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## 1. Introduction

I started working with pixels whilst studying with one of those professors one remembers fondly for having been a great source of inspiration. In fact, this story ends with another unforgettable professor. But let's take it one step at a time.

With Daniel Rozin, I learned to look at and work with digital images, one pixel at a time (or, as the course was named: pixel by pixel). The principle is in fact quite simple: if every image is so many pixels wide and so many pixels high, and each pixel contains more than a single colour value, we can examine pixel by pixel in order to analyse, change, or play with it... and by doing this we can virtually create any possible image.

From this point of view, a digital image is, regardless of its origin, nothing more than numerical data. It can be generated by a camera, a computer, or can be one of the twenty-five images per second that make up a video. All these images are coded in the same way, and can therefore be handled in the same way.

For an artist, this is a fascinating fact. It doesn't matter whether it is a still or moving, synthetic or real image: through programming, it turns into an immensely rich creative medium. Programming isn't easy, but it isn't beyond anyone's reach either. After all, programming is reduced to a relatively small series of logical and mathematical operations that even a child in his last primary school years could learn.

In fact, it is surprising how we are constantly using programmable devices these days, and yet programming the majority of them remains not only technically impossible, but also undecipherable to almost everyone. Think of any electronic phone, or a domestic television set. Why isn't it possible to reprogram my remote control to make it carry out the tasks that are most convenient for me, or to lock my phone by pressing a sequence of keys of my choice?

In the 70s, Alan Kay led the Xerox Alto project, which was a direct precursor of today's personal computers. It allowed for the

possibility of using a simple programming language, which is one of the activities that groups of children visiting the Xerox PARC would do: they would programme their own applications. The very name of the programming language they used, *Smalltalk*, already suggested that Kay thought about programming as something that needn't be in the hands of just a handful of people.

Living in a culture that many consider to be 'digital', we should perhaps begin to question whether the ability to program a computer (which is also an excellent way to learn about logic, maths and geometry) shouldn't be universal. Even though the opinion isn't a mainstream position, within the art world there is already a huge group of people who have used programming and digital media as just another artistic tool for a long time, and many have decided to use it as their main medium.

The present text is a personal, descriptive account of how I entered the digital art world through programming, understood from the insignificant position of a programmer who isn't a proper programmer.

## 2. Liquid Video

*Liquid Video* is a piece that came about as a result of working with pixels in the way I described above. It is, at the same time, a modest example of something that is also related to the last piece that I will present within this text: the concept of emergence, which describes complex phenomena generated by repeating simple rules and processes<sup>2</sup>.

In fact, *Liquid Video* isn't really an interactive work. The term 'reactive' doesn't define it correctly either. The most appropriate term to describe it would be that of a live painting, or a mirror. It is a work that converses with its environment<sup>3</sup> regardless of whether the environment contains a human presence or not. In this way, the viewer can choose whether to participate in the constant creation of the image that develops within it or not. If he does, he has to adapt to the rules and rhythm of the piece, as its process will continue regardless of the image being read by the camera.

The installation works as a continuous loop; a coming and going between two states that can be defined, from their appearance, as liquid and drying states. The piece consists of a projection screen and a video camera that feeds the system with the images it works with. In this way, always using images from the video, the first state presents the visitor with a reflection that is increasingly distorted. The colours smear along the digital canvas as if a 'water effect' had been applied to them until shapes are unrecognisable, and the only recognisable features that remain are the actual colours of the environment and the viewer.



Liquid Video: 'Water Effect'

At this point, the system enters the drying state, and the image from the video gradually pulls itself together again. The colours slowly return to their original place, but leave small traces and strokes behind them along the way. In this way, the resulting effect is similar to that of a painting drying, which is created by using the image of the mirror that emulates the video. Just when the image begins to look like a simple replica of what we would see through a conventional video, the process of the water begins again.



Liquid Video: Drying state

The process that creates these two effects is actually extremely simple. The system is only reading a limited number of pixels that make up the image of the original video (just 10,000 out of a total of 307,200), but instead of painting them where it should, it places them on a point that is generated by a basic programming concept: the *Random Walker*.

