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# Research Methods – What is Best for Developing and Evaluating Human Computer Interaction and Interactive Artistic Installations?

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**Abstract.** Research in human computer interaction (HCI) covers both technological and human behavioral concerns. As a consequence, the contributions made in HCI research tend to be aware to either engineering or the social sciences. In HCI the purpose of practical research contributions is to reveal unknown insights about human behavior and its relationship to technology. Practical research methods normally used in HCI include formal experiments, field experiments, field studies, interviews, focus groups, surveys, usability tests, case studies, diary studies, ethnography, contextual inquiry, experience sampling, and automated data collection. In this paper, we report on our experience using developing and evaluation methods to assess artifacts. Four defined outputs (projects) were examples of the different methods application to gather information about user's wants, habits, practices, concerns and preferences. An interactive artistic installation, Sea Grains – an immersive poetics in interactive artistic experience, is another example of the use of research methods for development and evaluation of artifacts. The goal was to build an understanding of the attitudes and satisfaction of the people who might interact with those artifacts. Conversely, we intend to present a framework design to be applied on the design for interactive applications, to promote better user's experiences.

**Keywords:** human computer interaction, mixed methods, human work interaction design, interactive artistic installations, framework for interactive artistic installation's evaluation

## 1 Introduction

Practical research methods normally used in HCI include formal experiments, field experiments, field studies, interviews, focus groups, surveys, usability tests, case studies, diary studies, ethnography, contextual inquiry, experience sampling, and automated data collection.

This paper reports authors' experience using the evaluation methods focus groups, surveys and interviews and how they were adopted to develop artifacts: either interface's design or information and technological systems. Conversely, the use of research methods on interactive experience with an interactive artistic installation is presented. What makes the challenge greater for interactive art installations is that

they often deal with evaluation of easier perceptions. Inflexible usability evaluation methods may fall short of measuring the successful or unsuccessful outcome of an interactive activity that is supposed to have an artistic effect on the participant. It is not easy to adapt HCI methods to an artistic context [1]. Instead methods inspired by HCI for understanding usability issues that might be part of the experience of interacting with an art piece should be used.

In this paper it is considered that HCI can support with the methods for evaluation at the development phase and mixed methods should be used along the whole design process to evaluate the easier perceptions.

The paper is structured as follows: section two – describes the considered research methods for evaluation, which comprises the methods in HCI, user centered design and mixed methods. Finally, research methods for interactive artistic installations are listed. Section three – presents a summary about the developed artifacts and the methods applied in those artifacts. Section four - contains the results and discussion highlighting human work interaction design approach and a framework for interactive artistic installations' evaluation. Lastly, some tips are presented on the conclusion.

## **2 The Use of Research Methods for Evaluation**

This section presents the concepts and approaches used by the author to get and analyze data obtained from the development of artifacts and artistic installations. The focus was on user-centered design, focus groups, surveys, interviews, observation, prototyping and other methods used in artistic installations. Despite considering that participatory design (PD) is a research method it is out of the scope of this paper to deeply considering it. Authors can inform that PD was handled since all the stakeholders were involved during the design process as active participants. The methods used in HCI and in interactive artistic installations are presented.

### **2.1 Methods in HCI**

Human computer-interaction (HCI) focuses on the investigation about relationships between computer technology, human activity, and society. Various methods and tools are being applied within organizations to improve the understanding of user task requirements to support the design process and evaluation. HCI is a multidisciplinary field, which justifies the use of all the social sciences evaluation methods, as well as, some engineering and medical research methods.

Qualitative methods of research permitted to get data related with user's motivations, expectations, and behaviors. Questions are asked, notes registered. "we tend to project our own rationalizations and beliefs onto the actions and beliefs of others"[2].

The use of different research methods on the development of artifacts, services and systems that improve people's lives, and that in particularly, engage and amuse people, i.e. that give positive experiences on people are reported. During the design process: design, creation, and evaluation developers/artists use different research

methods. Authors focus on user centered design approach method and on mixed methods.

### **2.2.1 User Centered Design**

There are some techniques, described by design research, which explains how to add context and insight to the design process. These techniques are known as user research. The design research included the careful analysis of findings, turning them this way and that, looking for patterns [3]. The tools of design research are both quantitative and qualitative methods. However, most design research is qualitative, not quantitative.

