Collective Creative Function in *Riverrun*

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Riverrun

Introduction

A shared interest in collective phenomena, creativity, complexity and collective intelligence can be seen as the starting point for this project. Approaching these themes from different perspectives, an artist and a scientist, in collaboration with programmers, began to consider how an online collective writing project could be framed in such a way that it functioned, not only as the basis for a real-time art installation, but also as a valid object of scientific analysis.

Part of this process involved debate about the interactive architecture of *Riverrun* and how experimental conditions and initial values set prior to each experiment might increase the probability of emergence. The debate also centred on how such initial values could be integrated by the programmers. It was also necessary to consider, firstly, how the data generated in the course of the experiment should be rendered in real time to comply with the project's artistic function, and secondly, how this data should be recorded in order to ensure the viability of post-event theoretical and scientific analysis.

With regard to artistic function, it was decided that the creative decisions should not only be outputted in textual form, but also codified as sound. A data processing algorithm would mark the rhythm of contributions and reflect the frequency of words and letters chosen across the global text as it evolved. In this way, unseen patterns could be made sensible to the installation visitor. The role of the sound programmers in *Riverrun* is therefore significant in terms of artistic agency.

Bearing in mind the above, it is clear that the visible signs and forms of texts created by the living community of online writers in the installation will be produced, exhibited and analysed within an operational and presentational frame designed by an artist, scientist and programmers. This interdisciplinary collaboration has established the parameters for viable, creative and collective function. The installation and evolving texts can therefore be considered works of a living community which is in part artefact.

Part 01 of the following text seeks to explain the multiple aims of those involved in the setting of these parameters before the event. Part 02 then examines the event itself, the role of the online writers and the programming in the production of the work, and the experience of the installation visitor. To further the effectiveness of the explanations in both Part 01 and Part 02, comparisons with other relevant creative works will be made.
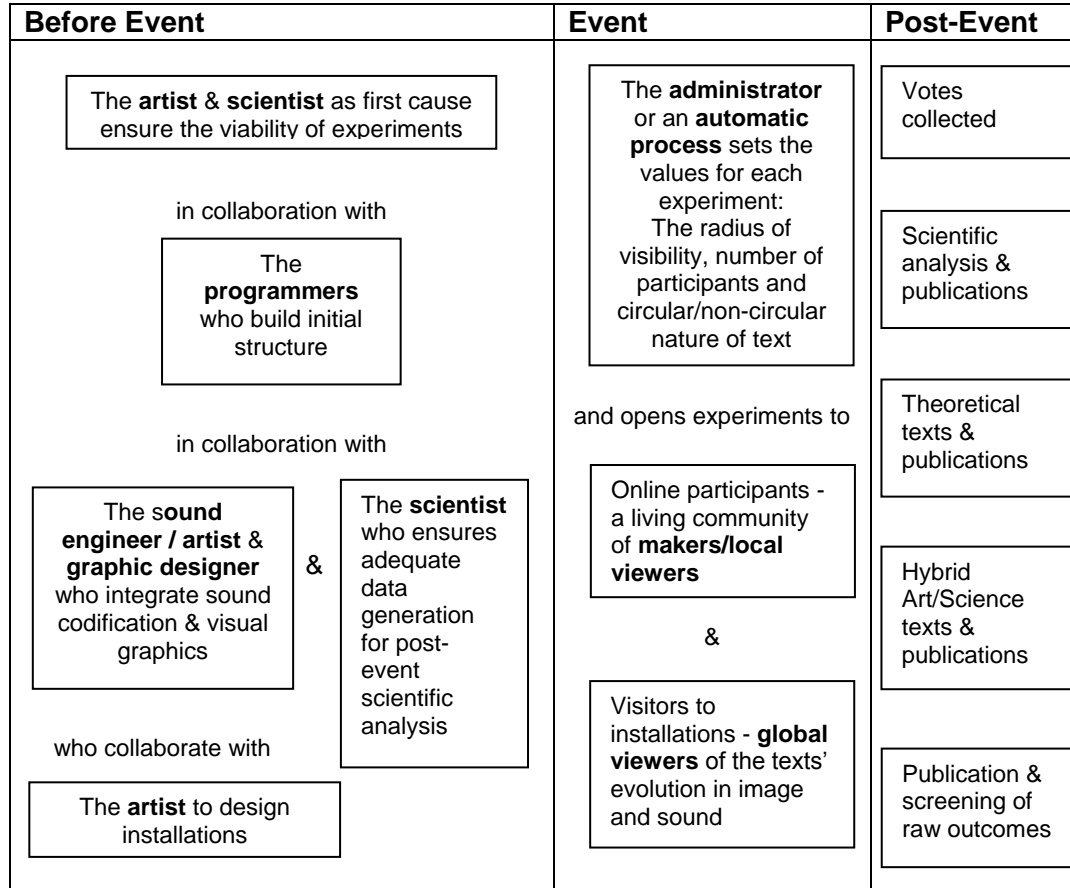
Riverrun

Before Event	Event	Post-Event
The **artist** & **scientist** as first cause ensure the viability of experiments	The **administrator** or an **automatic process** sets the values for each experiment: The radius of visibility, number of participants and circular/non-circular nature of text	Votes collected
in collaboration with		Scientific analysis & publications
The **programmers** who build initial structure	and opens experiments to	Theoretical texts & publications
in collaboration with	Online participants - a living community of **makers/local viewers**	Hybrid Art/Science texts & publications
The s**ound engineer / artist** & **graphic designer** who integrate sound codification & visual graphics & The **scientist** who ensures adequate data generation for post-event scientific analysis	&	
who collaborate with	Visitors to installations - **global viewers** of the texts' evolution in image and sound	Publication & screening of raw outcomes
The **artist** to design installations		

Fig. 1: Schematic Action Plan for *Riverrun.*

Part 01 Before the event

(a) The artist

The three main aims of the artist in the setting up of these collective experiments are:

1   To explore and amplify the collective creative potential of online writers.
2   To provide a means of making the experiments sensible[1] for the global viewer/installation visitor.
3   To offer insight into the collective creative process.

1 To explore and amplify the collective creative potential of online writers.

    a) To explore

As the experiments run, it is hoped that a number of texts of artistic interest will be produced in which coherence emerges; in which the whole is greater than the sum of the parts.

This aim can be considered consistent with the argument that for an interactive artwork to be successful:

> "it's essentially a question of framing in a way that doesn't just elicit and record observable behaviours but, more importantly, opens the situation out onto the qualitative level of thinking-feeling where expanding potential appears, so that being appears in the act of becoming." (Massumi, 2007, p.79)

To extract meaning from a given experience, human beings require a signal between order and disorder (Peak & Frame, 1994; Galanter, 2003). Céleste Boursier-Mougenot played with this in his recent installations at the Barbican in London and La Casa Encendida in Madrid[2]. Visitors walk through a room re-configured as an aviary for a flock of zebra finches. In this enclosed space, there are electric guitars placed horizontally on stands, their fret boards and strings acting as interactive sound-emitting perches. As they perch, eat, land and take off, the birds "create a captivating live soundscape."[3] The "soundscape" captivates human visitors.