The *Random Walker* is nothing other than an element whose position is constantly moving up or down, or right or left, randomly. It is a typical exercise in introductory programming courses. This is therefore the foundation of the piece: to read pixels in one place and paint them in another. What is meant by reading and painting is the reading of colour information of a point in the video, and the drawing of this very colour on another point, keeping in mind only two rules: it should not be painted in a completely arbitrary place; a *random walk* would be used starting from the point where the original colour was read, and that not all the pixels should be painted, only a small amount. The only change from one state to the other lies in a slight tendency of the *random walk* to take the points back to their original position, where they constantly read their colour value. The fact that not all of the pixels change allows for the drying effect to emerge, which is nothing other than the traces of colour that a pixel leaves behind when it returns to its original position.

So, they are simple rules that generate far more complex results than might be expected from the mere analysis of rules, at least from an aesthetic point of view. Which is why the concept of emergence was mentioned earlier, as that is how the drying state came about. It wasn't a planned or sought after effect, it came about when the highly simple rules that underlie the piece's programming were carried out, with small variations from the liquid state.

The result is a painting in a state of continuous movement that imposes its rhythm on the viewer, or, rather, its surroundings. When placed before an urban landscape, it turns into an interpretation of it that reminds us of how painterly what is occurring before the camera actually is. The installation was up for a few months in Manhattan, pointing at the crossroads between Broadway and Waverly Place. By night, the taxis' headlights would leave white and red traces on yellow. The passersby, mostly without knowing, also added some colour to the composition, and the newspaper stands would appear and fade away continuously.

Within other environments, *Liquid Video* can be an intimate mirror that plays with one's own image, slowly drawing out and blurring one's features. Leaving traces behind and evoking multiple metaphors about life and the passing of time.

### 3. Painted

*Painted* was made after *Liquid Video*, and, in some way, can be understood as an evolution of the latter towards something that is actually an interactive installation. *Painted* was strongly inspired by works such as Daniel Shiffman's *Swarm* and Rozin's mirrors.

Just like in the previous piece, this work is a digital painting that tries to converse with its environment, but in this case it also starts up a dialogue with the viewers; in fact, *Painted* only converses with its environment when it detects movement - a symbol of life, or at least of activity - within it. Similarly to the way a work of art does not exist without eyes to look at it, this work only exists with the presence and movement of the viewer's body. If nothing happens in front of it, nothing within *Painted* changes. If something moves, a section of the image will change so that it becomes impossible to come close to the work without altering it. It is therefore a work that constantly looks for change in order to respond to it. This is the dialogue it offers. If nothing happens and nobody moves, the piece also remains inactive.

This work, just like *Liquid Video*, uses pixels as its raw material and video as a source of information. It also never updates a frame completely. In *Painted*, only a small section is updated (changed) at a time, based on a specific point. In fact, it uses the point, or one of the points, where movement is detected, so that the viewer is also subject to the rhythm of the piece.

Each section is repainted radially, from the interior to the exterior, as if it were a centrifugal explosion of digital paint. Furthermore - just like in *Liquid Video* -, in the redrawn area, not all the pixels are updated, some are, some are not (once again, randomness is used). This gives the painting a sort of pointillist appearance that makes it more interesting.

The fact that only a single point can change the image at any given moment also allows the user to only leave behind mere traces of his presence. The video that is at the foundation of it all therefore remains in the background after creating an almost painterly image. Consequently, this is a piece that continuously looks for change and movement, and only acts when it detects it. Just like *Liquid Video*, *Painted* is a piece that demands the same space of a conventional painting, but also offers interaction. Its ideal situation could be an art gallery, but also the lobby of a busy space or even a street, as I already described above.





Painted

The piece has an aesthetic value, as its presentation offers a sort of image that is much closer to the art of painting than that of television. It is simply an invitation to look. But it also invites participation and dialogue. If the viewer so desires, he can, on his own or in a group, play with the making of the image. The rules are simple enough to learn, or to sense, quickly, and the result is elaborate enough for time to extend through an act of exploration, which is in fact a participation in the very creation of the piece.

#### 4. On Beauty

*On Beauty* is the third and last piece of this first series. It is a proposal that asks for the viewer's participation in a more direct way, and, in this sense, is a more conventional interactive installation. Following on from previous works, *On Beauty* presents a space with a white screen to the viewer, which is surrounded by the subtle projection of an image that is being processed from a life feed of a camera placed behind the user. Next to the screen, the viewer will find a paintbrush with a small built-in light. By moving this paintbrush towards the screen, he will see how a still image unveils, following his movements. This image is worked on through algorithms that are similar to those used in *Painted* to present a real image in an almost painterly in a sense, embellished, style. In this way, the viewer finds himself in a technologically advanced environment (a plasma screen. a projection. a modified paintbrush ...) and some images that are, at first sight, just pretty images.