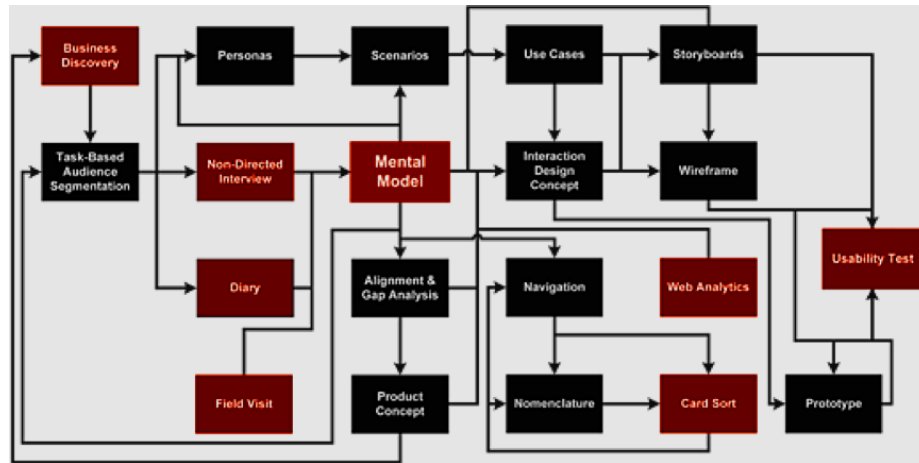
User centered design is a multidisciplinary design approach based on the active participation of users to improve the understanding of user and task requirements, and the iteration of design and evaluation [4], [5]. The user centered design methods most used are: field study, user requirements, iterative design, usability evaluation, task analysis, focus groups, formal heuristics evaluation, user interviews, prototype without user testing, surveys, informal expert review, card sorting, participatory design [6].

Figure 1 provides an overview of user-centered design techniques [7]. The research activities are task-based audience segmentation, personas, scenarios, use cases, storyboards, wireframes, interaction design concept (...) and prototype.

The design team is responsible for the analysis of user research. The projecting analysis techniques include the design of personas, mental models, storyboards, etc.

Various methods and tools are being used within organizations to improve the understanding of user task requirements to support the design process and evaluation.

One of the key characteristics of Interaction Design process is the need to focus on users [8]. User involvement from an early phase of design process is beneficial because it can increase user acceptance of a product. Within interaction design perspective, observation of users will help the designers to focus on users and their needs.



**Figure 1 – User Centered Design Techniques [7]**

Design techniques have been used to obtain information about the subjects and their environment: Users' background or experiences and the specificities of the user and/or environment [7].

Prototyping is a method common to HCI and to user-centered design to elicit information from users. One example of prototype usage is the technology probe - a high-end prototype that is used in its real intended environment over an extended period of time. Technology probe had been used to successfully collect data about user experience in the real world setting and as a tool to test the engineering aspect of a product [9].

### 2.2.2 Mixed Methods

The use of mixed methods research applied to human computer interaction field is generally used when we consider both quantitative and qualitative techniques [10]. Mixed research deals with compatibility and pragmatism [11]. The idea is that quantitative and qualitative methods are compatible and pragmatism meaning "researchers should use the approach or mixture of approaches that works the best in a real world situation".

Qualitative research is more subjective, based on smaller, targeted sample sizes, and is concerned more with how and why questions [12]. Quantitative research, on the other hand, is often about large, random, statistically significant sample sizes and is designed to answer what questions. The quantitative methods permitted to obtain numerical data concerning, for example, in general, the number of prospective users for our applications, the number of those that were used with similar applications, the tendency of use, etc. Both qualitative and quantitative research, in combination, provided a better understanding of the research problem. Although, mixed methods research is generally concerned with the combination of quantitative and qualitative

methods, authors present the paradigm of mixing almost qualitative methods. The methods may be a mix of qualitative methods [13]. Table 1 presents examples of mixed research methods used in HCI and in user-centered design approach.