We could ask in what proportions the musical outcome is due to the birds' agency,[4] or in what ways the outcomes could be their response to the physical space, dressed with musical instruments, into which the birds have been placed, or how it could be the result of their interaction with the moving humans in the aviary.

Although their behaviour is unpredictable, the birds interact with the musical objects and move around within the limits of the exhibition space given to them by the artist and curator and a certain order does seem to emerge, or is at least perceived. (See later section on anticipation of comprehension).

In *Riverrun* the potential for emergence is also explored. In this case, it can be assumed that intention plays a part in whatever happens, regardless of how different or even

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[1] This should not be confused with 'representation', since *Riverrun* does not rely directly on the recognition of familiar forms (or indeed the mirroring of already-defined things) for its appeal.
[2] See: http://www.paulacoopergallery.com/artists/CBM/works/26
Another installation featured as one of the works in the group exhibition "*on&on*" at La Casa Encendida, Madrid from 19/11/2010 to 16/01/2011
[3] Quoted from webpage: http://www.barbican.org.uk/artgallery/event-detail.asp?id=9713
[4] It should be pointed out that here there is an assumption that intention is not necessarily implicated in agency: "It is through the local interactions of countless inanimate components that the universe's most spectacular creation has emerged–the organism." (Dorin, 2001)

idiosyncratic each human collaborator's individual role might be, since makers/local viewers are made aware of a common goal when they are asked to write until they feel their own contribution best fits those around it.

Individual makers/local viewers may choose to introduce dissonant elements to the evolving text. They may even seek to controvert and subvert the common goal, but these actions could be interpreted as evidence of competition and cooperation which themselves can contribute to coherent collective behaviour. It is shared intention and an awareness of a common goal which may encourage the emergence of an unspoken understanding or associative logic across the global text. But such coherence, in the form of a crystallizing story, can only emerge if influence somehow *can* spread beyond the local. The relational architecture for the experiments must be viable in this respect.

For this reason, parameters must be defined by the artist and scientist, and creatively implemented by the programmer, if artistic experiments with the potential for emergence are to be the result. To this end, the design and programming must firstly address how an effective communication of influence beyond the local can be facilitated in experiments involving groups of writers of different sizes, and secondly, how this can be done without determining the artistic outcome.

The first question we might ask with regard to the second point is:

> "How may the sophistication of interactions be increased to the point where behaviours which may not be predicted, even in general, arise?" (Dorin, 2001)

For this to occur, it is essential to design *Riverrun*'s program in such a way that it does not restrict the potential for variation and idiosyncrasy in the behaviour and creative output of individual makers/local viewers.[5] The authorship and partial autonomy of the makers/local viewers forming this community must be respected.

An interesting point, which could be considered a warning for projects such as *Riverrun*, is raised by Alan Dorin with regard to the use of evolutionary algorithms in visual art. He argues that they can restrict outcomes to the extent that "none of the pixel arrays voice the thoughts of the wanderer. Instead, they tirelessly repeat the name of labyrinth." (Dorin, 2001)

Dorin refers us to evidence of the dominance of the programmer in certain creative software projects such as the applet Richard Dawkin's described in his 1986 book *The Blind Watchmaker*[6] and William Latham's *Mutator*[7]. Each program dictates constraints on its user. The result is that the range of forms which may be created in both programs is restricted. Creative output is shaped by the actions of a human user, but the forms produced by each program inevitably have a "trademark *style*" (Dorin, 2001) imposed on them by the code. It is therefore impossible to produce an image with *The Blind Watchmaker* like one from *Mutator*. From an artistic perspective, the imposition of such limitations on creative output is to be avoided.

Scientific researchers should also be aware of the dangers of ignoring the implications of artefacts in modelling or visualisation processes. This can lead to mappings, visualisations or illustrations with determined results being blindly accepted by non-experts (and even experts) as raw, objective and unmediated.

Art historian Martin Kemp cites the example of Charles Arthur's article in The Independent of 7 June 1997 describing images of the atmosphere of Jupiter based on

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[5] It would be interesting to explore this in relation to the history of the use of chance operations as a creative technique by artists working in and across the fields of music, visual art, writing, dance, performance and film. *Riverrun*'s creative process and its relation to this art historical context will be explored in a future text.
[6] *The Blind Watchmaker* applet is described here:
http://www.phy.syr.edu/courses/PHY106/PHY106.02Spring/Labs/bw_lab.htm
[7] *Mutator* can be found here: http://doc.gold.ac.uk/~mas01whl/index.html

data gathered by a suicide probe dispatched from Galileo. Arthur compared the images to a Turner painting. But as Kemp explains,

> "He was referring to the "false colour" image printed as a panorama, rather than the inset illustration of 'how it would appear to the human eye.'" (Kemp, 2006, p.59)

It should also be pointed out that even if the journalist had referred to the inset illustration, viewing this image could never be considered equivalent to the actual experience of viewing the atmosphere of Jupiter with the naked eye.

> "What something 'looks like' to us is not the same as its optically accurate transcription in an instrument." (Kemp, 2006, p.260)

This dilemma is one of order of experience and extends, not only to what something looks like, but also to how it feels. A representation or codification of an event can never be sensed or felt by one person in the same way that a first order experience of it has been sensed or felt by another.

Despite this, it could be argued that in "making sensible" the collective creative process, *Riverrun* offers the global viewers a different type of meaningful first-hand lived experience[8], in this case, that of an art event. *Riverrun* seeks to "make sensible" the ongoing creative decisions taken by each maker/local viewer by showing these as moves within the context of a field of constant creative flux. As makers / local viewers adjust their contributions to those of others in order to achieve coherence, prevarications and doubts and new endings and starting points[9] are observed, sensed and felt by the global viewer. In other words, the "making sensible" of the creative process, as an evolving field of intensities, affords *Riverrun* a viable artistic function. (This point will be expanded on in the next section).

The community of makers/local viewers in *Riverrun* could be considered in part artefact, in that the overarching structure of each writing experiment is set according to parameters set out by the artist, scientist and programmers. But this does not imply that the creative outcomes themselves, in terms of the texts and sounds produced, are determined prior to the event. On the contrary, the artistic viability of *Riverrun* rests on its openness to the unpredictable and idiosyncratic in the behaviour of the collective of makers/local viewers and its capacity to amplify this living community's creativity. Only then can it be possible to present evolving texts which generate a multiplicity of sensations, connotations and interpretations.

The structure for each experiment is varied in order to empirically explore the artistic potential of *Riverrun* and provide the breadth and quantity of data required for a post-event scientific analysis. From an artistic perspective, one of the main aims of this interdisciplinary approach is to explore how it might be made more possible for makers/local viewers, as individuals, to adapt effectively and efficiently to each others' contributions; to self-organise in order to produce interesting texts where structure, surprise, novelty, noise and redundancy (Peak & Frame, 1994 pp. 228-233) play their part in the formation of a coherent whole.

