Open Interactions: The Balance of Specification

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ABSTRACT

This paper addresses interactive art within the context of participatory culture, mapping current developments towards more open and creative forms of interactivity labelled 'open interactions'. The size of the elements within an artwork, the 'interactive granularity', is stated as key to the creation of open interactions. The metaphor of conversation is used to explore interactivity and suggest future research/practice directions. It is suggested that the potential for interactivity to propagate further creativity relies heavily on the balance of specification for both interactor and system. Furthermore it is stated that truly conversational interactions are inherently open-ended and can result in both positive and negative outcomes by whatever standard.

Keywords

Interactivity, interactive art, open interactions, specification, conversation, control, granularity, resolution, creativity, art, participatory culture, systems, moral compass, automatic, reactive, instruments, platforms, *Light Tracer*, *Line Rider*, *Sonasphere*, Beck, emergence, adaptive, autonomous.

1. INTRODUCTION

In an interview for new media weblog 'We Make Money Not Art' [16] artist-researcher Douglas Edric Stanley addresses the evolution of interactivity in what he sees as a 'move away from specific interactive objects as an end-all, and the emergence of a culture of software, instruments, and platforms for artistic creation'.

In the current climate of 'User Generated Content' (UGC) made popular by 'Web 2.0' portals such as MySpace, YouTube, and Flickr, it seems appropriate and almost inevitable that a shift towards more participatory forms of interactive art would take place.

At first glance Stanley's observations could appear to simply mark out overtures to the much touted Web 2.0 and UGC phenomenon. Indeed on that front 2006 was a landmark year of hype, with the term 'Web 2.0' the most cited Wikipedia entry in weblogs [39] and Time Magazine declaring *You* the person of the year [23]. However rather than simply contributing to the hype, Stanley attempts to map out one possible direction for interactive art within the greater context of *participatory culture*[1].

Within such a context this paper attempts to address the implications of a shift towards more open, participatory, and creative forms of interactivity, which I term 'open interactions'. Furthermore, this paper looks at what these changes mean for the genre of interactive art and questions how it can evolve from here on in.

2. HISTORY & CONTEXT

Researcher and theorist Erkki Huhtamo has suggested it is naive to consider interactive art as being in its infancy [27]. Rather, he notes, it is an artform which in its early stages evolved within the research and development community with artists such as Myron Krueger creating the interactive *Videoplace* system from the 1970s onward. Looking further back, writer and theorist Jack Burnham notes, '[w]e have already seen in happenings, kinetic art, and luminous art some premature attempts to expand the art experience into a two-way communication loop' [7].

The writings of Roland Barthes [5], Umberto Eco [20], and Marcel Duchamp [19] suggest a rich prehistory for interactive art in the form of non-physical interaction:

> All in all, the creative act is not performed by the artist alone; the spectator brings the work in contact with the external world by deciphering and interpreting its inner qualifications and thus adds his contribution to the creative act. [19]

The general term 'interactivity', much like present day Web 2.0, became a source of huge hype during the 1990s and subsequently suffered from a lack of meaning attached to the word. Huhtamo notes:

> 'Interactivity' has become one of the keywords of the techno-saturated culture of the 1990s. We have seen a proliferation of all kinds of things interactive from computer games and interactive television to interactive banking, shopping and networking. Interactivity is featured daily in a growing number of public discourses, from entertainment and education to marketing and even art. This proliferation and simultaneous diversification has obscured rather than clarified the concept and the range of meanings assigned to it... As early as 1990, one critic called interactivity the 'already soggy buzzword of the 90s'. If it ever had any conceptual integrity, it is quickly disappearing. The word, and its most fashionable derivative, interactive media, are rapidly becoming mere floating signifiers. [26]

The muddy meaning of the term 'interactivity' still continues some ten years on. Artists such as Rafael Lozano-Hemmer choosing to adopt alternative terms for their works due to the lack of clarity:

> This word [interactive] has become too vague, like 'postmodern', 'virtual', 'deconstruction' or other terms

1 The term *participatory culture* is used by researcher Henry Jenkins in reference to 'a culture with relatively low barriers to artistic expression and civic engagement, strong support for creating and sharing one's creations, and some type of informal mentorship whereby what is known by the most experienced is passed along to novices' [28].

that mean too many things and is exhausted. Duchamp said "the look makes the picture" and when we say that every artwork is interactive, the word is not that interesting anymore. Also it sounds too much like a top-down 1-bit trigger button —you push and something happens— which is too predatorial and simple. [2]

3. OPEN INTERACTIONS

Often referred to is the Massachusetts Institute of Technology (MIT) Media Lab working technical definition of the term 'interactivity' put forth by Andy Lippman: 'Mutual and simultaneous activity on the part of both participants usually working towards some goal but not necessarily' [6].

Importantly Lippman suggests '[t]he model of interaction is a conversation versus a lecture', a useful metaphor that goes some way to defining the unique characteristics of interactivity: responsive, interruptible, and potentially allowing the system a degree of influence (or even rebuttal).

