Project and Focus-Specific Definitions of Interactive, Experiential, and Dynamic Systems
Literature Survey and Discussion

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Introduction

This research assistant project is being conducted in response to a call brought forward by the Terminology Cross-Domain Research Team at Workshop #3 (Los Angeles, September 2002) for project-specific definitions of **dynamic**, **experiential**, and **interactive systems** and **records**, which are to be included in the InterPARES 2 Glossary. Given their centrality to InterPARES 2, it is fundamental that definitions for the above terms that distinctly reflect the Project's focus and context be established. To date, working definitions relating to the above terms have been provided in the detailed proposal which was submitted to SSHRC. These definitions include the following:

- **Experiential Digital Objects** – "objects whose essence goes beyond the bits that constitute the object to incorporate the behavior of the rendering system, or at least the interaction between the object and the rendering system" (Lynch, 2000).
- **Interactive System** – "is one in which each user entry causes a response from or an action by the system" (IEEE, 1997).
- **Dynamic documents** – "documents that are dependent upon data that might have variable instantiations and be held in databases and spreadsheets" (Ross, 2000).[1]

The above definitions provide a starting point from which to build those for use in the Glossary. In addition, it was suggested at Workshop #3 that given the cross-focus nature of this project, multiple definitions of the same term may be included. Accordingly, bodies of literature representing the three Focus groupings (Artistic Activities, Scientific Activities, and Government Activities), should be explored in order to identify focus-specific definitions of terms to be included in the Glossary. Finally, in

[1] Taken from: Duranti, Luciana. *International Research on Permanent Authentic Records in Electronic Systems (InterPARES): Experiential, Interactive and Dynamic Records*, *Detailed Description.* 2001: 1.1-3.

order to adequately define dynamic, experiential and interactive records, one must logically first define the systems[2] in which they are created. Because of this, the focus of this paper is solely upon systems, with the expectation that records-focused definitions will be sought at a later time. As such, the goal of this paper is to assist the Terminology Cross-Domain Research Team in its efforts to define dynamic, experiential and interactive systems by identifying relevant definitions and/or meanings as they are expressed within literature pertaining to each of the Focus groups.

Project Design

For the purpose of this project, a survey was conducted of primarily academic literature that both focused on one or more of the above systems and was specific to either the Arts (including the fine, literary and performing arts, as well as musical composition) or Sciences (including physical and applied sciences). Literature corresponding to the third Focus Group – Government Activities, was not explored as this is currently being addressed within another research assistant project. In addition, relevant materials from within the computer science field were also consulted in order to gain helpful background or contextual information, or any historically important definitions of our terms. After an extensive search was conducted, the chosen articles, conference proceedings, books, etc., were reviewed and pertinent information regarding the meaning of our terms was then recorded in order to form the basis of this paper.

It is important to note that few explicit definitions for our terms were provided within the literature. As such, their meanings need to be drawn by inference from examples provided in the readings, contextual information, etc. While it was found that the term "interactive system" occurs repeatedly in the survey materials, the term "dynamic system" occurs much less frequently and the exact term "experiential system" could not be found at all. In fact, dynamic or experiential components were most often discussed as part of interactive systems; a tendency in the literature that is reflected in this paper, and which will be addressed directly in the discussion section. What follows is a summary of the definitions and/or meanings of each of our terms as found within the

[2] Within the context of this paper, a system refers to "the entire computer system, including input/output devices, the supervisor program or operating system and possibly other software." (Howe, 2002)

three types of literature, as well as a discussion of what these findings may mean in relation to the task of finding Project and Focus specific definitions for the InterPARES 2 Glossary.

Definitions and meanings within Computer Science

It is helpful to begin this discussion by considering the definitions which are provided for our terms within the field which first conceived of and developed these systems. "Interactive systems" are hardly a new concept within the computer sciences, as they have been in existence for almost thirty years. In fact, the term "interactive" was first used in reference to computers to describe the function of being able to interrupt a computer run (Saul, 1999, 5). In this instance, a high speed tape which was fed into the machine could be altered while the machine was running. This was an important improvement from the previously used punch cards, which were not alterable once fed to the machine.