The remarkably simple mechanism employed by *Riverrun* is the radius of visibility which can be set automatically or manually by the administrator immediately before experiments. This has the effect of defining the number of lines visible to each writer. It is theoretical physicist Bartolo Luque's thesis that there exists a critical value for the radius of visibility relative to the number of writers which would lead to the emergence of complexity at the edge of chaos and the most interesting stories. The random

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[8] This relies on the assumption that there exists an intimate relation between vital experience and meaning. The writings of Henri Bergson and William James (Kallen, 1914, pp. 52 -90) in support of this assumption are relevant to this debate.
[9] *Termini ad quem* and *a quo*.

positioning of the writers is also important from an artistic perspective since it introduces randomness into the process.

For the makers/local viewers', emergence of complexity at the edge of chaos may indicate that their collaborative experience is at a point of maximum tension, or intensity, since crystallization occurs when makers/local viewers waver and finally begin to resist making further changes. From an artistic perspective, it could perhaps be expected that in these moments the most interesting stories would emerge.

This raises the question of what "interesting" means. As Davis Shneiderman and Tom Denlinger point out, a coherent or intriguing whole of evocative connections for some may well be dismissible gibberish for others. They illustrate this point with a short Kurt Schwitters' quote:

> "Lukewarm milk fight Thine soul's triangle." (Shneiderman & Denlinger, 2009, p.212)

This suggests that attitudes to the same *Riverrun* text will most probably vary between individuals and groups, reflecting individual and shared experience. Despite this, it could be argued that the expression of a large collective degree of interest in a text could be taken as a positive aesthetic judgement of it, and an indicator of its artistic merit. This would suggest that some kind of voting mechanism may be useful.

An interdisciplinary study (Draves et al., 2006) of artist Scott Draves' internet work *Electric Sheep*[10] links the interest, or lack of it, shown by voting users of the online interactive work in certain sheep to the complicated notion of "aesthetic value".[11]

In *Electric Sheep*, the server continuously updates ratings (based on the number of votes received) for sheep. These ratings are then used as the basis for deciding whether sheep should be allowed to survive or be killed off:

> "The votes of the users form the basis for the fitness function for a genetic algorithm on a space of fractal animations."[12] (Draves, 2005)

Scott Draves et al. (2006) expected to see a correlation between fractal dimension, taken as a measure of the complexity of the fractal image, and the rating of the sheep. Such a correlation was found:

> "The data show an inverted U-shaped curve in the relationship between aesthetic judgments of flames and their fractal dimension, confirming and clarifying earlier reports." (Draves et al., 2006)

In *Electric Sheep*, users' votes form the basis for the fitness function and as such are a measurement of the aesthetic value given to each sheep. Users are simply asked to vote for their favourite by pressing the arrow-up key or register a negative vote by pressing the arrow-down key on their keyboards.

A voting mechanism will also be used in *Riverrun* to evaluate the degree of collective interest in texts. The degree of interest expressed will, in turn, be considered a measure of the text's artistic merit. Such an open and free mechanism allows voters to come to their own decisions without interference from any external influence or rules. It does not, for example, exclude the role connotative associations may play in the forming of aesthetic judgements. It thus evades the risk of distortions which may occur in exclusively quantitative[13] and formalist analytical approaches which limit themselves to a

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[10] See: http://electricsheep.org/
[11] This study takes as its starting point the earlier work of one of the co-authors of the paper, physicist Clint Sprott (1993, 1994, 2003). In these studies he had proposed fractal dimension as a measure of complexity of a fractal image and examined its relationship to aesthetic perception.
[12] The artist describes the operation of this function as an "aesthetic evolution" (Draves, 2005) and refers to earlier artistic work of Karl Sims[12] and theoretical analysis by Alan Dorin (2001) in this area.
[13] Massumi also points out the limitations of a quantitative approach to art. (Massumi, 2002, pp. 135-136)

consideration of the roles noise, coherence and novelty play in judgments of aesthetic value (Peak & Frame, 1994).[14]

While members of the collective of voters may express an interest in *Riverrun* texts according to different subjective criteria, it would seem probable, considering previous studies including that of Draves' *Electric Sheep* (Draves et al., 2006), that after a public vote, a strong correlation between a high total number of favourable votes cast and emergence of complexity at the edge of chaos would be discovered.

An earlier study (Abraham et al., 2003) using visual stimuli of varying mathematical complexity shows how differences in individual responses may be very marked, outstripping differences attributable to differences in cultural background, gender or age. Nevertheless, the individual correlations between complexity judgments and aesthetic judgments were still very high. 12 of the 18 participants scored more than 0.8 and one scored a maximum 1.0.

It is very striking that this study, aside from showing a high correlation between complexity and aesthetic judgements, also suggested that there is a shared response across different cultural groups to the same visual stimuli[15]. It would be interesting, as part of *Riverrun*, to conduct a similar study of the individual and shared patterns of response to a broad range of texts generated. Such a study could take the form of online collective writing experiments involving both the general public and groups of writers and voters of different cultural backgrounds, languages, ages and levels of expertise. There would be little risk of skewed results, since readers would be able to vote completely freely [see appendix 03] and different makers/local viewers could approach the writing task in radically different ways, should they wish to do so.

b) To amplify

In *Riverrun*, it is expected that the human-computer interaction, a mixture of random and automatic processes, human control and personal creative contributions, will increase the potential for emergence in the collective creative process. The creative potential of the collective should be amplified in the sense that the whole becomes greater than the sum of the parts.

This can be compared to the human-computer interaction and its positive effect on creative production in Draves' *Electric Sheep*. Genomes for new sheep come from three possible sources: Randomness, a genetic algorithm (which performs a mutation or crossover) and user contributions, since users can post hand-designed genomes to the project (Draves et al., 2006). But crucially, users' votes decide which genomes should remain in the gene pool. Post-event analysis of data gathered from *Electric Sheep* indicated that:

> "*Electric Sheep* functions more as an amplifier of its human collaborators' creativity rather than as a traditional genetic algorithm that optimizes a fitness function." (Draves, 2005)

The first two operators in *Electric Sheep*, randomness and a genetic algorithm, are processes which are not controlled by users. This is also true of the random positioning of each maker/local viewer in the *Riverrun* texts and the radius of visibility setting. Furthermore, in *Electric Sheep*, the last operator **is** influenced by the user who is able to input his own creative design to the gene pool. This process can be compared to that of

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[14] American mathematician George David Birkhoff acknowledged the limitations of his mathematical measure of aesthetic value in art, music and poetry of different cultures: Aesthetic Measure (M) = Order (O)/Complexity (C). His attention was "directed almost exclusively toward the formal side of art". (Birkhoff, 1933)
[15] While *Electric Sheep* simply asks users, as will *Riverrun*, to vote for their favourite, these experiments on fractal dimension, complexity and aesthetic judgements asked participants to rank images according to their perceived beauty. "How beautiful was the image?" is a very different question from "Which text did you find most interesting?" or simply asking participants to vote for their favourite.

the makers/local viewers writing and submitting their own creative contributions to the textual mix in *Riverrun*.

"Complexity from simplicity" is a theme of A-Life and a goal for much human endeavour (Dorin, 2001). Bartolo Luque expects that in *Riverrun* it will be possible to establish a mathematical relationship between the value set for the radius of visibility as a function of the total number of writers and the probability of emergence of complexity at the edge of chaos. Should such emergence produce texts deemed more interesting in a vote, this being taken as a positive indicator of artistic merit, it should be possible to programme *Riverrun* in the future so that the settings for future experiments are likely to produce a marked amplification of the writing collective's creative potential.