Lippman cites the MIT developed *Aspen Movie Map* (See Figure 1), a system which enables the user to do a virtual tour of Aspen, Colorado, as an example of conversational interactivity. Lippman makes special note of the interactive 'granularity' [6], the size of the individual elements, in contributing to the interactive experience. For the *Aspen Movie Map* system, this equates to giving the user the impression that there is an 'infinite database' [6] of elements, and at any given moment they can veer off their current course and tour some other part of the city at will.

Figure 1, Aspen Movie Map (1978-83) developed by the MIT Architecture Machine Group.

The concept of interactive granularity, and the balance of specifying the size of these individual elements is of key importance in defining what I call 'open interactions'. Unlike *Aspen Movie Map*, open interactions consist of an even finer degree of granularity, often using mere pixels, sound samples, words or letters. Due to this level of granularity, there are no large blocks of artist-made content stored in a database or otherwise. Open interactions are therefore not narrative based, but instead focus on free-form creativity and play at the base level. Promoting highly participatory creative experiences, rather than arranging heavily authored content into narrative-like structures.

4. MORAL COMPASS

Stanley has created what he labels a *moral compass* for interactivity; a scale designed 'to measure distance in the *use* of the machine starting from its reactive/automatic level and stratifying from there' [46]. The *moral compass* evolves on the following scale:

Reactive → Automatic → Interactive → Instrument → Platform [16].

Stanley's use of the scale ties heavily into his research on the increasing use of algorithms for artistic creation. However it is interesting to reinterpret the scale as a means to locate interactive works based on their interactive *granularity.*

Coarser granularity with larger individual elements occupy one end of the scale, labelled by Lippman as merely *selective* rather than truly *interactive* [6], with the user selecting from a finite number of presets. On the other end of the scale finer granularity provides smaller individual elements with which the interactor can begin to construct and create in diverse ways.

A similar paradigm can be found in computer science where programming languages are referred to on a scale from low-level to high-level based on the level of abstraction between the programmer and the machine. Low-level languages offer great control, but at the same time require attention to huge amounts of detail when programming. High-level languages automate much of this detail and consist of larger blocks of code for specific tasks.

For interactivity, the level of granularity has significant implications for the level of engagement felt by the interactor; less specification allows greater creative possibilities but can potentially create a more complex learning process.

In reinterpreting Stanley's scale, it is worthwhile to take a closer look at each category to clarify how it relates to *interactive granularity*.

4.1 Reactive

Lozano-Hemmer's rejection of the word 'interactive' stems both from the lack of clarity and the general association of the term with control-structure based interfaces. Architect Usman Haque and Paul Pangaro label such interactive systems the 'one-way, reactive interaction model (ORIM)' [24] and suggest:

> ORIM got a firm foothold in the minds of interactive designers (in both art and industry) because it provided short-term results that were easy for people to grasp and use. In other words, because it relies on a causal relationship between 'human' and 'machine' ('I do X, therefore machine does Y back to me') people are very quickly able to understand the system. [24]

While such reactive systems limit the expression of the user to *selective* interactions at best and binary on/off interactions at worst, reactive structures offer an appropriate level of control to navigate the increasing volume of digital information. The field of Human-Computer Interaction (HCI) subsequently evolved to its current state with user as master and computer as slave; a far cry from interactivity as 'a conversation versus a lecture' [6]. Artist Jim Campbell addresses this relationship by stating:

> The computer industry's goal of making computers and programs smarter is simply to make computers more efficient at being controlled by the user to get a job done. Why should they do anything else? This is generally what

> we want computers for: we want them to be passive slaves. One can see this in the software, hardware and interfaces that are currently being used. This model is fine until it collides with art. [10]

Indeed from the outset artists such as Lynn Hershman have sought to experiment with this form of interactivity. Her installation *Lorna*, developed from 1979 onwards, acts as a precursor to non-linear narrative, and predates the popularisation of LaserDisc, CD-ROM, and later DVD media. Ironically the same 'push and something happens' [2] interface paradigms are still being repackaged for the internet and mobile devices; albeit the work of internet artists such as Jodi seek to question these paradigms by quite literally turning them 'inside out' [40].

4.2 Automatic

Automatic systems function without interaction, but rely on a set of author determined rules or algorithms to run independently. New media theorist Lev Manovich talks extensively about the role of the database in new media [36], with his *Soft Cinema* [37] project making use of predetermined software rules to draw footage from the database and edit movies in realtime.

Lacking any physical interaction as such, automatic systems inhibit the user from making any choices which can directly influence the form of the artwork. As a result, they should represent the coarsest level of granularity in the reinterpreted scale.

4.3 Interactive

Over a decade on from Hershman's early experiments with branching narrative structures, interactive CD-ROMs reached a critical mass of popularity during the 1990s. Such projects typically ported *old* media into *new* media; reducing interactivity to a mere gateway to the 'real' content inside.

Andy Polaine, co-founder of art-collective Antirom, notes that '[f]rom navigational menus to videogames, interactivity is often part of an interface to other content. This ignores the experience of the moment of interaction and relegates it to a mechanism of control at best and something to be mastered and "got through" at worst' [41].