In a sense, computer scientists have always been driven by the challenge of enhancing user control and naturalness in the human-computer relationship. Accordingly, topics surrounding issues of interactivity have been present in the literature for some time. For example, in a 1977 publication entitled *Behavioral Issues in the Use of Interactive Systems*, authors L.A. Miller and J.C. Thomas discuss interactive systems and their related user behavioral issues. Within this paper, interactive features in computer systems include such capabilities as: prompting and defaults within commands, text editing, querying files or catalogues, data and file manipulation, and time sharing. This paper also discusses such possible "future" interactive capabilities as distributed interactive work in real-time. These features are now much taken for granted, and are hardly thought of when we think of the word "interactive." They are, nonetheless, interactive features of computer systems, and point to the fact that most computer systems today are, in fact, interactive systems.

Definitions of interactive systems or interactivity appear to have changed little since the "early days" of computer science, most of which are more or less similar to the definition which was provided (also from within this field) in the InterPARES 2 proposal. You will recall that this definition states that an interactive system "is one in which each

user entry causes a response from or an action by the system." While somewhat simpler, it is essentially consistent with the following one which is provided on FOLDOC (Free on-line dictionary of computing), which defines "interactive" as:

> "A term describing a program whose input and output are interleaved, like a conversation, allowing user's input to depend on earlier output from the same run. This interaction with the user is usually conducted through either a text based interface or a graphical user interface. Other kinds of interface, such as speech recognition and speech synthesis, are also possible" (Howe, 2002).

This definition incorporates the much-used analogy of interactivity as a "conversation" between the user and the system. It also expands upon the IP2 working definition by noting that the user's further input will also be affected by the system's output, thus completing a full cycle of interaction.

Many present-day authors on the topic, however, appear to be making an effort to expand the definition of interactivity given the growing sophistication of digital systems. For example, one author states that while a user input that elicits a system output may be considered an interaction, the interaction should also be *meaningful*. Paul Dourish defines this concept of meaning within interaction as "Embodied Interaction." According to Dourish, "Embodied Interaction is about the relationship between action and meaning, and the concept of practice that unites the two" (Dourish, 2001, 206). Action and meaning form a duality where action "both produces and draws upon" meaning, and meaning, in response, "gives rise to and arises from action." This calls to question whether, in the instances where user input elicits a nonsensical output response from the system (for example, when attempting to "converse" with an online chatbot[3]), a true interaction could be considered to have occurred.

In fact, an expansion of the "standard" definition may be necessary. When current authors discuss interactive systems in computer science literature, they are far exceeding the "input/output" expectations of interactivity. Interactivity is now discussed within the context of virtual reality systems, artificial intelligence, and complex systems[4].

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[3] A chatbot is a "conversation" generating software which is most often used to populate on-line chat sites. To experience the lack of "embodied interaction" that can happen while interacting with a chatbot, visit "Chatting to Maybelle" at: http://www.maybot.com/cgi-bin/char/maybelle/maybelle.cgi

[4] Complex Systems Theory is a field of research that studies simple subsystems as they increase in complexity (Sommerer and Mignonneau, 2002).

It is also clear that for the purposes of InterPARES 2, we are not interested in just any interactive system, but ones with greater complexity. For this reason, the project must choose its definition of interactive systems carefully. It may be true that within the field of computer science the old definition of an interactive system still applies. However, the word interactive, in common parlance, has really come to represent the "most dramatic demonstration" of interactivity (Dysart, 1999, 1).

As mentioned in the introduction, the terms "dynamic systems" and "experiential systems" are far less prevalent in the literature as a whole. Where the term "dynamic system" was used or described in the computer science literature, its meaning was fairly consistent with that of the working definition which was provided for dynamic documents: "documents that are dependent upon data that might have variable instantiations and be held in databases and spreadsheets." In this case, the dynamic system would simply be the system that produced the dynamic document. Many references were made to the system's use of dynamic datasets where the data is rendered graphically in order to help with the user's visualization of complex relationships (Ding and Aoki, 1998, for example), while others focused on the user being able to "dynamically navigate" 3D environments, etc. (Silver and Wang, 1997). In two separate articles, the term "dynamic system" was tied to particular algorithmic programming and mathematical system capabilities, as expressed in this statement: "The identification of dynamic systems concerns the definition of a mathematical model which behaves like a process solely on the basis of its measurements" (Escobet and Quevedo, 1998).