2 To provide a means of making the experiments sensible for the global viewer/ installation visitor.

As makers/local viewers create collectively across networks and neighbourhoods, their creative decisions are projected as text and codified as sound in an audiovisual installation. For visitors (global viewers) to the exhibition space, this 'making sensible' happens in real-time.

The main broad aim of the installation design is to provide a mechanism for connecting global viewers, through this appeal to sensation, to the event's expanding potential as a collective creative process.

This process can be split into two component aims:

    a. To heighten anticipation of comprehension in the global viewer
    b. To adequately reflect the intensity of the feeling-thinking of the makers/local viewers

a. To heighten anticipation of comprehension in the global viewer

For Susan Laxton (Kochhar-Lindgren et al., 2009, p.30), it is a condition of the organic work of art[16] that "anticipating the comprehension of the whole guides the comprehension of the parts."[17] As visitors move around the *Riverrun* installation anticipation of the global work's meaning[18] guides them to detect links between, and understand, what otherwise would seem disparate and unconnected parts of it. Such a process is at least in part subjective, as pointed out earlier. *Riverrun* does not in any way pre-suppose a fixed unitary meaning for the global text or for the individual actions of the collective, but rather affords a potential for interpretative variety. This process, for most visitors, begins before the global story has fully crystallized, if it ever does, since its evolution and sound codification are experienced in real time. The visitors' anticipation is both challenged and amplified as both the whole and the parts of the artwork are in flux. This feeling of anticipation is a both a registering of and connection to the situation's expanding potential.

A similar sensation occurs in Boursier-Mougenot's zebra-finch installations[19] described earlier. On walking around the installation, visitors anticipate that a musical coherence exists or will emerge in the variety of distinct sounds they hear. This expectancy guides

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[16] Susan Laxton was referring to the traditional exquisite corpse technique as an organic work of art.
[17] A mathematical/ biological perspective of the whole and its relation to the parts offers an interesting and compatible view: "Parts of an organism – leaves, roots, flowers, limbs, eyes, the heart, the brain- don't individually create themselves to be later assembled into a whole, as happens in a machine. Instead, they emerge as the result of interactions inside the organism as it develops." (Goodwin, 1998, p.240)
[18] The related theme of the importance of novelty in the communication of meaning should be addressed later.
[19] For visual documentation see:
http://www.barbican.org.uk/artgallery/event-detail.asp?id=9713 and
http://www.paulacoopergallery.com/artists/CBM/works/26. Another installation featured as one of the works in the group exhibition "*on&on*" at La Casa Encendida, Madrid from 19/11/2010 to 16/01/2011.

their comprehension of the live *soundscape* as their attention fixes on, and switches between, the actions of particular birds perched on one instrument or another.

In the *Riverrun* installation, global viewers' interpretations, sensations and feelings are also mediated by their previous experience and emotional insight. This extends to their perception of sound since there is sound codification of the textual modifications.

Last but not least, it should also be remembered that one of the graphic designer's roles in *Riverrun* is to use typography to reflect the text's genre or style. This engages with the global viewer's memory and visual record, heightening their anticipation of comprehension, as both the familiar and the novel are experienced together in real-time.

b. To adequately reflect the intensity of the feeling-thinking of the makers/local viewers

An important feature of *Riverrun* is that while makers/local viewers interact, only their inputted textual modifications are registered and visible to other makers/local viewers and global viewers. A large part of the lived interactive process, the sensations, doubts and prevarications occurring in the spaces in-between these inputs remain hidden from view.

This creates a resonance, an intensity (Deleuze, 1968 trans. 1994) in the transitions[20] between the evolving visible words or form themselves and what can only be imagined of the living creative process involved in that evolution; each passing thought or change of mind or momentary stop and start. As makers/local viewers anticipate and adapt their rhythm and steps to those of others, this resonance must surely be felt for coherence to emerge.

This intensity or affect[21] is felt by the makers/local viewers as they create. A sense of it can also be transmitted to the global viewers.[22] *Riverrun* seeks to provide a heightened lived experience of this intensity to the maker/local viewer and the global viewer as its experiments unfold in real-time.[23]

(b) The scientist

As one would expect from a collaborative endeavour whose first cause is a shared interest in collective creativity, the aims of the scientist coincide with those of the artist. This is particularly the case with regard to the first and third aims of the artist outlined above: "To explore and amplify the collective creative potential of online writers" and "to offer insight into the collective creative process."

If a hybrid approach is to be viable, the parameters set must not only ensure *Riverrun*'s viability as an art event, but must also allow for a scientific analysis of outcomes. It is therefore essential that *Riverrun* gathers sufficient relevant data[24]. The mechanisms which make subsequent scientific analysis possible and the ways in which this analysis might offer insight into the collective creative process will be outlined below.

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[20] Massumi (1998) links such transitions to the virtual: "The virtual is not contained in any actual form assumed by things or states of things. It runs in the transitions from one form to another."
[21] Brian Massumi describes affect as "precisely this two-sidedness, the simultaneous participation of the virtual in the actual and the actual in the virtual, as one arises and returns to the other." (Massumi, 2002, p.35)
[22] This was evident in some of the initial *Riverrun* trials which have already been performed.
[23] Massumi reminds us that "Deleuze and Guattari, following Bergson, suggest that the virtual is the mode of reality implicated in the emergence of new potentials. In other words, its reality is the reality of change: the *event.*" (Massumi, 1998, pp. 16-24)
[24] Physicists need a sufficient number of observations in order to discover "laws" related to collective human behaviour, as Condorcet explained in "Essai sur l'application de l'analyse à la probabilité des decisions rendues à la plurité des voix", 1785

For each *Riverrun* experiment:

    a. The range of visibility for each maker/local viewer is set manually or automatically.
    b. The random position of writers does not change and their contributions remain discrete.
    c. Its status as a circular or conventional text writing experiment is set beforehand.
    d. The total number of makers/local viewers is always known, even if it changes.

These known values allow Bartolo Luque to quantify the range of possible direct and indirect influences on each maker/local viewer.

The ongoing outcomes related to the position, timing and content of individual modifications must also be adequately recorded if Bartolo Luque is to perform a post-event mathematical analysis of the collective behaviour of makers/local viewers and consider how the work has evolved in relation to the above settings' values.[25]

Bartolo Luque's thesis, based on earlier mathematical studies and physical models of complexity and self-organisation[26] is that a phase transition will occur in *Riverrun* at a certain radius of visibility relative to the total number of makers/local viewers.

