



**simplicity**



**simplicity**

meaning                      conceptual modelling  
similarity                      grouping  
                 recursion                      creativity  
abstract           metaphors                      order  
                 symbols                      organisation  
symmetry                      bistable  
                 figure ground                      dynamics  
                 continuous  
                 gestalt                      complexity  
                 mappings                      emergence  
                 pattern                      logical, emotional  
                 line                      perspective  
                 curves                      shape  
**art**

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**mathematics**

# Reflections on Simplicity in Art and Mathematics

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Conservatorium of Music, Newcastle

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Art and Music” at the  
*Jon Borwein Commemorative Conference*

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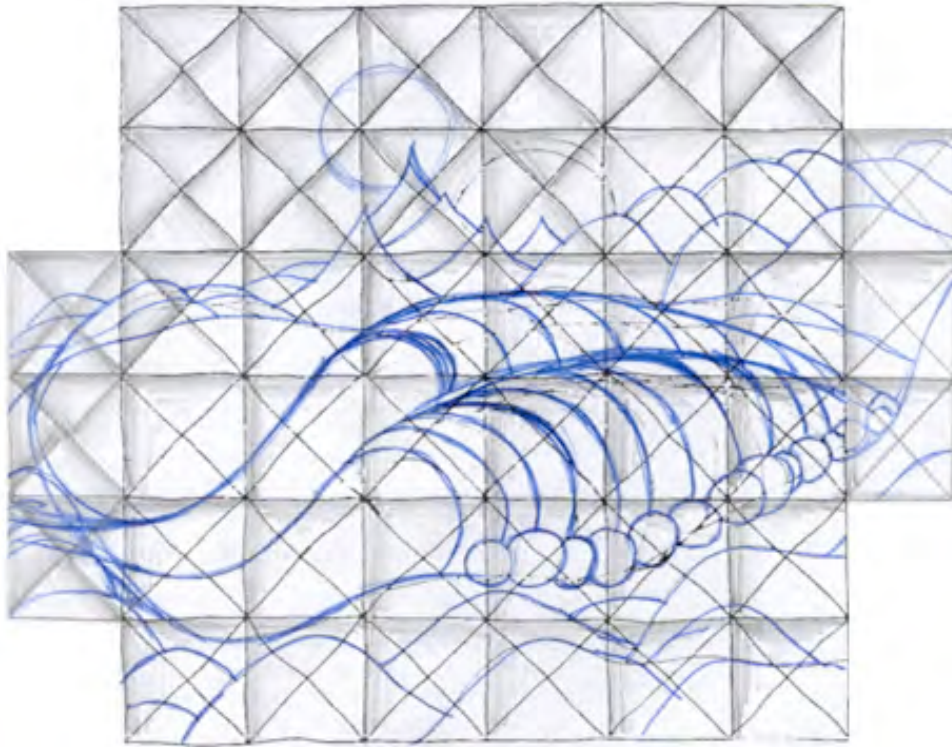
Since I have an interest in both mathematics and art, it is not unusual for me to reflect on some of the similarities, and differences, between these two complementary ways of thinking.

For me, art is the opposite of mathematics - a freeform, non-rule based, almost illogical type of thinking. A random walk through my new thoughts and ideas. For me, art is about trying to capture the landscape of my thoughts. The forces that drive the internal waves that make my ideas. Waves of thought that collide or diverge as I create.

But my art, is also like mathematics. It is about observing patterns, abstracting, making connections, and ordering knowledge. I deal with shape and line, colour and space. Sometimes with symbols. I am trying to be true to the logic and rules of my personal nature. Overtime the patterns in my mind tend to repeat; I paint these recurring patterns and reflect on them as I do. Art, like mathematics, is a language of communication - although I use my own collection of symbols. Since the things I paint emerge from my subconscious, not even I have a complete understanding of what I paint and why.

In this exhibit I present a collection of pictures related to a pattern that has consumed my thoughts for 20 years or so. I call it “*Simplicity*”. It is about incompatible opposites, that are connected yet always apart. Only one of the parts can be in focus at any moment. So there are complex dynamics as the opposite parts shift in and out of focus. From this duality, this shift of viewpoints, comes much complexity. I prefer to think of art and mathematics as just such complementary opposites.