The exact term "experiential system" (as it pertains to IP2) was not found once within the whole of the surveyed literature. It is, however, referred to (by extension) in an article from the same author who provided the working definition for "experiential digital objects." But a closer look at Clifford Lynch's article *Authenticity and Integrity in the Digital Environment: an Exploratory Analysis of the Central Role of Trust* reveals an important omission in the working definition which defines experiential digital objects as "objects whose essence goes beyond the bits that constitute the object to incorporate the behavior of the rendering system, or at least the interaction between the object and the rendering system" (Lynch, 2000). What is missing here is the user. In the above article, Lynch also includes the role of the "human sensory apparatus" in "experiencing" what is

rendered by the system. Without considering the sensory apparatus of the user, a digital object alone could not be considered "experiential," no matter how it is rendered. It is also important to mention that within this same paper Lynch also describes experiential digital objects as a type of interactive digital object (and by extension, experiential systems as a type of interactive system).

Finally, it should be pointed out that the term "experiential system" may have a different meaning within this field than what it does in the context of InterPARES 2. Within the Project we appear to conceptualize experiential systems as ones which immerse the user in a sensory experience. However, there is also a branch of computer science which studies experiential systems as ones which have "experiential awareness." Experiential awareness is the ability of the system to both respond to and experience the environment (Bradley, 1998). Differentiating between the two types of experiential systems at this point may help to avoid confusion at a later time.

Definitions and Meanings within the Sciences

No explicit definitions of interactive, experiential, or dynamic systems were found within the scientific literature. While the expression "interactive system" was used frequently, the nature of interactive systems in general was not discussed. Rather, there appeared to be a tacit understanding of what this type of digital system is. This may be due to the fact that, in the majority of the readings, the systems that were described were constructed for pragmatic reasons, usually for modeling, simulation, or educational purposes. In these cases the emphasis is upon the purpose of the system, not its interactive, dynamic, or experiential nature per se.

If the literature from the physical and applied sciences does not overtly define our terms, then we must find their meanings by looking at examples of digital systems which are described as "interactive," "dynamic," or "experiential", and are used for science-related activities. One such example is the Interactive Multimedia Atlas of Switzerland, which is the topic of an article entitled *Visualization of change in the Interactive Multimedia Atlas of Switzerland* by Oberholzer and Hurni. Within this initiative, many different scientific branches are hoping to promote the development of digital visualization techniques for analyzing and viewing multidimensional data. The

interactive component in the Multimedia Atlas is only within pre-defined frames, where new cartographic visualizations (maps) are created directly from existing databases, depending upon the input or manipulation of the user (Oberholzer and Hurni, 2000). Though this article does not explicitly state it, this system includes elements which could be considered experiential, dynamic, and interactive: it features dynamic data-modeling, cartographic-type visualizations of datasets (experiential), and provides the user with the ability to manipulate the presentation of data (interactive).

Serial Periodic Data Programs are another type of interactive system that was described. Within their paper entitled *Interactive Visualizations of Serial Periodic Data*, John Carlis and Joseph Konstan present this data modeling method which enables the visualization and presentation of dynamic data for large fields where several datasets can be shown simultaneously (Carlis and Konstan, 1998). Here, the dynamic, experiential and interactive components are, once again, present in the user's ability to manipulate large and dynamic datasets to construct presentations which help the user to visualize otherwise incomprehensible relationships. These three elements are also to be found in software which teaches spectrography to students. This software features an "interactive discovery-driven interface" where students may manipulate both models of the spectra and the molecular structural displays, create their own spectra, and conduct "virtual experimentation," all of which allows for more "dynamic and student-controlled" learning (Lahti and Motyka, 2000).

In fact, most the systems featured within the scientific literature featured some form of dynamic data-control and manipulation as well as a high degree of visual emersion, ranging from one dimensional graphical rendering of meteorological readings to real-time 3D navigation of the human anatomy. These systems include flight simulators, GPS systems, virtual experimentation programs, and pattern recognition programs to name a few. While these systems do not conflict with our working definition of what an interactive system is, they clearly surpass the simple user input/system output paradigm.

Definitions and Meanings within the Arts

Papers and articles corresponding to the Artistic Activities Focus group yielded considerably more explicit definitions for the term "interactive" as it applies to digital systems. Once again, however, no concrete definitions were found for experiential or dynamic systems. As was experienced in the readings from the two previous areas, these terms were often discussed within the context of interactive systems. In addition, the term "experiential" was used much more in this area of the literature than in the other two.