The term phase transition is more commonly used to describe changes of state in matter at certain temperatures or pressures. For example, a liquid becomes a gas and abruptly changes in volume when it is heated to its boiling point. But abrupt changes very similar to this collective phenomenon have been observed in human behaviour, communication and organisation. For example, in 1971, Henderson (Le Roy F. Henderson, a mechanical engineer) showed that the movements of people in crowds seem to obey the Maxwell-Boltzmann statistics of the kinetic theory of gases (Ball, 2003). Pedestrian movement has been shown to be self-organising (Helbing et al., 2001).[27]

Models of social interaction seek to explain collective human behaviour in terms of simple rules regarding interaction between individuals[28] and a few key stimuli. *Riverrun* shares certain characteristics with multi-agent systems in that these are communities of at least partially autonomous agents which perceive and act on their own, but may also cooperate with others in the community to achieve a common goal (Sun, 2006). In multi-agent systems, no agent has a global view of the whole field of interaction and no one agent has control over outcomes. (Wooldridge, 2002)

Scientific models or simulations of social interaction and cognition (Sun, 2006) cannot address the multiplicity of lived sensation and psychological complexity of social interaction.[29] Nor can post-event mathematical analysis provide a complete understanding of real-life collective behaviour. But what models have shown us is that organisms do not have to communicate globally in order to co-ordinate their actions or self-organise. (Ball, 2003) As individual organisms, perhaps humans can only respond to the movements of their near neighbours, but as a result of this local interaction, influence can spread globally.

As we mentioned above, Bartolo Luque expects that in *Riverrun* there exists a critical value for the radius of visibility relative to the number of writers which will lead to the

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[25] It should be pointed out that while the changes each individual makes in *Riverrun* are observable as discrete modifications, the influence a change has on others could be very subtle or, at the other extreme, immediately effective.

[26] Such collective phenomena can be observed in particles, fish, bacteria, insects, birds and humans and modelled using the techniques of statistical physics.
See (Spanish): http://www.dmae.upm.es/WebpersonalBartolo/divulgacion_Complejidad.html

[27] Philip Ball has explained the role of statistical physics in understanding collective social behaviour in a broader sense, e.g. in the transmission of cultural traits, voting, in economic markets etc. (Ball, 2003)

[28] See appendix 01 for examples.

[29] These aspects of lived experience are a fundamental part of any collective art event. Indeed, as explained in the previous section, it is one of *Riverrun*'s aims to heighten such sensation.

spread of influence beyond the local and to the emergence of complexity at the edge of chaos (see diagram below). Should this occur, his thesis continues, more interesting texts should be produced.

It is easiest to understand the effects of the radius of visibility by examining the two extremes:

1. Were each writer contributing in blind isolation (at radius of visibility = 0), there could be no emergence. The maker/local viewer would have no influence as a creative node or transducer and no potential as an agent whose modifications could influence or reconfigure the global text. Modifications would occur in isolation and the global field, the text as a whole, could not become comprehensible for the global viewer unless this occurred purely by chance.

2. Conversely, were each writer to have complete access to the global text (at radius of visibility = number of writers), the excess of information would most likely overwhelm the writer, hampering them from changing their own line. Emergence would be very improbable and the text would fail to crystallize.
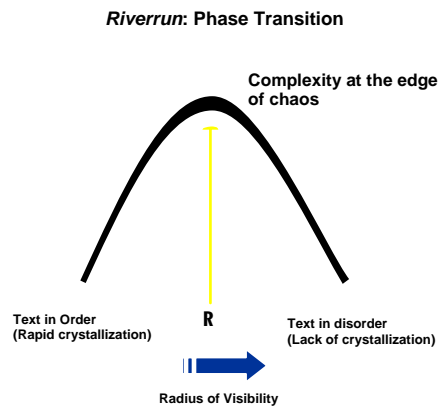

Riverrun: **Phase Transition**

Fig. 2: Bartolo Luque expects that there exists a critical value for the radius of visibility relative to the number of writers which would increase the probability of complexity at the edge of chaos.

If there does exist a critical value for the radius of visibility relative to the number of makers/local viewers, complexity at the edge of chaos would more probably emerge at this critical value.

Complexity at the edge of chaos would indicate that the text as a whole has reached the point of maximum tension between order and disorder. Understanding when this has occurred is a question of observation and analysis of behaviour rather than the content of the text. However, the question raised, as to whether at this point of maximum tension the most interesting, or optimal, text has emerged, will be addressed post-event through an analysis of the votes cast for each text.

Bartolo Luque expects that a correlation between the mathematical complexity of texts and the number of votes[30] they receive will become evident. If this correlation does become apparent, this would imply that *Riverrun* could become an efficient tool for maximizing the potential for producing interesting texts in future installations and experiments.

(c) The programmer

The role of programming is central to *Riverrun* since it is as an agent for bringing online interaction and physical environments onto the same affective plane of perception in a

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[30] As above, it is assumed that a collective expression of voter "interest" is an indicator of "artistic merit".

way which ensures that the experiments are viable as both artworks and as objects of scientific analysis.

Riverrun solicits creative behaviour from makers/local viewers who are placed randomly within a field of collective interaction. Members of this living community cannot see the evolution of the whole work. Makers/local viewers' visibility is limited to a certain radius relative to the total number of participants. This value is set automatically by the program or manually by the administrator at the beginning of each experiment.

The program assigns a random position to each of the makers/local viewers as they join the experiment. It can also be set to adjust, whenever necessary, the total number of lines in an experiment. When this setting is chosen, the text can expand in order to accept new makers/local viewers and contract to remove those who have joined but not contributed to the experiment, or those who have clearly abandoned it. These mechanisms represent two ways in which programming is crucial to the success of each experiment. The former introduces randomness[31]. The latter ensures experiments do not fail or break down due to frustrating queues and unoccupied or dead lines.

It is a principal task of the artist to bring these unscripted experiments into embodied existence[32] for the global viewer. Without appropriate programming, this aim could not be achieved.

From a scientific perspective, the data the programme generates and records is essential to perform an adequate post-event analysis. This data relates not only to the settings and operational outcomes of the above mentioned mechanisms but also includes the contents and timings of each writer's contributions.

An early basic trial version of *Riverrun*, developed using open source web application framework *Ruby on Rails* by programmer Pablo Villalba, can be found at: http://github.com/micho/riverrun. This version, however, does not adequately address the artistic and scientific requirements of the project.

For this reason a totally new version will be produced. It will not only ensure the viability of *Riverrun* in terms of artistic and scientific function, but will also respond to feedback received from trial runs of the earlier version of the program with regard to design and usability.

The new program will add the following features:

a) The number of lines in the global text will adjust automatically to the number of makers/local viewers i.e. the global text will expand and contract when makers/local viewers enter or abandon the experiment.

b) The radius of visibility will have two operating modes: automatic and manual.

c) The design will be simple with a strong emphasis placed on usability.

d) As in the trial version, a textual record detailing each change to the global text, along with its timing and position, will be generated for each experiment to facilitate post-event scientific analysis.

e) The program will include the codification of the participants' creative decisions as sound.

f) Participants will not be restricted in the amount they can write. They will also be able to see the whole content those within their radius have inputted. A scrolling system enabling this will be used.

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[31] This could be compared and contrasted with the use of chance operations in art forms, such as the Dada practice of drawing words blind from a bag to make poetry.
[32] Again, this refers to making *sensible,* rather than the provision of a literal *meaning.*

g) The visualisation and projection mechanisms which permit global viewers to see the texts as they evolve will include the option of incorporating typographic elements.

h) Options for outputting each text as video after the event will be included. A simple sequencing application which automatically orders the timing and placement of contributions and sets the typeface to be used will suffice.