# Fluid Dynamics (2010)



Original Sketch (1996)

During my youth I spent a lot of time surfing. Waves fascinate me and I can watch them for hours. Here is a wave picture. Of course there are connections back to the real world of my coastal home, but when I paint waves I am thinking about how the waves of thought inside my head. So my pictures are not meant to represent things on the outside. But then, what is on my inside is informed by my perceptions from the outside. The system feeds back on itself. The boundaries to what I think are quite difficult to define. One thing you should notice from this picture is that the boundary is more complicated than you might expect. (Most people think paintings are shaped like rectangles.) When I have to frame these odd-shaped pictures, I laugh and call it one of my framing problems. My head is full of framing problems.

During the early 1990s I wrote a lot of FORTRAN code for mathematical modellers, porting simulations between computer platforms. Often the simulation of fluid dynamics involved defining grids over an enclosed space. There was always some consideration about how to define the boundary conditions. In the same way, the framing or context of an idea is important for interpretation. In fact I don't believe in a blank canvas. When I have an idea, no matter how new it seems, it cannot come from nothing. When I create I suddenly have something where there seemed to be nothing before. I call this my zero-one problem. I have nothing and then I have something, but it cannot come from nothing. A paradox when you create things.



Oil on shaped  
canvas  
(~1200 x 900)



This picture also reflects the opposite tensions of *Simplicity*. There is the use of very natural, curved lines that contrast with the more manufactured, man-made straight lines. Straight and curved lines are two of the common, opposite concepts I work with. As in many simulations, the definition of space (and time) are often critical decisions in the modelling process. In this picture there is some tension between the way space is represented. Is it continuous or discrete. In simulations the same modelling decisions also apply to time (is it continuous or discrete?).

## Mirror Image (1999)



Original Sketch (1996)

This is one of my more abstract pictures. It was initially sketched down during a very boring meeting in 1996 (Something to do with the software not being ready on time – the meeting, not the picture).

Oddly, an image sometimes just appears fully formed in my mind's eye. I try to sketch it down as quickly as I can. But it can take quite a few years before they actually get painted and during the painting they can also change a bit.

At the time I sketched this I was working in the area of Software Engineering. We were designing and implementing quite abstract object-oriented models for representing knowledge. Object-oriented approaches to building software were quite new, and there was a degree of thinking about how to represent quite abstract concepts such as aggregations (parts and groups of objects) and hierarchies (what properties objects inherit).

My paintings also tend to be about conceptual models of what I'm thinking. Blue prints of my thoughts. This picture explores some more of the conflict between straight lines and curved lines along with higher orders of organisation. Especially order that emerges in complex systems. The late 1990s was a time when agent-based modelling, emergent behaviour, and complex systems were hot topics. Here, I was thinking a lot about symmetry as an ordering principle.



I remember when I started painting the picture I was studying Information Visualisation. This field is about defining abstract spaces and colour mappings for abstract data. It also considers perceptual grouping principles which are important if you wish to find patterns in your data.