The surprise lies in the content of the images, which is revealed by moving the paintbrush. These contain images of children and adults injured at war, and of victims of police abuse. Images that represent social injustice in places that are far from advanced societies, where the heavy presence of technology is often sustained by different conditions in other parts of the world.



On Beauty

Hence the name of the piece: *On Beauty* is a modest claim, a small outcry against the unquestioned acceptance of technology's pre-eminence in advanced society, which often goes hand in hand with opulence; the unnecessary and unbridled consumption of products that have been fabricated under conditions that we would find, in theory, unacceptable.

In fact, there was a clear element of provocation within the work, and the question of whether it might be too risky a piece, whether it might anger some viewers upon realising that they were painting injured children, was raised. The fact is that throughout the two days of the initial presentation, not a single user appeared to bat an eyelid. Many didn't even realise what the image they were revealing actually represented, perhaps because they were not looking for a figurative image within it. Perhaps, also, we are already immune to this sort of images.

*On Beauty* concluded this small trilogy, which was based on the handling of real images. This third piece, which was different to the first two works in terms of presentation, also opened the door to proposing a greater implication from the viewer. All of this influenced the fourth and final piece presented in this text.

## 5. Digital Babylon

This story began with a professor, and I mentioned that it would finish with another. This other professor is Daniel Shiffman, who I had the privilege of being one of his first students. Thanks to his enormous patience, he was able to untie the first knots of my programming Ariadna strings, which were made up of functions and variables, and made up some fabulous classes that inspired the last project that is described here: *Digital Babylon*. Throughout the entire process, he constituted the most valuable support.

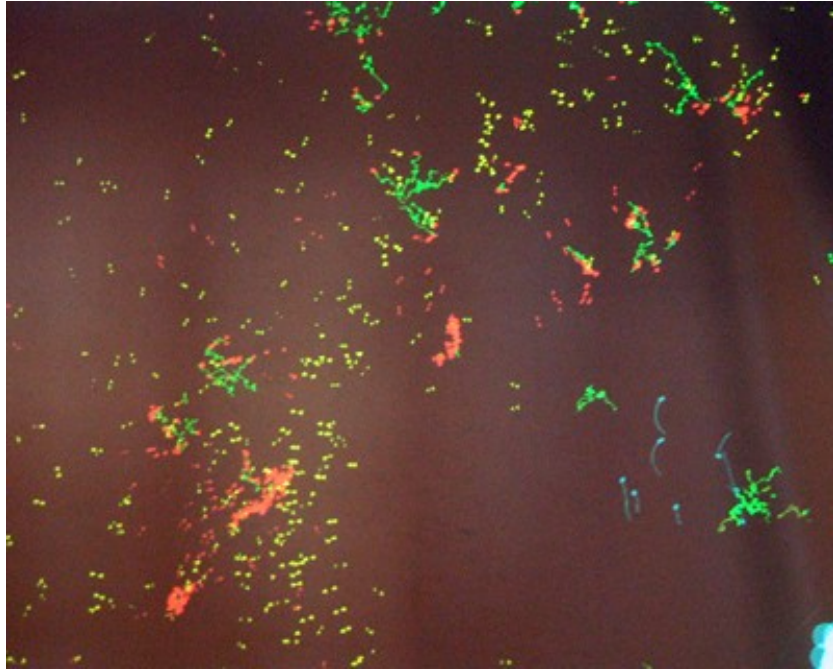
*Digital Babylon* is an interactive installation that is very different to the previous ones. In the first place, its aesthetic, which abandons work with real images in order to concentrate on synthesised ones. Synthetic and simplistic images, as the elements that make them up are intentionally simple so that movements and interactions can give the piece its intended feeling.