(d) The sound engineer / composer and graphic designer

Deciding on how this installation should be designed requires an understanding of how best to bring visual, textual and sound elements together into a common field of relations for the global viewer. In order to do this, the design will be carried out in collaboration with a sound artist and a graphic designer.

This codification process will clearly affect global viewers' perception of the evolving work in the physical space of the audio-visual installation. It may also lead to post-event engagement with theoretical debates surrounding art, technological production, language and chance.

Codifying processes are not unusual in the contemporary arts. In the case of the French artist Céleste Boursier-Mougenot mentioned earlier. Many of his installations merge, or codify relations between behaviours, the visual, sound and word.

His 2005/2009 piece *index* codifies everyday social actions. *Index*:

> "hinges on a computer program designed by the artist that translates fragments of language typed on the gallery's office computers into a musical score played in real-time by an acoustic piano placed in the gallery. The program isolates a set of notes, dynamics and other musical terms from the language typed on the gallery's computers to build its ongoing score. Acting as conductor, composer, and instrumentalist all at once, the piece renders an in situ musical phenomenon that registers the labour of the gallery and plays it in song."[33]

Such codifications are not direct unmediated translations. In *Index*, A letter does not simply correspond directly to a sound. The codification structures the typing events, since a program, rather like an automatic composer makes creative decisions. It isolates recognised musical properties and patterns in the writing event and then presents them as sound in real-time. This attempt to link the properties and patterns of office workers typing with those of music is reflected in *Riverrun*'s intention to link makers/local viewers' textual inputs with sound, and in this respect, the projects share certain important technical and procedural requirements.

Riverrun also addresses how creative decisions occurring within a closed system of interactions are affected by that system's structural parameters. It artistically explores and scientifically addresses how these parameters influence creative outcomes in ways that make them different from those we would expect from a purely random system.

In codifying decisions as sound, emergence may become perceptible as sound. If so, it would be interesting from both a theoretical and scientific perspective, to explore whether in such an instance, the associated text produced receives a high number of votes.

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[33] Quoted from webpage: http://www.frenchculture.org/spip.php?article2335

02 The event

(a) The maker/local viewer (See Fig. 1)

Riverrun imagines the collective creative event as a living interactive process. Its viability, as a creative process and event, depends on the participation of makers/local viewers. If they do not participate, nothing happens. This is, in an important sense, similar to *Electric Sheep*. As Scott Draves says:

> "*Electric sheep* centers on the role of experiencers in creating the experience. If nobody ran the client, there would be nothing to see." (Draves, 2005)

Riverrun also focuses on the living community of makers/local viewers and their experience as interacting creative agents. Their perspective and experience of the unfolding creative experiments cannot be the same as that of global viewers, since in *Riverrun*, makers/local viewers have a delimited range of visibility with regard to the actions and decisions of their immediate neighbours.

For the maker/local viewer, the creative decisions and perceptual fluxes occur within a neighbourhood of immediately available local knowledge, set within a broader plane of social interaction. This is radically different to linear techniques such as the traditional *Exquisite Corpse,* and many of its later modifications, in which sequential and blind contributions are followed by revelation. In such traditional techniques, any instance of emergence can only be explained by referring to abstract phenomena such as psychic interplay between the contributors or by pointing to the creative social influence occurring before, and not simply through, the event.

In *Riverrun,* makers/local viewers see, and are influenced by, their immediate neighbours' contributions in real time. As the constructors of signs and forms, they are its living creative tissue. Everyone is directly linked to their immediate neighbours and influenced by them, regardless of whether they choose to compete or collaborate. A maker/local viewer's contribution can never be described as the outcome of a solely internal, individual or personal process. Subjective and idiosyncratic contributions are perfectly possible, but a maker/local viewer's autonomy can only be partial, since their decisions are inevitably influenced by an external flux of ever-changing surrounding content.

Yet makers/local viewers cannot see the whole organism. There is a kind of fold between the seen and unseen for each maker/local viewer, between their neighbourhood group and other ones. Since these neighbourhoods overlap, a maker/local viewer may be indirectly influenced, through intermediaries, by others beyond their local field of vision and awareness. Influences on them cease to be purely local in character. This raises the question of whether influences might extend across the whole collective, guiding *Riverrun's* text towards some form of crystallisation and organisation. Such an outcome would indicate an emergent "unconscious reality" or intelligence.

In an early *Riverrun* test, set up during the recent Electrosmog Festival of Sustainable Immobility[34], it was shown how this can happen with a small number of total writers. One writer introduced a "seal" as a character in a short story. Interest in this character as a useful comic element picked up among neighbouring writers and the seal slowly came to appear throughout the whole story. It remains to be seen whether such influence can extend itself across a wider number of participants.

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[34] See http://www.electrosmogfestival.net/

(b) The global viewer

On entering the installation, the global viewer experiences the event from a very different perspective than that of a maker/local viewer. The global viewers perceive the total field of interactivity and creation as projections of evolving textual forms and signs accompanied by sound.

The concepts underpinning the work are not immediately evident. Since the texts are evolving in real-time, rather than presented as completed literary works, any 'reflective judgement'[35] or meaning garnered can be considered a function of the global viewers' sensation, feeling, interest and comprehension as they move around evolving forms and texts, rather than the result of their engagement with a coherent static work. The degree and character of affect and comprehension will depend on the redundancy, novelty[36], noise, harmony and dissonance (Peak & Frame, 1994, p.232) perceived in the installation itself and connotations linked to the visitor's past experience, expectations and temporary mood (Forgas, 1995). Their movement around the space will fundamentally impact on this experience.

The evolving artworks can therefore be seen as a shifting relational architecture open to many types of engagement. They are experiential events for the maker/local viewer and the global viewer as the words and lines continuously transform and reconfigure themselves. For global viewers, there are no neighbourhoods and the parts of each text can never be emancipated from the whole.

(c) The administrator

The radius of visibility and the number of participants can be manually set by the administrator at the beginning of each experiment or preset to vary automatically from one experiment to the next. This allows for a continuous exhibition of evolving stories in the installation. When the story is to be stopped can also be preset automatically or taken manually whenever clear evidence of emergence has appeared.[37]

The above is significant because adjustments to these settings will affect creative outcomes. As mentioned earlier, should the values set be conducive, it is Bartolo Luque's contention that emergence will be more probable.