**Table 1 - Research Methods**

HCI	User Centered Design
Formal Experiments Field experiments Field studies Interviews Focus groups Surveys Usability tests Case studies Diary studies Ethnography Contextual inquiry Experience sampling Automated data collection	Field study User requirements Iterative design Usability evaluation Task analysis Focus groups Formal heuristics evaluation User interviews Prototype Surveys Informal expert review Card sorting Participatory design

There are other research methods used to evaluate artifacts: Delphi technique (is a focus group method that is usually used to gain consensus on a particular issue and is used for gathering data from participants within their domain of expertise), nominal group technique, which prevents the discussion being dominated by one person whilst at the same time encourage passive members to engage and speak out [14]. Performance ethnography is a descriptor for per formative methods. It must be seen as stories to open space between analysis and action [15].

Another research method found in literature is narrative thinking – the narrative thinking (NT) process organizes thoughts temporally. NT is a distinct way of understanding, which came from the work of feminist researches where participant voices and marginalized stories are included [14]. Barone [16] Elbaz [17], Clandinin and Connelly [18] among others, used this narrative form of meaning making. Narrative work is a methodological bridge between thematic and arts-based research.

## 2.2 Research Methods in Interactive Artistic Installations

Interactive artistic installations overlap with other data collection methods such as photography and digital approaches. Installations can be static and situated pieces or can be other forms when participants become part of the installation. An interesting

method for participants' interaction is Collage. Collage is a method that requests participants to reflect and communicate based on, for example, the juxtaposition of different materials such as pictures, artifacts, natural objects, words, phrases, textiles, sounds and stories [19]. This method allows constructing meaning about the research questions and the process, the participants and other themes.

Collage portraits in qualitative research and analysis [20]. Portraiture is a method of documentation, analysis, and narrative development that uses a variety of mediums including photography [21], poetry [22, 23], jazz [24], performance [25] and visual art [26, 27, 28]. The goal of Gerstenblatt [20] was to encourage a range of linguistic and non-linguistic representations to articulate authentic lived experiences.

Heinrich [29] used a circular method (or cybernetic) process, consisting of firstly theory formation as a discursive process that questions and re-describes already existing theories on beauty, and secondly the validation of her theoretical findings by means of observation and analysis of interactive artifacts by various artists as well as own artistic experiences.

Reflective writing method makes part of field notes, which involves record of behaviors and events. It comprises date, time, location and details of what or who is being observed.

Digital storytelling refers to a two to five-minute audio-visual clip combining photographs, voice-over narration, and other audio [30] among other fields it is applied for an arts-based research method [31].

Table 2 summarizes the main methods used, according to literature, for interactive artistic installation evaluation.

**Table 2 - Research methods in Interactive Artistic Installations**

<b>Methods</b>	<b>Other Medium</b>
Collage portraits	Photography, poetry, jazz, performance, visual art
Circular method	Theory formation, validation of theoretical findings (observation)
Reflective writing method	Field notes, record of behaviors and events
Digital story telling	Combination of photographs, voice-over narration, other audio

### 3 The Developed Artifacts

In this paper four examples of digital application's development using mixed methods are described. 1. A Framework for e-government, 2. Frameworks used by Information Technologies Companies, 3. User centered healthcare design project, and

4. Learning Tool for Musicians [32]. Complementarily, an interactive artistic installation is described [33].

The description of each output is, from now on referred as project. The main goal of project 1 was to understand how information systems of different social centers for the elderly were aggregated. And how to improve the quality of operations and services, as well as, the interaction process of the collection, requirements and information system aligned with those of the social centers for elderly.

The goal of project 2 was to study the impact of frameworks use in Information Technologies companies.

The goal of project 3 was the quality improvement of information flow and the design of interactive application.

For project 4 the concern was to develop a technological application for musicians that solve some of the encountered problems on other available systems.

The methods applied on the developed projects were focus groups, surveys and interviews for conducting user research, since they are suitable for answering questions about what, why or how to fix a problem and they are methods to collect data to enrich different interface and systems design and development. These methods permitted categorizing attitudes and providing a view of what people think about the interface/application in development.