The piece presents the viewer with a small virtual ecosystem. The system works without the need for the viewer's intervention, although she can actually intervene in order to alter it. by entering a designated space in front of the projection that presents a virtual space. This installation was born out of the will to propose an alternative to a process that was commonly found in interactive installations. That is, one of a clear duality of states: a first state of waiting, always identical, and a second of interaction. Usually, once the second state is over, the piece simply returns to the first state. *Digital Babylon* proposed to try and make an installation that would accumulate each and every one of the audience's interactions, to offer a proposal to the viewer that is always changing. The point was to offer the viewer two levels of interaction. A level where one finds and understands immediately, and another, more subtle one, closer to the idea of a piece that converses with its surroundings, that we might call cumulative interaction<sup>4</sup>.

The work, inspired by works such as *A-Volve* by Christa Sommerer and Laurent Mignonneau, or Karl Sims' *Evolved Virtual Creatures*, offered a double level of interactivity. One is obvious, with the viewer entering the installation space, and another subtler one of accumulation, developed through evolutionary programming. What follows is a description of the work and its processes.

Upon entering the installation space, the user finds himself before a projection of a black background. Within it, two types of visual elements are moving and a third one gradually appears. They constitute the two species that live within this virtual ecosystem with a third element that they feed on.





Digital Babylon's Virtual Ecosystem

The first species (which we shall call main species) is made up of between a few and a few hundred of simple looking beings (small triangles that change colour when their state changes). Its basic functions are to feed and breed. If they don't do the first of these enough, they die. And if they do it up to a certain level, they can accumulate enough energy to attempt the second function. If the attempt proves to be fruitful, a new being of the same species is born and enters the chain. All of this is done whilst avoiding contact with the other species, which is its predator, as much as possible. The second species also has its own different ways of feeding and breeding. It feeds at the expense of the main species, as it is by eating them that it obtains its food.

The main species finds nourishment in plants, which appear where the lifeless body of one of the members from either species lies, as if its body were a fertiliser for the digital land. The predatory species is aware of this, and always moves around the areas populated by plants. If they find a member of the other species on their way, they will attack it to trap it and eat it.

All these rules and interactions between each individual element generate a considerably complex system, which in its own way creates its own balance and rhythm. There are phases where there is a lack of food, which lead to the death of many individuals, which in turn generates a large number of plants, and, consequently, a new phase of abundance.

Within this whole process, one may observe traces of the aforementioned concept of emergence, as complexity sometimes appears to go beyond the explanation that comes from the mere analysis of the parts

that make up the work, especially if we consider one last aspect that is yet to be explained.

Both species evolve through genetic algorithms. a computer technique that was first described by John Holland in 1975 and then used by artists linked to *A-Life Art* (art made by generating artificial life systems). These works applied basic ideas of genetic evolution to programming. In short: genetic algorithms usually begin with a population of elements (agents, programming subroutines, etc.) made in an arbitrary way within a number of predefined parameters (the genotype): each of these elements (phenotypes) is then evaluated according to predetermined criteria (fitness); the most successful elements are selected to then create a new generation of the population, which will be evaluated again, and so on. The variables that make up each of the elements act as virtual DNA, which is re-combined in consecutive generations. In this way, new individuals, even if they are not the same as their progenitors, inherit the characteristics that have made them successful. Finally, there is also the possibility of applying mutations. That is to say, to randomly alter one of the variables that conform some of the individuals. This allows for the insertion of new possibilities into the system that are different to predetermined ones, and which, if efficient within the environment they emerge in, will enter the evolutionary process.

All of this is applied to the two species of *Digital Babylon*. Every time two individuals of the main species mate, a new individual appears, inheriting their abilities. Here, as in other *A-Life Art* pieces, there isn't a predetermined fitness criteria, Their success or failure depends on their interactions with the rest of the elements within the virtual ecosystem and, as we shall see, on the viewers' actions.

With regards to the predatory species, the process is very similar. Although the reproduction process depends on its actions as a group, the result is the same: only individuals who obtain a certain amount of success within the environment will be able to reproduce.

All of this makes up a complex and, at the same time, changing environment. Both species are constantly evolving. When only a certain type of individuals reproduce, the species as a whole gradually changes, and this in turn affects the rival species<sup>5</sup>. If we finally add the audience's actions to all this, we may come to an understanding of the idea of a double level of interaction. The way this interaction is produced is, simply, through the user's presence within the installation.