Conclusion

Riverrun, as a series of unscripted experiments, never divorces itself from the perspective that life is both a process of interaction with others and a continuous unfolding of non-transferable individual experiences[38]. (Maturana, 1995, p.3)

Its design, which must accommodate both artistic and scientific needs and a hybrid approach to understanding collective creative process, seeks to provide a collective creative function for the living community of makers/local viewers. For this community, the intensity experienced is part of a live collective creative process as they all (inter)act, perceive, think and sense. Global viewers are witnesses to this process as it unfolds in real-time in a shared physical space. They are placed in the context where emergent relations are made sensible. This collective creative process is not straightforward. As in

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[35] A term used by Kant in the Third Critique.
[36] The importance of novelty in artistic experiments became clear in *Electric Sheep*. Draves found that the audience became fatigued by repeated exposure to variations of a successful genome. The audience stops voting for them, even if these once popular sheep are re-introduced much later. (Draves, 2005)
[37] The administrator controlling the "stop" button could have a pernicious effect on outcomes. This responsibility should not be passed over lightly. Scott Draves (2005) points out that in *Electric Sheep* administrators interfered in the collective process by occasionally killing sheep, explicitly directing mating, provoking mutations, reincarnating previously dead sheep and voting without limit.
[38] "vivimos nuestro ser cotidiano como un continuo devenir de experiencias individuales intransferibles." (Maturana, 1995, p.3)

life itself, which exists at the edge of chaos, it is unpredictable, since it involves randomness and chance. *Riverrun* is an event.

The artist is concerned with lived experience; the intensity of the thinking-feeling of makers/local viewers as they interact and that of global viewers as potential expands during this event.

Each creative decision taken indicates paths which a maker/local viewer has chosen not to take. As they exercise their poetic freedom, this collective summons a world yet to come. In order to explore the rich potential of such collective creativity in all its possible variations, experiments should cover a wide range of literary forms. Groups of writers from across and within different language-speaking zones[39] should be invited to take part and experiments for both lay and professional writers should be performed. It would also be valid to repeat experiments with the same makers/local viewers. The outcomes should be compared post-event. Voting rounds should be conducted within and across different groups to see if there is a variance in voting results. Attention should also be paid to individual differences in response.[40]

The data produced in the course of each event is a register of the forces exerted on each text[41]. While this is not the creative process itself, this data opens up each experiment to scientific and critical analysis.

The scientific approach reflects Bartolo Luque's conviction, shared by many theoretical physicists, that in order to reduce nature to laws, all that is required is an adequate number of observations and a mathematics complex enough (Ball, 2004, p.66).

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[39] In the short run, speakers from different Spanish speaking zones, such as Mexico and Spain will be invited to participate. Parallel projects in English could also be set up. In the future, this will be expanded to include speakers of other languages.

[40] Previous studies in visual art suggest that information garnered from previous experience leads to a more cognitive mode in the reception of artworks while non-experts tend to respond in a more direct emotional mode. (Leder et al., 2004)

[41] This could be compared to mathematical biologist D'Arcy Wentworth Thomson's observation that shells, horns, and such-like are non-living by-products rather than living tissues in their own right. (Kemp, 2006, p.203)

Appendix 01: Mathematical models of Collective Human Behaviour

The Voter Model

The voter model is a mathematical model which describes the formation of opinions, attitudes or cultural attributes through social contact. It models how randomly chosen agents come into contact with neighbours and how they adopt or reject those neighbours' attitudes or cultural characteristics such as political opinions or musical tastes.

Geneticists Kimura and Weiss (1964) introduced the stepping stone model. This was developed by other geneticists over twenty years. It was subsequently discovered and named the voter model by probability theorists Clifford and Sudbury (1973) and Holley and Liggett (1975). Since then, it has been adapted and extended for a wide variety of contact process applications.

The voter model can be used to simulate and consider a broad range of emergent phenomena, including social interaction. The model generates structured output from a given random input. The output can be visualised in agent-based form using cellular automata, coloured cells representing agents which may change shape or colour over time as they come into contact with neighbouring cells. Probabilistic rules are assigned to the behaviour of agents, their movements and how and with whom they interact over time. Since the physical status, colour or shape, of each cellular automaton indicates the agent's current set of attitudes or characteristics, we can analyse how contact with a neighbour or neighbours affects them over time. For example, they may or may not imitate the majority around them.

In some computational models, the actions of agents are simultaneous and in others they are asynchronous. For asynchronous actions an activation order for agents must be decided. Agents could simply take actions randomly, or according to their geographical coordinates, movements, the number of neighbouring agents or certain endogenous characteristics such as age, propensity to conform, or incentive to act.

When talking about social systems, it is important to avoid strict determinism. Randomness is also important since it can help us account for very human aspects of decision making, such as making mistakes, the desire to experiment or the influence of personal bias. It should be noted that "randomness" is not synonymous with random behaviour. In a language competition model adding such probabilistic random noise might mean that an agent mistakenly assumes a neighbour speaks their language. Agents are more likely to make such mistakes when surrounded by others who do not share their characteristics.

Since interaction between speakers of different languages is one of the specific themes of this research project we might take a closer look at some existing voter models of language competition:

The Abrams-Strogatz model (Abrams & Strogatz, 2003) is a model for the dynamics of endangered languages and addresses competition between two languages. In this model an individual within a network can be in two possible monolingual states: A speaker of one language (A) or a speaker of another (B).

The agent's status or rather change of status depends on the density of speakers of each language in the surrounding local community, the social prestige of each language and the volatility (inertia or propensity of the agent to change language).

The Minett-Wang model (Wang & Minett, 2005) extends this model to take account of bilingualism. Agents can therefore speak one language (A or B) or be in a bilingual state (AB) and so the three rather than two local densities for each state must be considered in relation to each agent (node).

Equations allow us to calculate various probabilities on the basis of these densities, the prestige of each language and the volatility: The probability of a monolingual agent (A or B) moving to the bilingual community and the probability of a bilingual agent (AB) moving to the monolingual (A or B) community. When an agent changes state from one monolingual state to the other (A to B or B to A) the agent passes through an intermediate AB state.

The Abrams-Strogatz model and the Minett_Wang model (Cellular Automata: Screen capture of applet[42])

APPLET: Abrams-Strogatz Model VS Bilinguals model
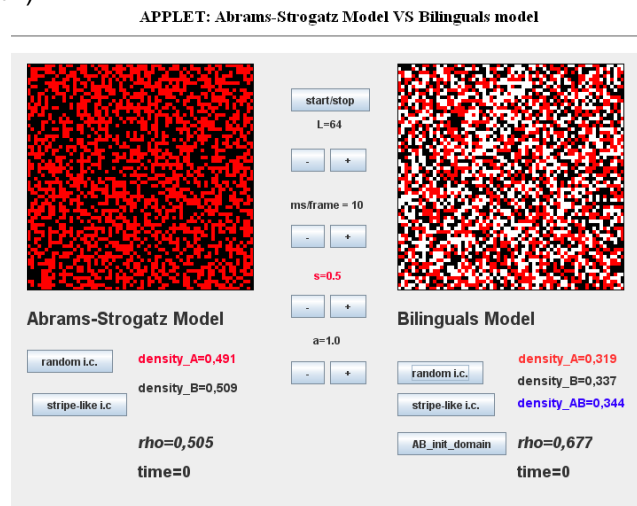
Castelló, Eguíluz, and **San Miguel** (2006) proposed another 3-state extension of the voter model concerning language competition. The specific aim of this model was to explore possible mechanisms which might lead to a state of stable co-existence, or meta-stable states, rather than the eventual dominance (or extinction) of one language. They paid particular attention to the role of bilingual agents and social structure, including small world phenomena due to communication and interaction between geographically distant agents, in complex networks.