Antirom chose to react against such interfaces, instead creating works where 'the interface was the content and the purpose of the interaction was the experience of the interaction' [41]. This approach allowed Antirom to explore interactivity in its own right, without being tied to narrative forms such as cinema or literature as with Manovich [36] and Janet Murray [38]. The Antirom approach to interactivity is in this sense close to the ludology approach to examining games simply as just *games* [1] - where the events that take place, the *gameplay*, are of key importance. By focusing on the experience of the interaction itself, interactivity shifts away from being a mere control mechanism towards the metaphor of interactivity as conversation.

Interactive art pioneer Roy Ascott [3] and Polaine [41] himself suggest that *feedback* is the basic principle that links the participant and the system to form an interactive conversation. As early as 1973 Stroud Cornock and Ernest Edmonds created a series of diagrams [15] detailing the relationship between artwork/participant/environment and illustrating the interactive feedback loop. In 2006 an updated paper was published and stated that '[w]hen defining these categories, Cornock and Edmonds proposed that rather than talk about "artworks", it was helpful to think in terms of "art systems" that embraced all of the participating entities, including the viewer' [21].

However the danger with such an approach is that given all the elements of the art system are present - does that equate to an artwork? Huhtamo notes the tendency to ignore the context when addressing interactive works:

> ...most people are content to define interactive media as a certain kind of technology, without considering the uses to which it is put.... The problem lies in the failure to grasp the fact that media products cannot be defined as interactive merely because they use or have access to certain kinds of hardware and software. The crucial question is one of contextualisation... [26]

While Cornock and Edmonds' diagrams provide a useful framework to understand art systems and their components, this point of focus ignores the context, and moreover the resulting interaction and subsequent aesthetic responses which result from such systems. Jenkins stresses this point by stating that: 'Interactivity is a property of the technology, while participation is a property of culture' [30].

If as Stanley suggests, interactive objects will make way for instruments and platforms for artistic creation, then rather than the structural make up of the art system itself, how the participant interacts and the subsequent results of that interaction become the point of focus.

4.4 Instruments

Though the term 'instrument' has the connotation of either being a tool or somehow related to making music, it is used here in the sense of an interactive system which allows the interactor to engage creatively. The focus is not upon the creation of a subsequent artifact, but rather the interactive experience that develops.

Japanese artist Toshio Iwai has worked with creating interactive music systems since his time at the University of Tsukuba as a graduate student. Iwai initially drew inspiration from mechanical music boxes where holes could be punched into card and feed through to create melodies. This simple idea to relate the spatial arrangement of holes in card, to the sequence of sounds produced, can been seen in his subsequent work with software titles *SimTunes* and *Electroplankton* (See Figure 2) [29], as well as the 1995 installation *Piano - As Image Media*. In each of these works the interactor is invited to play with sound and image elements, with the ability to assemble and sequence them in a myriad of different ways.

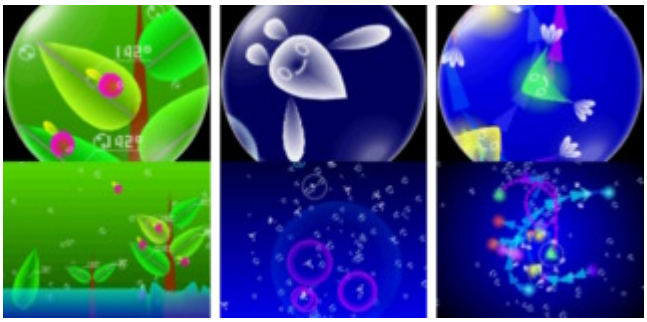

Figure 2, *Electroplankton* for the Nintendo DS, by Toshio Iwai, 2005 [29].

During a talk at the Tokyo Metropolitan Museum of Photography [28], Iwai noted the popularity of the iPod and in particular how its ability to store thousands and thousands of *existing* songs is changing the way we consume music. Juxtapose this with the simple rule structures, sound samples, and synthesis that can be used creatively with Iwai's work, and it is evident how different these two approaches are.

Within my own work I have taken the approach of creating instrument-like art systems, most notably with the interactive drawing installation *Light Tracer* (See Figure 3) [51]. *Light Tracer* invites the participant to write, draw and trace images in real physical space using a series of light sources. The motivation behind the project was to create something which allowed others to create, and as such how the participant uses the system is left entirely up to them.

Figure 3, *Light Tracer* by Karl D.D. Willis, 2005 [51].

With no pre-existing content provided, all imagery must be created from scratch by either drawing with a light emitting device (penlights, cellphones, lighters etc...) or tracing physical objects with brighter lights such as a camera flash. Participants choose both the tools they will draw with and what they draw; subsequent imagery created has ranged from impassioned Hezbollah slogans to trivial tic-tac-toe games and everything in between.