**Focus groups** are a method to explore opinions about a specific product and topics. They were used on the application for musicians (project 4) and on the project about the elderly center (project 1). In the field of human computer interaction, they are used to explore user perspectives on systems and their usability. However, focus groups tend to be less useful for usability purposes, for a variety of reasons, but it provides a top-of-mind view of what people think about a brand or product concept in a group setting. This method was a prevailing tool for the systems development; nevertheless it was not the only source of information to get data about the user behavior and to discover what they wanted from the systems.

**Surveys** represent one of the most common types of quantitative research. Survey sampling is particularly useful when the population of interest is very large or dispersed across a large geographic area. Survey research is widely used in human-computer interaction (HCI) to measure users' attitudes and collect product feedback. Online surveys was conducted to gather feedback about a learning tool proposal (project 4) and to measure user's satisfaction about framework's use. In survey research, the researcher selects a sample of respondents from a population and directs a standardized questionnaire to them. Questionnaires and surveys are complementary tools: A questionnaire is a research tool that uses questions in the gathering of information from different respondents while a survey is the systematic collection of information from different individuals. Also, a questionnaire is a survey tool while a survey is the process of using questionnaires to gather information. A survey is broad while a questionnaire is a specific type of gathering information. The questionnaire, or survey, can be a written document that is completed by the person being surveyed, an online questionnaire, a face-to-face interview, or a telephone interview. On the experiments carried out the goals of the conducted surveys were the measurement and categorization of attitudes or the collection of self-reported data that could help track or discover important issues to address on the application or interface development.



**Interviews** permitted, by asking questions that explore a wide range of concerns about a problem, to give interviewees the freedom to provide detailed responses. Interviews were used in almost any phase of the project, from initial exploration to requirements gathering, evaluation of prototypes, and summative evaluation of completed interfaces/systems. Interviews were applied in all the projects. In some case, interviews followed the survey to complement the gathered data. When the interviews were concluded a new phase arose, the data transcription and analysis. From that moment, different codes were defined to give rise to several categories. This analysis process was made with other spreadsheet and from there charts and diagrams were constructed. In one of the projects (musical learning instrument) additional questions complemented those included on the survey.

SandBox is an interactive artistic installation that, by means of poetic immersion, (re) presents life stories, scenarios or simply moments lived from the representation of that place: the sea [33]. In this work a combination of several qualitative methods was used: questionnaires, interviews and observation. Questionnaires and interviews were used before the prototype development phase, and along the interaction process between the whole interactions and the interactive installation. The interviews allowed to explore several problems we had and to get users' information, which was used, on the installation.

The presented methods were used either for conducting the design process or for the artifact's evaluation. The next section contains an explanation about this subject.

## **4 Results and Discussion**

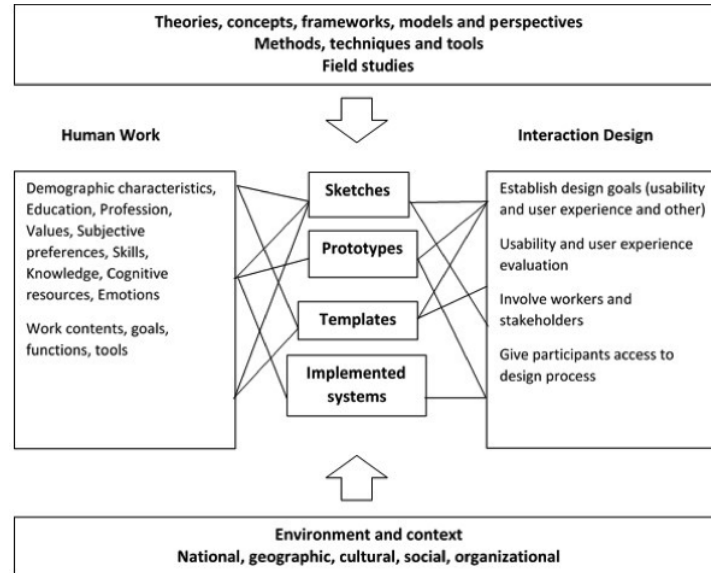
This section presents the author criticism about the research methods used on the artifacts design and artistic installation. Human work interaction design framework is introduced as a kind of research method to be considered on HCI. Conversely, authors propose the use of mixed methods approach as, according to literature, the more complete one to evaluate a diversity of artifacts.