Additional Points

As a visualisation tool, such models permit the analysis of unfolding events both in real time and retrospectively. The movements and actions of agents can also be re-traced as required. However, we must be cautious. Such computational models do not codify real social phenomena or observed social behaviour, but simulate it.

In the voter model, consensus is said to be reached when a model arrives at an "absorbing" (constant) state. Although different initial conditions and applied rules affect the outcome, the result is always consensus in the end. In language competition models, for example, one or other language always prevails. Thus, consensus is defined as a stable block of agreement.

Other models do not necessarily lead to an "absorbing" state. Axelrod (1997) proposed a model on cultural dissemination in which, as in the voter model, agents' characteristics or traits converge as a result of concrete social interaction. Agents also tend to interact with those most similar. However, the model concluded that, on a global level, we are tending towards a state of multiculturalism (polarisation), rather than convergence.

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[42] Available here: http://ifisc.uib.es/eng/lines/complex/APPLET_LANGDYN.html

Appendix 02: A Brief Chronology of Previous Research on the Relation of Complexity to Aesthetic Value

The Venus of Lespugues, a figurine carved from a mammoth tusk about 25,000 years ago, employs "an advanced musical arithmetic previously ascribed to Pythagoras, the Vedic Aryans, or the old Babylonians." (Abraham & Thompson, 2006)

Experimental aesthetics has a long history. Scott Draves et al. (2006) point out that around 1588 Galileo's father, Vincenzo Galilei, discovered one of the earliest non-linear relations[43] known in physics when he performed experiments on vibrating strings. In *Dialogues Concerning Two New Sciences*, first published in 1638, his son reflects on musical dissonance and consonance in terms of frequencies, sensation and effect on the eardrum and makes reference to his father's findings (Galileo Galilei, 2010).

Psychologist Gustav Fechner developed an equation which describes the non-linear relationship between physical stimulus and psychological sensation and published his research on the Golden Ratio (Fechner, 1876). Later, American mathematician George David Birkhoff (Birkhoff, 1933) proposed the following formula as an aesthetic measure in art, music and poetry of different cultures: Aesthetic Measure (M) = Order (O)/Complexity (C)

Rashevsky (1938) identified aesthetic value with excitatory effect and proposed a measure of this based on mathematical assumptions of excitation and inhibition in cortical neurons. This measure bears a curvilinear rather than direct relation with Aesthetic Measure (M) as proposed by Birkhoff and reaches a sharply delineated maximum when M is at an intermediate value.

Leder et al. (2004) summarise more recent experiments performed on the effect of visual complexity, and other variables in visual stimuli, such as colour, intensity, brightness, saturation, symmetry and size, on viewer preference.

With regard to complexity and aesthetic response Berlyne's 1974 theory (Messinger, 1998) is particularly relevant to Bartolo Luque's thesis. This theory states that viewers' pleasure in response to an object will increase with increased complexity, to an optimal level. With increased complexity beyond that optimal level, pleasure begins to decline. It is expressed in an inverted U-shaped curve for pleasure, with a linearly increasing line for complexity.

Subsequent experiments have produced varied results, some in agreement with Berlyne's theory and others which are not. These include a study of verbal preferences and sequential variability which did produce an inverted U-shaped curve indicating a correlation between complexity and pleasure (Munsinger & Kessen,1964).

Benoit Mandelbrot's 1983 book, *The Fractal Geometry of Nature* (1982), explored the relationship of fractal mathematics and dynamical systems to aesthetics.

More recently, David Peak and Michael Frame, inspired by the work of Richard Voss and others on noise, coherence and novelty in music discussed the relevance of the same concepts to analysis of the visual image. (Peak & Frame, 1994, p.232)

Nadal et al. (2010) found that divergence in experimental findings on the relation between complexity and perceived aesthetic value was mainly due to differences in the conception, manipulation, and measurement of visual complexity itself.

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[43] "The pitch of sound (or, better, its frequency) is inversely proportional to the length of the string and linearly proportional to the square root of the tension (if the linear density of the string is held constant)". See: http://www.icmm.csic.es/within-experimental-error/?page_id=207

Appendix 03: An Overview of Recent Research on Affective State, Experience and Aesthetic Judgements with particular reference to Contemporary Art

Leder et al. (2004) argue that abstract concepts and theoretical concerns have become increasingly dominant in contemporary art. This does not negate the importance of formal appearance or stylistic variation in artworks. It does show, however, that top-down influences cannot be divorced from aesthetic response to contemporary art. Viewers' past experiences and knowledge of practice, language and theory may be very different. The complex interplay of novelty, originality and familiarity may therefore be perceived very differently by an expert and a novice as they encounter the same work. Aesthetic pleasure is more probable, Leder et al. continue, if the viewer "understands" the work.

Cupchik and Laszlo (1992) claimed that in forming aesthetic judgements less experienced viewers refer more to emotional response, while experts' reception is more cognitive. They therefore differentiate between pleasure-based and cognitive-based modes of reception.

Leder et al. (2004) argue that the use of everyday materials, objects and new media, such as video and the web, has led to a "marked tendency" to abandon the notion of beauty as a measure of artistic merit in favour of pleasurable response and cognitive stimulation and interest.

Blood and Zatorre (2001), found that there is a clear correlation between pleasure and emotional arousal. They studied neural mechanisms underlying pleasurable responses to music. They measured changes in blood flow in different cerebral regions, heart rate, electromyogram, and respiration in participants as they listened to music they had self-selected for its capacity to send shivers down their spine. They found that intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion.

In a later study, Salimpoor et al. (2009) made continuous real-time recordings of subjective pleasure states and simultaneous recordings of sympathetic nervous system activity. This enabled them to obtain an objective measure of emotional arousal. Results revealed a strong positive correlation between ratings of pleasure and emotional arousal.

Forgas had found in the early to mid 1990s, that affective states modulate the modes in which we process social judgements (Forgas, 1995). His "Affect Infusion Model" asserts that when we are presented with more complex stimuli, which demand substantial cognitive processing, our response and evaluations are more heavily influenced by our mood. If we are in a positive mood, we tend to respond holistically, while we respond more analytically when feeling negative.

In the short term, the aesthetic experience itself might change our affective state. Leder et al. (2004) argue that aesthetic experience is a cognitive process which folds into continuously updating affective states and vice versa. The result of this is an (aesthetic) emotion. They agree with Scherer (2003), who found that cognitive and affective experiences are reciprocally related.

To date, as Leder et al. (2004) explain, there is no scientifically comprehensive theory to explain what constitutes an aesthetic experience in psychological terms.

Semir Zeki, since the 1980s has studied the neural basis of aesthetic experience with particular emphasis on colour and motion and the neural correlates of subjective mental states such as love and hate[44]. He has shown that we see different attributes of visual

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[44] See http://www.neuroesthetics.org/statement-on-neuroesthetics.php

input at different times (Zeki, 2004). With regard to our visual memory, a crucial agent in cognitive process and affective experience, he states that:

"What we see today, or are actively engaged in artistically, also forms part of the visual memory record and no doubt modifies it in ways that neurobiology has still not properly addressed." (Zeki, 2001)

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