Instrument-like art systems have the potential to allow users a simple and intuitive path into creativity, with granularity such that the raw elements of the system (sound samples or pixels as the case may be) can be combined to create a virtually unlimited range of output. Thus the artwork itself is never finished in the conventional sense but continues to propagate further creative interaction.

4.5 Platforms

Although this paper primarily seeks to address the field of 'interactive art', as artists evolve along Stanley's scale towards *instruments* and *platforms* they inherently begin to distance themselves from that very term. Indeed this is as Stanley suggests, a 'move away from specific interactive objects as an end-all' [16]. A prime example is David Rokeby's interactive sound installation *Very Nervous System* (1986-1990), which was subsequently developed into a set of realtime video processing and tracking plugins called *SoftVNS* [44]. Users of *SoftVNS* can now utilise the same computer-vision based technology created by Rokeby in their own works.

Cases of artist developed software/hardware spawning further artistic creation are numerous, with perhaps the most well known project being the 2005 Prix Ars Electronica Golden Nica recipient *Processing* [22] by Benjamin Fry and Casey Reas. *Processing* is an open source programming language and environment which enables artists/designers to create and control image, sound, and much more using accessible yet powerful programming functions. As mentioned in the competition jury notes [8], questions were raised about the suitability of Processing for the 'Net Vision' award category; in particular one member of the jury questioned whether the appropriate category should be determined by the application itself or the subsequent works authored using Processing.

Such questioning is inevitable as new genres surface and old ones evolve beyond their established bounds. Using Stanley's scale to address 'interactive art' in the strictest sense would exclude far to many of the evolving genres on the outskirts. To encompass these it is useful to broaden the scope and look at systems which seed creativity within participatory culture.

5. PARTICIPATORY CULTURE

On top of the staggering numbers of blog posts, videos, and photographs submitted to online Web 2.0 portals each day, several studies conclude that content creators now represent a significant and growing proportion of internet users [33, 34].

However much of the focus of Web 2.0 is placed upon online services which facilitate posting, sharing, and commenting, without due attention given to the realm of accessible software tools used for content creation. For the most part, software that drives Web 2.0 is markedly different from the interactive artworks set out in this paper so far, being primarily focused on the creation of artefacts rather than the experience of the interaction and its overall context. With that said, there is an increasing amount of crossover; Adrian Ward's software art projects *Autoshop* and *Auto-Illustrator* parody their Adobe counterparts and question if it is possible to 'embed creativity within software' [50]. A more recent work entitled *The Sheep Market* [32] by Aaron Koblin, questions online participation and commerce by paying online workers US 2¢ each to draw a total of 10,000 sheep.

Participatory culture is an immensely large field that in its entirety lies beyond the scope of this paper. What I do hope to address is the characteristic of *participation* common to both interactive art and contemporary culture. Rather than attempting to categorise and create divisions between the two, this section will examine several projects which are not interactive art, but nonetheless represent open interactions by encouraging user creativity.

5.1 Line Rider

Line Rider [9] is an online flash toy created by Slovenian university student Boštjan Cadez, which combines simple rules with an open, score-free structure of play. By drawing a series of lines onscreen, users can craft out a track for the tiny *Line Rider* character to cruise along (See Figure 4, 5). Hitting the play button

sets the character off on the track, rolling down slopes or up ramps, bound by the rules of virtual physics.

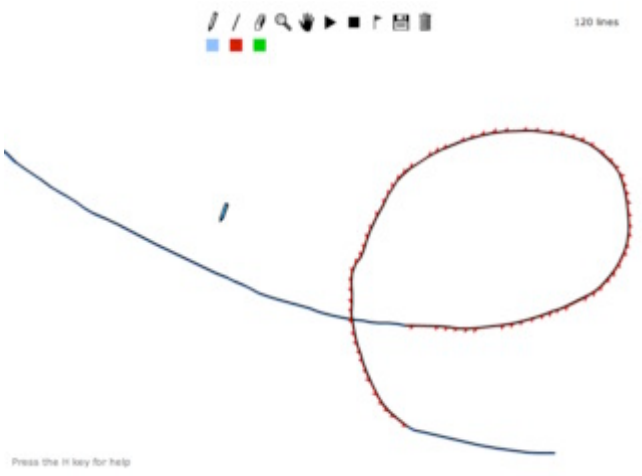

Figure 4. *Line Rider* in draw mode, Boštjan Cadez, 2006 [8].

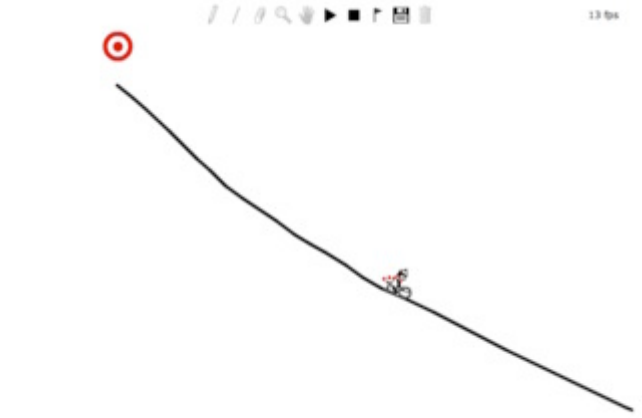

Figure 5. *Line Rider* in play mode, Boštjan Cadez, 2006 [8].