Definitions from within this field often focus upon the roles and relationships between the audience, the artist, the art, and the blurring of the three which is a common element of interactive digital art. This is evident in a definition provided by David Rokeby:

> "A technology is interactive to the degree that it reflects the consequences of our actions or decisions back to us. It follows that an interactive technology is a medium through which we communicate with ourselves, a mirror. The medium not only reflects back, but also refracts what is given; what is returned is ourselves, transformed and processed" (Rokeby, 1995, 103).
>
> According to Rokeby there are four models of interactive artworks:

- **Navigable structure**: An articulation of space; real, virtual or conceptual. Here the artist provides the architecture and the audience chooses the path (ex: hypertext narratives).
- **The use of new media**: Artistic interaction via new medium invented by the artist (ex: programs with modify user input into a visual or sound medium).
- **Transforming mirrors**: viewer image becomes an active force in a computer generated context (ex: video installations).
- **Automata**: not intended to be extensions of the interactor; creations are essentially self-motivated and autonomous (ex: autonomous robots).

In the above models, the artwork starts as a "set of possibilities, which are eventually narrowed down by a series of creative choices until one of the possibilities has been manifested in the complete work." At some point within this process, the interactive artist decides to not to choose from among the remaining possibilities, but to create an "audience-actuated choosing mechanism." The decisions made here by the spectator, refracted back by the system, should in some way cause some form of permanent change or enrichment for the spectator. Increasingly, it is expected that some form of enrichment

from the exchange should happen in the system as well (as is the case in complex systems theory).

Another concise definition of an interactive system is provided by Simon Penny:

> "An interactive system is a machine system which reacts in the moment, by virtue of automated reasoning based on data from its sensory apparatus. An Interactive Artwork is such a system which addresses artistic issues. A painting is an instance of representation. A film is a sequence of representations. Interactive artworks are not instances of representations, they are virtual machines which themselves produces instances of representation based on real-time outputs."[5]

This definition focuses upon the temporal and dynamic component of interactive art, where the "art" is in the process, not the final product or goal. This too, is a common feature in definitions of interactive systems used for artistic activities.

A recurring concept which was discussed in the context of interactive systems used for artistic activities is that of "engagement." In her article, *Making Connections: a model for online interactions*, Susan E. Metros identifies "engagement" as a key component of interactivity. According to Metros, "engagement occurs when the user's attention is held long enough to induce participation in an activity, and the vehicle for engagement is interactivity." She also states that the interaction itself can be either passive or dynamic. Passive interaction takes place with computer programs by the user browsing, lurking, or identifying with some aspect of the program. Dynamic interaction, however, happens when users dynamically interact with the program by participating with it (Metros, 1999).

Metros makes the point that a higher degree of engagement is present in the second type of interaction. This higher degree of engagement, however, is not necessarily a product of more advanced or sophisticated systems or interface design. She cites, for example, text-based on-line multi-user domains (MUDs), where players interact with each other through keyboard commands and improvised dialogue, as being relatively archaic, but highly engaging. On the other hand, exposure to explicit visual imagery or other sensory media often causes desensitization, and a low level of engagement. The

[5] Saul, Shiralee, p. 13. This quote is from *From A to D and Back Again: The Emerging aesthetics of Interactive Art*, 1996, by Simon Penny.

author states that "despite the hype of virtual reality and multimodal interfaces, the on-line experience still remains mostly passive and shallow."

Similar to engagement is the concept of control which is used in describing interactivity in digital systems. In *Delusions of Dialogue: Control and Choice in Interactive Art*, Jim Campbell places interactive work on a spectrum, with controllable systems being the least interactive and responsive systems being the most. By controllable systems, Campbell means systems where the viewer's input correlates 1-1 to system reactions (example: CD-ROMs). Responsive systems, on the other hand, are ones where the actions of the viewer are interpreted by the program to create the response of the system (example: complex systems). The reason that Campbell makes this distinction is because when the user notices that the work is responding in a predetermined way, then they will feel fully in control and the "possibility of dialogue is lost." The author of this article does state, however, that at this time "probably the only meaningful dialogues that occur while interacting with work are between the viewers and themselves in the form of feedback systems" (Campbell, 2000).