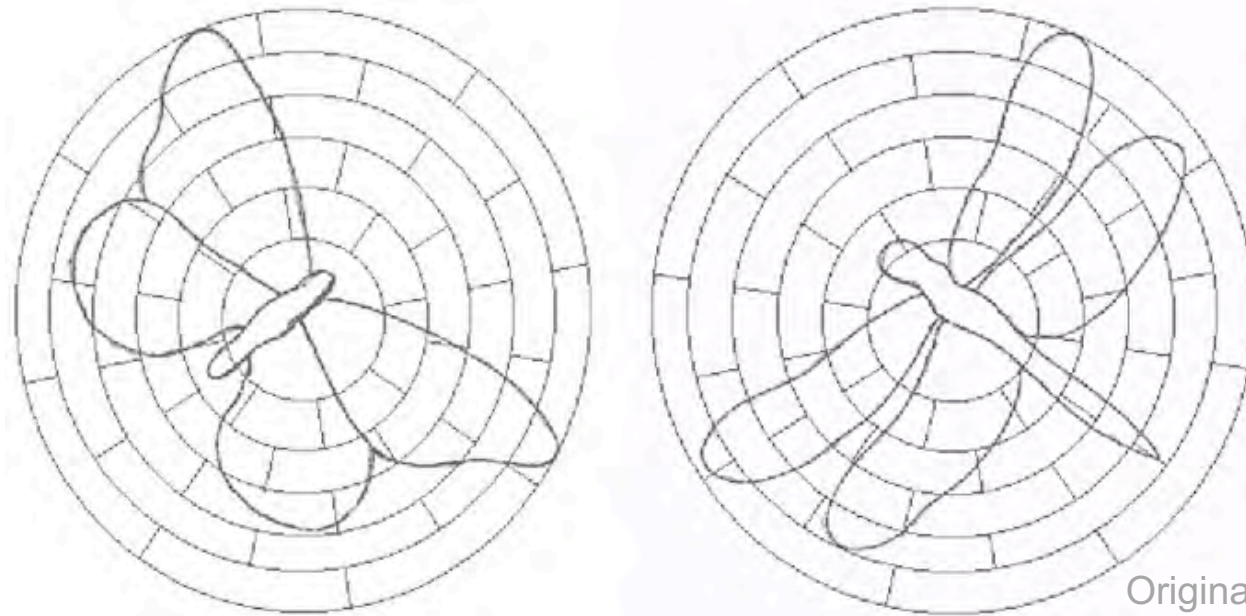
This picture reflects organisation principles related to perception (but also cognition). It considers the Gestalt principles of grouping which include continuity, similarity, closure, proximity, symmetry, fate, familiarity, figure and ground.

For example. the green, purple and blue areas create higher levels of order - grouped by *similar* colour. Lines are closed in a *continuous* way across the discontinuity that divides the two parts of the picture. Although there was no intention to create recognisable forms, I saw a Celtic, female form with horns in the top half of the picture and an inverted devil-like face in the bottom half. This is something that happens with abstract shapes and in Gestalt terms is referred to as the law of *familiarity*. We tend to find familiar objects in abstract shapes, even when they don't exist.

For me, the discontinuity between the left and right part is actually a critical part of the picture – otherwise I would just have used a single canvas. The picture is joined by the reflected symmetry, and not by a real physical space. Overall, the whole is different to the sum of the parts (another Gestalt idea).



Diptych - Oil on canvas (2 x 1190 x 390)



Original Sketch (2001)

## Butterfly, Dragonfly (2002)

A natural follow on from my interest in complex systems were concepts such as Lorenz attractors, fractals, self-similarity, recursion and chaos. While these terms are founded in mathematics, I also found something innately poetic about the idea of strange attractors and they fluttered into my art. At its most abstract, this is just a picture in two parts, showing two opposites. For me this also represented a mythical love story about a green-eyed butterfly and a blue-eyed dragonfly. This has more to do with my lyrical imagination than the ways these concepts are used in mathematics. Still, from the interaction of simple things complexity emerges, and where systems change scale you can find turbulence. Strange attractions – sounds like a metaphor for love to me!

The two distinct parts of this system are the emotional (butterfly) and logical (dragonfly). The butterfly/dragonfly duality is also a female/male duality. It is self-similar to the ideas of yin yang. Yet the scale of these symbols in this picture is of a much higher order. It references the opposite flight behaviour of these insects, one random and unpredictable (butterfly), the other targeted and focused (dragonfly). So the same opposite concepts of *Simplicity*, but these are opposite patterns of behaviour, emerging at a high level of order.





There are a lot of other interesting mathematical concepts reflected in this picture. If you ignore the insects and colours, the design uses rotational symmetry based on the number eight. The balance of yin and yang, of opposite forces, is also associated with Zen and the eight-fold path.

I had previously written recursive algorithms for laying out nested objects in space, and I've often thought recursion makes a great way to hide something. More than four levels and it's very hard to think about what is happening. So it would be a good way to hide your subconscious. There are five levels of recursion in the nested circles of this picture. If the eyes are windows to the soul, then this picture is suggesting the same pattern (*Simplicity*) underlies the separation between conscious and unconscious, and even much of our own behaviour.

## Red, Blue, Black (2016)

Even though this is the latest completed work in the exhibit, the original sketch was done early in 1992. It takes its name from the coloured pens I had when I sketched it. There is a lot of complexity and detail. Quite a chaotic, confused picture. Appearing random, yet with imposed categorical order.