While this may sound overtly simple and almost childish, the user interaction and creativity that evolves is remarkably complex. User created tracks exploit the *Line Rider* virtual physics to throw the character off its sled, flip it through the air, and wheelie up and down terrain (See Figure 6).

In the later part of 2006 *Line Rider* became somewhat of an internet phenomenon, with coverage in Time Magazine [42] along with thousands of user created videos appearing on YouTube. Shortly there after Inxile Entertainment announced they had acquired the rights to Line Rider and a release for both the Nintendo DS and Nintendo Wii was forthcoming.

Without attempting to pinpoint how *Line Rider* became so explosively popular, the beauty remains in the fact that through an overtly simple set of rules, creative and complex user interaction can evolve. This is achieved in part by encouraging a state of play. The absence of a goal means there is no correct or incorrect way to interact; as a result the user is less concerned with the outcomes and more involved in the experience of the interaction itself and the possibilities it offers.

Figure 6. Screenshots of user created *Line Rider* videos [8].

While Huhtamo suggests, more traditional games 'are programmed to control the forms of the interaction and to channel it towards a clearly stated goal' [25], in contrast, *Line Rider* along with *Electroplankton* [29] and Andy Deck's collaborative online drawing system *Glyphiti* [17] (which I have previously discussed [52, 53]), lay testament to the potential of open interactive systems to propagate a wide range of creative approaches.

5.2 Beck's *The Information*

Outside the use of computers, experiments with audience participation featured heavily in performance works such as Yoko Ono's 1964 *Cut Piece* and Marina Abramovic's *Rhythm* series during the 1970s. While such confrontational works were often met with controversy, in the current climate of participatory culture it has been noted that '[t]here is a public expectation and even demand for interaction now' [45].

The album cover art for *The Information* by American singer-songwriter Beck addresses this in an attempt to 'provide something that calls for interactivity' [47]. Each CD comes packaged with a blank grid-lined cover and a set of stickers (See Figure 7), which can be arranged by fans to create their own personalised cover art (See Figure 8).

Figure 7. Album cover art for Beck's *The Information* - a blank grid-lined cover and a set of stickers.

An early example of such participatory art can be seen in Ascott's 1959 *Change Painting*, consisting of several painted plexiglas panels that can be positioned by the participant to create a composition. However such an approach by Beck, a mainstream musician, reveals the extent to which the idea of audience participation has taken hold at large.

Figure 8. Examples of cover art created by fans for Beck's *The Information.*

The commonality between *Line Rider* and *The Information* cover art, and no doubt a contributing factor towards their success, is the way in which they allow creativity through interaction. By providing an open structure, a fine level of interactive granularity, and a very simple set of rules, users are able to go forth and experiment. The resulting interactions not only exhibit great creativity, but no doubt go beyond the expectations of the authors.

6. BEYOND PARTICIPATORY

Participatory projects such as *The Information* cover art represent an increasingly popular direction. However in order to extend Stanley's scale beyond *instruments/platforms* and beyond *participatory*, it is useful to again frame interactivity based on the metaphor of conversation that inherently gives weight to both parties.

Discussing his early experiences programming on a time-share computer Burnham notes how 'a dialogue evolves between the participants - the computer program and the human subject so that both move beyond their original state' [7]. This mutual evolution and sense of progression infers a form of interactive collaboration where both the participant and the system have an active role. Haque and Pangaro point towards the work of cybernetician Gordon Pask as a means of developing more productive intelligent-type interactions. Using the metaphor of conversation they suggest:

> ...when we meet new people, being intelligent does not necessarily mean we will like them; we tend instinctively to like people if they are amenable and affable rather than if they are intelligent. However, it is conversations with intelligent people (in whatever terms) that in the long term are most productive because they are generative. That is, they lead to new perspectives and actions. The Paskian model doesn't necessarily rely on complexity of interaction: it relies on the creativity of the person and the machine that are negotiating across a technological interface. [24]

Stanley's *moral compass* extends towards interaction which leads to further artistic creation, however the role of collaboration and creativity on the part of the machine remains unknown. To gauge the role of the participant is relatively straight forward, but to judge the capability of the system to introduce new perspectives is a more difficult task. Moreover the question still remains: How can we interact with computers in a more conversational way?

6.1 *Sonasphere*

From 2003-2004 I was involved in the development of an audio application created by Nao Tokui, which attempted to use aspects of complex and chaotic systems to introduce new expressions and perspectives. While most software functions as a strict control interface, the goal of *Sonasphere* [49] was to introduce unpredictable and unexpected elements to the user, with the hope of triggering new ideas and directions in their work.

The software acts as a virtual 3d environment housing small nodes representing audio samples, effects, and mixers (See Figure 9). By loading an audio file into a sample node, then linking it through an effect node to a mixer node, a network is formed that applies the given effect and plays the audio file.