### **4.1 Human Work Interaction Design**

HWID includes the study of how to understand, conceptualize, and design for the complex and emergent contexts in which HCI and work are entangled. HWID aims to increase the benefit derived from elements from both interaction design and work analysis knowledge, such as work analysis, prototyping, organizational change, computer-supported cooperative work, human-computer interaction, and participatory design, by interrelating them and capitalizing on their individual concepts and empirical instruments [34, 35].

Secondly, it aims to develop a new and harmonized interdisciplinary framework for trans-mediated and smart workplaces that addresses the core challenge: how do you take a balanced and holistic design approach to improve the work experience in the organization? It aims to engage with and learn from partners' research in different work domains when identifying key attributes in the effective trans-mediation of

pervasive and smart technologies from one work domain to another. Figure 2 shows the HWID framework used for data gathering and analysis for the developed artifacts.



**Figure 2 - HWID Framework [ ]**

Human work analysis is traditionally focused on user goals, user requirements, task and procedures, human factors, cognitive and physical processes, and contexts (organizational, social, and cultural). Today, generic designs are applied to use-situations with very different purposes, as the same social software or games are used for both work and leisure situations. Thus, design shifts from design of a technology to design of various use situations encompassing the same technological design. There are other frameworks and tools to design and evaluate artifacts. For example, Norman model of interaction [36] provides a framework for examining interaction. The model concentrates on user's view of the interface. The model is also known as model of human action. It identifies processes involved in action, but does not specify how they take place. It is a useful tool for thinking and analysis.

Authors consider that this model and the overall approach are interesting to apply on the development of artifacts. It contains the guidelines to obtain and to analyze data. This framework was used on the artifacts examples described in this paper.

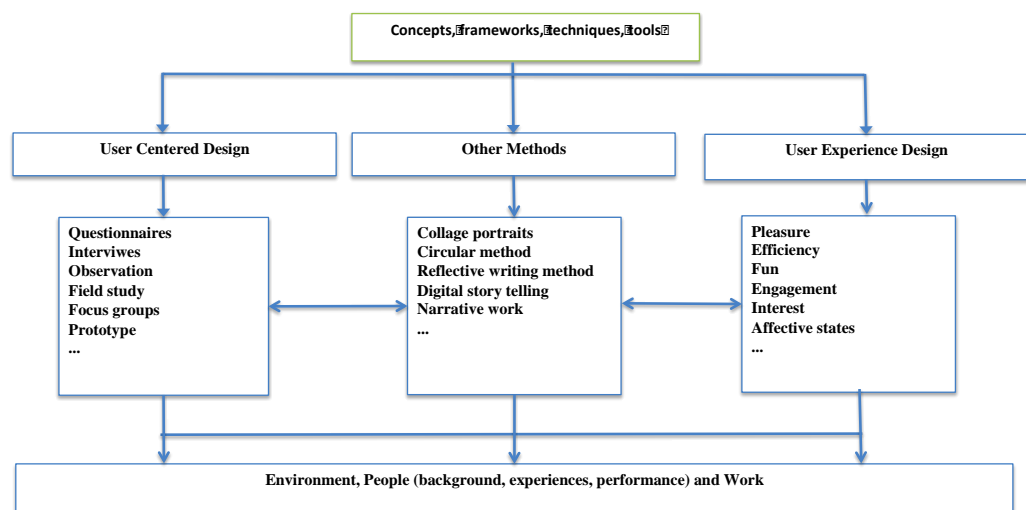
#### 4.2 Framework for Interactive Artistic Installation's Evaluation

Evaluation, in some sense, of an interactive system in action is the only way to understand its full dimensions [37]. The main feature an artist wants to evaluate is a range of aspects of the interactive artistic installation and its exhibition including the audience experience of the work and their involvement in research.

Authors propose the use of mixed methods for interactive artistic evaluation. These methods are the same used for data gathering and development of which the

questionnaire survey format is the most common. Evaluation is done mainly through general questionnaires, which helps to provide feedback for the artist to measure success in terms of audience attendance and general attitudes. Several forms can be used: log-data, video footages, interviews, and questionnaires for example. This data allows to identify the factors that raised the engagement and to understand how participants appropriated the interactive artistic installation, as well as, how they behave.