There is no other interface apart from the body of the viewer. His presence within a determined space in front of the screen leads to the appearance of a small dot that represents him within the virtual ecosystem. When this happens, and as long as they are not too busy eating and trying to mate, each of the individuals of the main species will tend to come more or less close to the newcomer, depending on

their virtual DNA code. So, some individuals will completely ignore him, and others will follow him everywhere. From this moment onwards, the viewer can decide how to interact with the individuals that follow him. He may decide to help them, or might do the opposite, which means he will put his followers in danger of being eaten by the predators.



A Visitor in Digital Babylon

Depending on what he does, he will make the individuals who are more prone to come close to visitors, or the more unsociable ones, have more or less possibilities of survival (and, therefore, of reproduction and of passing on their characteristics to consecutive generations). He will affect the interactions of future users of the work, making it easier or more difficult to interact with the individuals of this first species, depending on the sum of all the users' interactions.

It is in this sense that we can talk about a double level of interactivity: first, there is immediate interaction, where elements react to the visitor's presence; secondly, there is cumulative interaction, which is made up by each and every one of the users, and which makes the piece change a little with everyone, without any of the subsequent interactions having the capacity to eliminate the effects of those which were produced before it.

This double interaction, together with constant change due to genetic algorithms, is *Digital Babylon's* main proposition. The point is for the work to modify each of the individuals' movements; how members of the same species interact, how they interact with those from other species, with the environment, and how those of the main species interact with the user of the piece, as a result of all the different interactions and of evolutionary programming. The intention is that in

this way, if the installation is active during a long period of time (various days or weeks), the changes might be substantial enough, for a viewer who might return to perceive the work differently, and find it interesting once again.

### **Coming Full Circle**

Five years after the process described above, looking back on it with heavier baggage, has been an interesting experience. When one revises the ideas of a not so distant past, one sometimes sees new connections and new points of interest in them. From the distance a dilated, active, time lapse provides, some of the lights that I used to see in the pieces whilst making them have certainly diminished, but others are still active in the same way, or with stronger conviction. Other lights now appear to be new, new points of interest such as the connection between the first and last works, described in terms of processes of emergence. *Digital Babylon* remains a valid proposal. It is still valid to look for new levels of interactivity within art, to involve the viewer in subtle ways, to turn him into an accomplice of imbalance. And it is also still worth looking for a dialogue between the works and the environment, the way Jim Campbell demanded in his 2000 text.

He called for an interactive art that would converse with its environment, which had to be done through works that avoided constant repetition. The paragraph with which he finished the text that presented this idea, in spite of being a decade old (an eternity in terms of digital art), retains its strength, from its first assertion up until its final parenthesis: "The possibilities exist for works that perceivably never repeat themselves. Works that respond to their environment not just in a short-term way, but in a long-term way, unpredictably and meaningfully (easier said than done)<sup>6</sup>."

<sup>1</sup> The published text in the book contains errors in the chapter sections and also in Jim Campbell's final citation, which have been corrected here along with some details of the English text. The images in this PDF version are not included in the book.

<sup>2</sup> For a general explanation of the concept of emergence applied to the digital arts, and to consult a list of references, see Citation: Soler-Adillon, Joan (2010). "Emergence and interactivity: A-Life Art as a paradigm for the creation of experiences in interactive communication". Hipertext.net, 8, [http://www.upf.edu/hipertextnet/en/numero-8/a-life\\_art.html](http://www.upf.edu/hipertextnet/en/numero-8/a-life_art.html). See also Soler-Adillon, Joan (2011). "Creating Black Boxes: Emergence in Interactive Art". ISEA 2011 Proceedings: <http://isea2011.sabanciuniv.edu/paper/creating-black-boxes-emergence-interactive-art>

<sup>3</sup> The artist Jim Campbell proposed the idea of a dialogue between interactive work and its environment in an article from the year 2000: Campbell, J. (2000). Delusions of Dialogue: Control and Choice in Interactive art. Leonardo, 33, 133–136.

<sup>4</sup> The notion of cumulative interaction is described in more detail in the first article mentioned in note 2.

<sup>5</sup> The results of these processes can be very surprising. During a particular stage of the process, the Digital Babylon prototype was left working for three hours in a row. After this time had elapsed, whilst in a group, the main species moved and (apparently) acted in a way that was surprising, even for the actual programmer (video documentation of the results can be seen online: [www.joan.cat/project.php?id=1](http://www.joan.cat/project.php?id=1)).

<sup>6</sup> Idem note 3.