Nodes interact with each other in accordance with the virtual physics of the environment as partly defined by the user. Relationships can be mapped out between the nodes, for example the Z axis of an audio sample node can be mapped to the 'resonance' setting of a 'low pass' effect. As the environment is set in motion the changing position of that node determines the amount of resonance applied to the low pass effect.

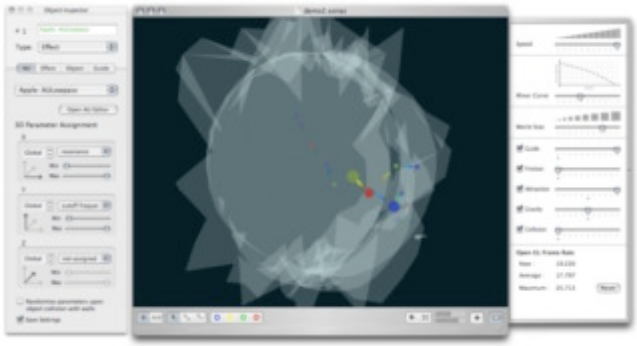

Figure 9. A screenshot of *Sonasphere* by Nao Tokui & Karl D.D. Willis, 2003-2004 [49].

As the number of nodes increases, *Sonasphere* starts to exhibit characteristics of a chaotic system. While users contribute their own audio samples and effects, in such a chaotic environment they are unable to exert full control over the system. Tokui, himself a dj/producer/musician, speaks of the desire to create moments of inspiration when interacting with computers and apply the methodology of generative systems to a general creative context [48].

The uses of *Sonasphere* vary from live performance to the creation and processing of audio samples. Within the context of Tokui's intentions, the open-ended nature of *Sonasphere* remains most constructive in seeking to propagate new directions for its users - regardless of whether such directions can be catered for by the software itself. This is a pivotal difference in approach given that software typically plays a passive role to facilitate the

realisation of existing ideas. In contrast, *Sonasphere* attempts to provide a context within which new ideas themselves can be triggered.

6.2 Emergence

The systematic nature of much computer art has been insightfully portrayed in Campbell's 'Formula for Computer Art' diagram (See Figure 10 - originally published in Leonardo [10] and also available as an animation online [11]), detailing a structural break-down of its components. In the animated diagram, inputs and outputs appear as cascading substitutable elements, represented in a somewhat trivial way as if waiting to be utilised. According to the 'Formula for Computer Art' the artist's role could be described as the selection and rule-making process mapping inputs to outputs.

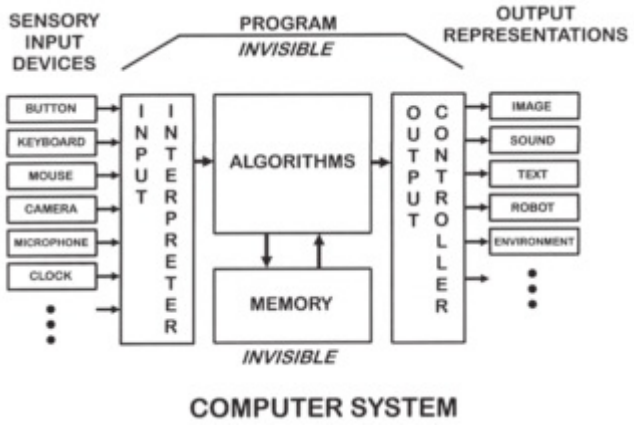

Figure 10. *Formula for Computer Art*, Jim Campbell [10].

For interactive artworks, rather than one off transformations of input into output data, the focus is on a loop of constant feedback and perpetual transition. Interactivity akin to 'a top-down 1-bit trigger button' [2], has been discussed as early on as Descartes in his influential 'Discourse on Method' text. Descartes contemplates how we could recognise a machine apart from a human, if it were to possess the exact same form as us:

> ...[the machine] could never use words or other signs arranged in such a manner as is competent to us in order to declare our thoughts to others; for we may easily conceive a machine to be so constructed that it emits vocables, and even that it emits some correspondent to the action upon it of external objects which cause a change in its organs; for example, if touched in a particular place it may demand what we wish to say to it; if in another it may cry out that it is hurt, and such like; but not that it should arrange them variously so as appositely to reply to what is said in its presence, as men of the lowest grade of intellect can do. [18]

To move beyond simple action/reaction interactive structures towards more generative and/or productive forms, ultimately encroaches upon the broader domain of emergence and machine creativity. While examining what constitutes emergence in full remains beyond the scope of this paper, it is a relevant research area in relation to creating truly conversational interactions. Neuroscientist Peter Cariani notes:

> The pragmatic relevance of emergence is intimately related to Descartes Dictum: how can a designer build a device which outperforms the designers specifications? If our devices follow our specifications too closely, they will fail to improve on those specifications. If, on the other hand, they are not in any way constrained by our purposes, they may cease to be of any use to us at all. Thus, the problem of emergence is the problem of specifications vs. creativity, of closure and replicability vs. open-endedness and surprise [12].