Cambell's idea of a spectrum of interactivity is similar to other writer's suggestions that there are different levels of interactivity among interactive systems. One such example is provided by Christine Sommerer and Laurent Mignonneau, who claim that existing interactive works can be divided into two different groups which have:

- Pre-designed and pre-programmed paths of interaction. These give viewers a variety of choices and paths to follow, making the discovery unexpected new paths of interaction rather limited, or
- Evolutionary image processes linked to interaction (Sommerer and Mignoneau, 1999, 166).

An example of the first type of interaction would be hypertext fiction with multi-choice paths, and with or without a high degree of sensory or visual emersion. An example of the second is Sommerer and Mignonneau's interactive artwork, *A-Volve*. *A-Volve* features a virtual pool of creatures whose intricate life cycles are determined by user input and biological and evolutionary principles, and with whom users can interact in a real-time environment.

Discussion

This literature survey yielded some interesting patterns, tendencies and omissions in terms of where and how our terms were used and described within the three Focus-based literature groups. The first comment that must be made is that there was an agreement in many of the readings that all or most of today's digital systems are in some way interactive. This is probably one reason why any overt definitions that were provided for "interactive systems" were quite consistent with each other, as well as with the InterPARES 2 working definition. However, there was also a tendency, especially within the computer science and art readings, to describe interactive systems using concepts which are meant to expand upon the simple "user entry/system response or action." For example, some author's suggest that the interaction should be meaningful, or that the user must have a certain balance of control and responsiveness within the interaction. Many of the authors stated that there are varying levels of interactivity, and used concepts such as user engagement to help illustrate what the varying levels may be. As proof of today's environment of systems innovation, some authors are expecting that as an product of interactivity, the systems should also become enriched by "learning" from the interaction that is taking place.

One article which was used in the survey suggests that art has some important lessons to teach in terms of how it looks at the human-computer relationship. The artistic field, perhaps more than any other, seeks out opportunities to explore and expand "the two-way communication (between user and system) using various interactive technologies" (Talbert, 1997, 27). In many ways the ideas found in the artistic readings surrounding what an interactive system is or what it should do were more imaginative than those found in the other areas. Indeed, within the science reading, the emphasis was not so much on pushing the boundaries as in developing systems which suited some concrete scientific purpose. What was most interesting about the science literature was that there appeared to be no need to overtly define what these systems are. They did, however, all share the commonalities of all having a high degree of user control, usually over the visual representation of large and variable datasets or navigation of visual environments.

As mentioned in the body of this paper, the term "dynamic system" was used much less often; and never overtly and succinctly defined. However, where it was used, it most often appeared to conform with the working definition in that the systems used "variable instantiations of data" from large databases, etc., usually for the purpose of producing a visual rendering to aid the user's comprehension of the data or to provide a visual environment that the user can become "immersed" in. In some cases, the word "dynamic" was also used to describe the user's real-time navigation of the rendered image, or their choice making abilities (for example, while participating in an on-line novel). Finally, in a few of the readings from the computer science section, "dynamic" referred to certain mathematical capabilities of particular systems. It seem unlikely, however, that this particular way of defining dynamic system would be useful for the purpose of InterPARES 2.

The least common of our three terms within the literature was "experiential systems." In fact, the meaning of "experiential" as it relates to systems was only explicitly discussed by Clifford Lynch. A closer look Clifford's article has made it apparent that not only should the working definition be extended to apply specifically to systems (rather than digital objects) but should be revised in order to include the "user sensory experience." In other areas of the literature (and particularly within the arts) the word "experiential" appears to refer to the systems ability to immerse the user in a sensory experience; most often visual, but also olfactory, tactile, auditory – or even just a mental sense of "being there" or being highly engaged in the interaction.

Most importantly, perhaps, is the fact that, according to the definitions and meanings which were drawn from the survey, all of the systems that were described were 1. interactive in nature, and 2. contained elements which could be called dynamic and experiential. The above tendencies, as well as the relative stability of definitions of "interactive systems" and an acknowledgement that interactivity within systems varies by degrees, are all factors that should be taken into consideration in the construction of the definitions for interactive, dynamic and experiential systems that will be included in the InterPARES 2 Glossary.

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