The proposed framework to evaluate the interactions and acceptance of an interactive artistic installation is presented on figure 3.



**Figure 3 - Framework for Interactive Artistic Installation**

The framework contains the main information about context and environment from HWID framework and the mixed methods from HCI, user-centered design, interactive artistic installations methods and from user experience design approach.

The main aspects of the user experiences are: pleasure, engagement, fun, interest, and other affective states revealed by the user. These aspects can be observed in several ways or evaluated by mixed methods. However, the user's role is very important: if he/she interact or not with an installation providing us a feedback to start the affective reaction's analysis.

#### 4.3 Critical Appraisal

The choice for the best method to use in HCI or, specifically, in the development of artistic installations, is a tough decision with different implications.

The discussion along the paper about research methods was presented in distinctive levels: different research methods used in HCI were described, according to literature; then, within this bracket a specific approach of design was explained together with the methods, normally applied to evaluate outputs; moreover, examples of developed artifacts were settled to reach the point that the same or different methods, for example, qualitative ones, can be applied independently of the artifact either to develop or evaluate it; finally, other methods for design were presented.

To clarify this endless discussion, it is necessary to focus on the following arguments: first of all, it is important to decide when to choose a method; is it to be used for helping the design process or for the output evaluation (user using the artifact)? Then, the following question must be answered: why is evaluation needed in HCI, or specifically in digital art? Starting from the end, author considers that evaluation produces information about user reaction to design (positive or negative emotions), validation and alternatives in design ideas. Also, evaluation makes part of the iterative design process.

In this discussion the focus is on the design stage and the designer and developer. The design stage comprises several moments: before, during and after the outcome. On the first stage, developers are focused on the context and requirements; on the second stage, the goal is to evaluate the choices of design ideas, the representations and the user reactions to design; the final stage is the moment for the revisions and to test the user performance. The evaluation serves as a critique either for the developer or for the user. When the focus is merely on a digital artistic artifact, side by side with the design process, the user/audience interaction is a very important source of information. The practice is similar to other forms of research but it requires thinking about how to design and implement the technologies involved and research about understanding how audiences respond to the interactive experience. The degree of audience engagement with the interactive installation is an essential clue to register, not merely by how long people look at an artifact, but how they sustain the interaction and the level of engagement: the overall behavior. To register this data, observation method is the main one to be used, although it can be combined with other methods in order to obtain substantial information.

The choice for a correct and unique method does not exist. The reason is because each method offers possible opportunities, not available by other means and also, each method has weaknesses and strengths. So, mixed methods research is the suggested solution since it comprises different and complementary methods. However, the focus about what and why to evaluate must be defined. Moreover, within the mixed methods approach and after considering the user-defined profile, the choice must contemplate those that permit to include tools inherent to the design for all.

## **Conclusion**

Author considers that the suitable approach for interactive artistic installations should be a mixed method approach to evaluate the easier perceptions.

HCI can support with the methods for evaluation at the beginning, during and after the developed output.

The interactive artistic installation's area is under development and there still is a lack of common practices, considering research evaluation methods compared to areas that deal with more traditional HCI. The main reason is probably on the dichotomy between objectivity and subjectivity. In artistic installations field the experiences are fundamentally subjective. They are evaluated as they are installed in real world situations – implicating that evaluation is carried out when user receives the implemented installation. Evaluation in the field should be inspired by HCI for understanding usability issues that might be part of the experience of interacting with an artistic installation.

HWID framework can help to sustain the theories applied and to organize the design structure of the interactive artistic installations. Both mixed methods in HCI and the HWID framework can be combined on the proposed framework for interactive artistic installations evaluation. This framework is under construction. Authors are testing it among artists and technologists who are developing artifacts.

The presented examples of research methods given in this paper are examples being adopted by the author but they are by no means exhaustive. They are intended only as examples, which begin to demonstrate a growing confidence in the use of different research methods in HCI in general, and in specific in interactive artistic installations.

In summary, the best method to use depends, firstly, on what the developers want to get. Design with or design for users/audience. If they want an interactive artistic installation centered on the user, which means that the user is involved from the beginning of the design process. Or if the goal is to register the affects, i.e., the audience experience with the work. The chosen method must help to answer the question settled at the beginning of the design process.

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