The issue of *specification vs creativity* is relevant for human interactions as much as it is for machine interactions. Open interactions have the potential to promote user creativity and propagate a range of outcomes we could not have predicted beforehand. Similarly, to produce emergent properties from a machine based system an optimum level of autonomy is necessary.

Addressing Descartes dictum in 1952, W. Ross Ashby [4] uses the metaphor of a mediocre chess-playing father attempting to teach his son to become a chess champion. Ashby suggests the father should not teach to impart every detail, save he become a replica of his father, but rather he 'must send him out into the world to be subjected to all sorts of unselected experiences'. Ashby concludes that some idea about 'how to use the "free" information in the world' must be taught in order to surpass the level of ones own teacher. He further notes systems akin to *Darwinian Machinery*, evolving through mutation and natural selection, could be used to address the dictum.

Within the field of computer games, the work of game designer Will Wright is a notable example of managing the balance of specification to allow for further creation. In a lecture for the Long Now Foundation with composer Brian Eno [55], Wright speaks of the simple underlying cellular automata rules behind the ground-breaking simulation and city building game *Sim City* [53]. Despite the simplicity of the rules pertaining to crime, traffic, pollution etc..., Wright noted complex emergent phenomena such as urban gentrification evolving from interaction within the rules. Rather than being hard-coded into the game system, these emergent behaviours evolved through user interaction; in a sense capturing the 'something for nothing' [14] feeling of emergence.

6.3 Adaptive Devices

Cariani suggests several categories of 'adaptive devices' [13] which could potentially exhibit emergent behaviour. If we consider the 'environment' of these devices to include the interactor, then the categories created by Cariani have very specific relevance to interactivity.

Adaptive computational devices are devices capable of altering their computational parts based on their performance within the environment. Implementation of a learning mechanism and specific evaluation criteria are required to document past interactions, judge performance, and make subsequent adjustments if necessary. *Adaptive computational devices* have been used to good effect within fields that have means to objectively judge the outcomes of interaction against the evaluation criteria. Cornock and Edmonds document such devices in an art context in their 1973 paper [15] (labelling them dynamic-interactive varying systems), however it remains to be seen if such systems can be developed to incorporate (and/or evaluate) the wide-ranging set of outcomes inherent in the field of art.

Structurally adaptive devices are devices capable of constructing sensors and actuators based on their performance. In the late 1950s Gordon Pask created and experimented with an electrochemical device capable of growing its own sensors. Using

an aqueous ferrous sulfate/sulphuric acid solution Pask's 'ear' could be trained over half a day to distinguish between two sound frequencies [12].

Pask's work has inspired a range of experiments within an art context, most notably Roman Kirschner's dynamic sculpture entitled *Roots* (See Figure 11) [31]. While *Roots* is based on the same electrochemical experiments carried out by Pask, its use of the evolving structure is aesthetic rather than aiming to evolve sensors or actuators. *Structurally adaptive devices* represent a challenging but nonetheless possible way to break out beyond the structure of Campbell's 'Formula for Computer Art' [10] diagram structure.

Figure 11, *Roots* by Roman Kirschner, 2005-2006, Photo: Jonathan Gröger [31].

Beyond these devices, Cariani suggests, could be *motivationally autonomous devices* capable of establishing their own performance-measuring criteria: 'Such devices would not be useful for accomplishing our purposes as their evaluatory criteria might well diverge from our own over time, but this is a situation we face with other autonomous human beings, with desire other than our own...' [12].

With *motivationally autonomous devices* interactivity comes full circle back towards machine autonomy, albeit with a very different nature from the 'automatic' systems labelled on Stanley's moral compass.

7. MAPPING INTERACTIVITY

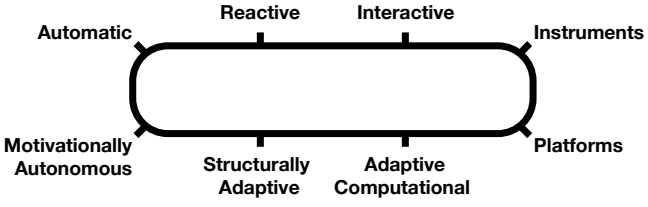

Figure 12. *Interactive Specification Loop*.

Figure 12 illustrations a combination of the categories established by Stanley and Cariani, detailing the balance of specification between (human) interactor and (computer) system. We see the formation of a loop as the balance of specification shifts from open interactions on the right side, towards system autonomy on the left. Details of each interactive system are given as follows:

Automatic - Automated systems which run without interaction or intervention from outside sources. For example, generative art systems such as Manovich's *Soft Cinema*.

Reactive - Systems which allow a minimum level of interaction, often defined by low definition input devices and coarse interactive granularity. For example, branching narrative structures, DVDs.

Interactive - Systems which incorporate a fundamental level of interactivity involving a continuous feedback loop of action and reaction. For example, goal based games, virtual reality systems.

