploration of this engine has helped us to identify interesting possibilities for our own practice through the methods used in video games. Methodological implications of our work are derived from the dramatization of the space, the writing of rules of interaction and behavior for autonomous agents that combine procedural logic and object-oriented programming.

The entire design process of the emergent version and the description of our comparison between the two styles can be found in [1]. The outline of this conclusion: it is easier to write a story, even an interactive one, than to design a world. From an intellectual and even an artistic point of view, the possibilities opened up by the emergent style are very promising, though this way to conceptualize an artwork as a set of localized and dynamic pieces is a break with the common practice of music composers. The scripted style is still a much more comfortable way to design and develop an interactive sound walk.

4.2 Supplementary survey and interviews

Our analysis takes the point of view of the designer, and more specifically one of the authors of this paper. As a consequence, they cannot be directly generalized. We prepared an interview for seven well-known designers coming from various fields (Samuel Bianchini, Xavier Boissarie, Roland Cahen, Luc Courchesne, Jean-Marie Dallet, Mikhail Malt, Eric Viennot). The complete result of this study can be found in [1] and seems to confirm our conclusions. Here is a summary of our main reflections.

We have established a global assessment by linking our own observations, outlined in the previous paragraph, to interviews conducted with developers of interactive works. Our investigation takes as its starting point the role that the designer claims to perform. The survey then tries to clarify the different interests and approaches of the notion of interactive pieces according to each artist's point of view.

Our survey reveals some trends of thought common to almost all artists. The interest in the design of interactive art works is to commit the interactor, to establish a co-design relationship and a dialogue between the interactor and the art work. This results to bring to the interactor something of an aesthetic experience that can not exist without this relationship.

As an example, consider the following sentences of Eric Viennot, the game designer of *In Memoriam*, one of the first Alternate Reality Games:

"At a given time, as a designer, we are creating a universe where some emerging part of the story may appear. It is something that we did not really foresee. It is really interesting and I call it emergent narration ...

I like to master the time when the player feels a given emotion. I think that we must find in some way a mixed solution: too open works miss some artistic dimension."

From the point of view of designers of interactive art works, there is no antinomy between control and autonomy. This conclusion relies on several reasons: the designer remains the designer unless he resigns, the feeling of the interactor's engagement can be created even in strongly driven interactive pieces, autonomous systems produce interesting situations if the control parameters are precisely chosen and intelligible to the interactor. They also all agreed on the fact that the emergent style seems to be more interesting but certainly much more difficult than the scripted one.

In summary, adopting the point of view of the interactor or the system at the time of design changes the process, but does not change the role of the designer.

4.3 Future Works

The comparison of the two versions of the same piece introduced here takes only the point of view of the composer. Until now, only the scripted version has been exhibited. As the emergent version is currently in development, it will be possible, by conducting interviews with the public, to have also the point of view of the interactor. Of course the scope of the results is limited to this piece but it is probably a unique experiment, as the same piece is rarely developed twice. From our personal point of view, we assume the risk to feel insecure as a composer moving our way of thinking from time to space and from determinism to emergence and interactivity.

"It is when artists combine the computer's capabilities of real-time autonomy and reactivity that they achieve a deeper form of interactive art. By making the computer listen to the audience (the first half of reactivity), think about what it heard (autonomy), and then speak its thoughts back to the audience (the second half of reactivity), the artwork can have a dialog, a conversation, with the audience. (By "speaking" and "conversation" I mean some sort of meaningful communication, not necessarily literal speech.) Interactivity is the cycle where both the artwork and the audience listen, think and speak to each other."

Andrew Stern [15]

Acknowledgments

Pierre-Henri Cubaud, Katharine Neil, Lubna Odeh

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