Instruments - Systems with a rich level of interactive granularity and a focus on interactions which promote creativity. For example, Rokeby's *Very Nervous System*, Toshio Iwai's *Electroplankton*, and the author's *Light Tracer*.

Platforms - Comprehensive systems focused on being utilised for further production and creation. For example, *Processing*, Rokeby's *SoftVNS*.

Adaptive Computational - Systems with the capability to alter and adapt their computational parts based on their performance in past interactions. For example, Interactive systems with a learning element.

Structurally Adaptive - Systems with the capability to adapt their structure parts based on their performance in past interactions, For example, Pask's electrochemical ear experiment.

Motivationally Autonomous - Systems capable of establishing their own performance-measuring criteria.

The *Interactive Specification Loop* is intended to primarily address real-time physical interaction in an art context, with the categories listed above not intended to be either definitive or mutually exclusive. Interactive systems could be classified as, or contain elements pertaining to several categories across the spectrum. Moreover interactivity is highly user specific; while one user may tentatively interact in a reactive way, other users may push the limits of interaction towards the realm of instruments.

To assist with locating works within the interactive specification loop the following questions can be used to determine the openness of the interactive work and the balance of specification. The intention is to question the outcomes of interaction rather than the interactor or system by itself.

- Is it possible to predict all ways in which interaction will take place?
- Is it possible to predict all outcomes which will result from interaction?
- Can the output of the system be evaluated as both a positive and negative outcome (by whatever standard)?

Although there are no correct or incorrect answers to these questions, their use lies in revealing how interactive systems manage the balance of specification by either encouraging or restricting either party.

8. CONCLUSION

While within the interactive specification loop there is no ideal field to work within, open interactions would appear to be gaining influence within the context of participatory culture. This paper is

a preliminary attempt to follow this direction and its potential path, regardless of the practical difficulties in developing such emergent systems at this stage.

It is hard to steer clear of value-judgements about what the outcomes of interactivity should or should not be. Often the role of interactive art has been 'self-referentiality' [10] or 'metacommentary' [26] on the medium itself. Such works provide useful discourses about the potential role of technology; however too many fall short of this goal and amount to mere 'naive celebrations of technology' [25].

While open interactions are by no means new, they do represent a stage of evolution beyond the transformation of the 'passive observer' into the so-called 'active creator'. It also remains clear that the evolution of the interactor is a constant; as new generations grow up with interactivity their ability along with their expectations exceed previous generations. Haque and Pangaro suggest the time is right for adopting more productive and intelligent-type interactions as 'we are no longer "naive" in dealing with our technological interfaces, and therefore we expect more from them and are more able to comprehend the structures behind them' [24]. They draw a distinction between *intelligible* and *intelligent* interactivity: 'Intelligibility requires predictability and a finite language. Intelligence, on the other hand, requires creativity and the unexpected' [24].

Coming across *the unexpected* when interacting with computers is almost inevitably perceived negatively as an unintended and unwanted 'bug'. Relatively little is know of creative processes that cede appropriate control to the system to allow for potentially positive unexpected directions. In their lecture for the Long Now Foundation [55], Eno and Wright suggest dealing with generative and emergent processes represents 'a new way of being an artist', where the process is one of 'surprise and discovery'. Wright notes that when using such processes, having an end goal in mind is made difficult by the inherently non-linear and counter-intuitive nature of the process. He instead suggests that simple experimentation with the rules of such processes can lead towards new opportunities and places you would not have thought to go.

Eno and Wright's insights into the creative process become especially relevant as we spend less and less time engaging with the 'un-selected experiences' [4] of the real world, and increasingly more time interacting with computers. Subsequently it becomes important to question how creativity is affected by these changes, and furthermore explore how interactivity can evolve within such a context.

A move towards more *intelligent-productive* [24] interactions may be desirable, but the question of what exactly that constitutes still remains to be delimited. Already many of the technologies envisioned in 1960 as key to the development of J.C.R. Licklider's *Man-Computer Symbiosis* are available, however the resulting human-computer partnership which will 'think as no human brain has ever thought and process data in a way not approached by the information-handling machines we know today' [35], has yet to eventuate. Pivotal to developing such a partnership is a stronger model of interactivity as a conversation, and a better understanding of the balance of specification for both interactor and system.

The suggestion of systems capable of 'amplifying our own creativity' [12] represents a positive direction for further research both within and beyond the field of art. However does such a definitive goal contradict the idea of a partnership and reduce the system to a mere tool? Truly conversational interactive systems are inherently open-ended and should thus produce positive *as well as* negative outcomes (by whatever standard). Even if the focus of such systems remains on propagating further creativity and ideas, this is not to say that such systems lack the ability to establish new discourses or disseminate new concepts.

The current groundswell of interest in participatory culture has a very strong and direct relationship to interactivity. If the research of Henry Jenkins is correct in assuming 'we are moving away from a world in which some produce and many consume media, toward one in which everyone has a more active stake in the culture that is produced' [30], then how we go about creating interactive systems today will have a real and lasting effect from here on in.

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