It has a lot less spatial order when compared to Red, Yellow, Blue, which shows divergence and flow, a more ordered creative process. By contrast Red, Blue, Black is more mechanical, constructed, chaotic, and unnatural.

For me it came to represent an abstract map moving from emotion (red) to logic (black). The blue is my engineering part – somewhere between the emotional and logical. From my *Simplicity* perspective this blue part would not really exist, it is merely a connecting wave between the two opposite states (red, black). It is the dynamics where the opposite parts come together and separate.



Original Sketch (1992)



Red, Yellow, Blue (2007)





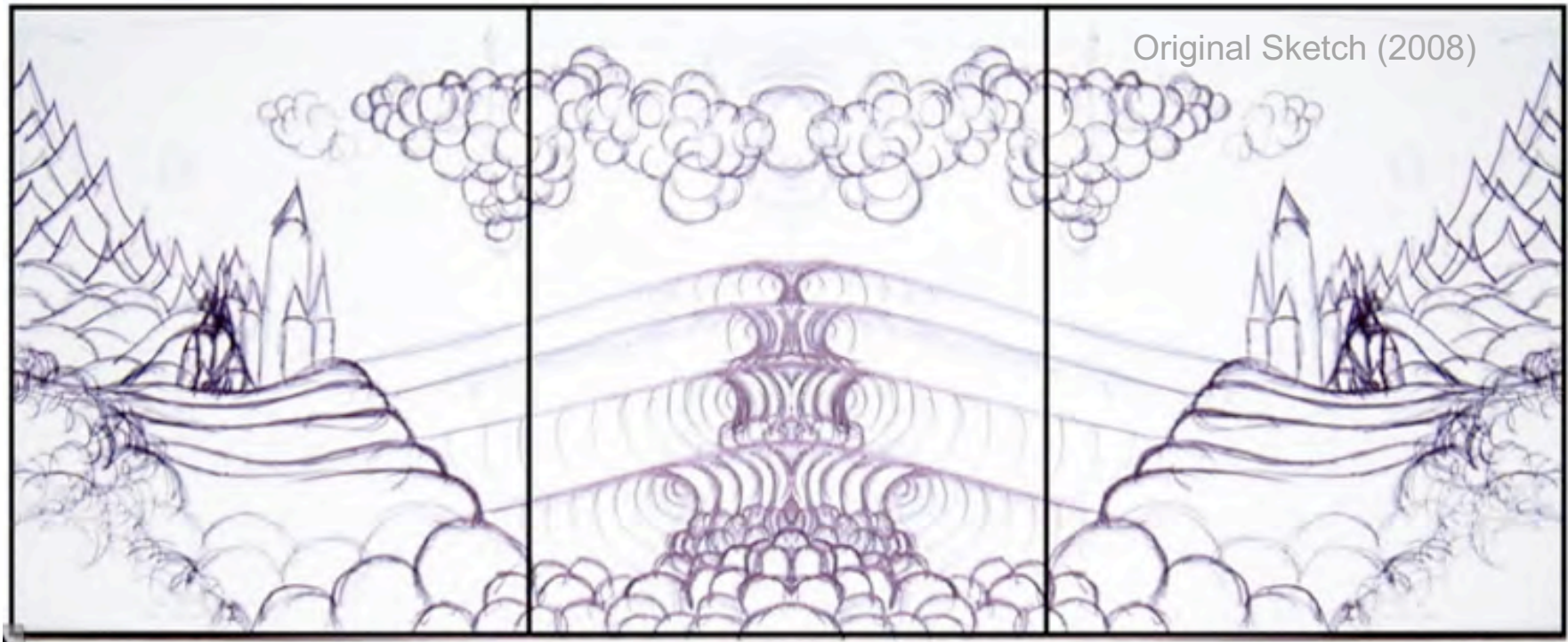
Even though it was sketched in a very random way with no intended order, some familiar patterns repeat across the picture, suggesting recognisable forms. I find something both biological and machine-like about the image. Because this picture has no particular sense of direction, it can also be turned upside down or reflected. Mostly I want to create endless symmetric tiles from the picture. Try and create order where none might exist.



Triptych - Oil on canvas (3 x 1230 x 380)



# Symmetry Breaking (2008)

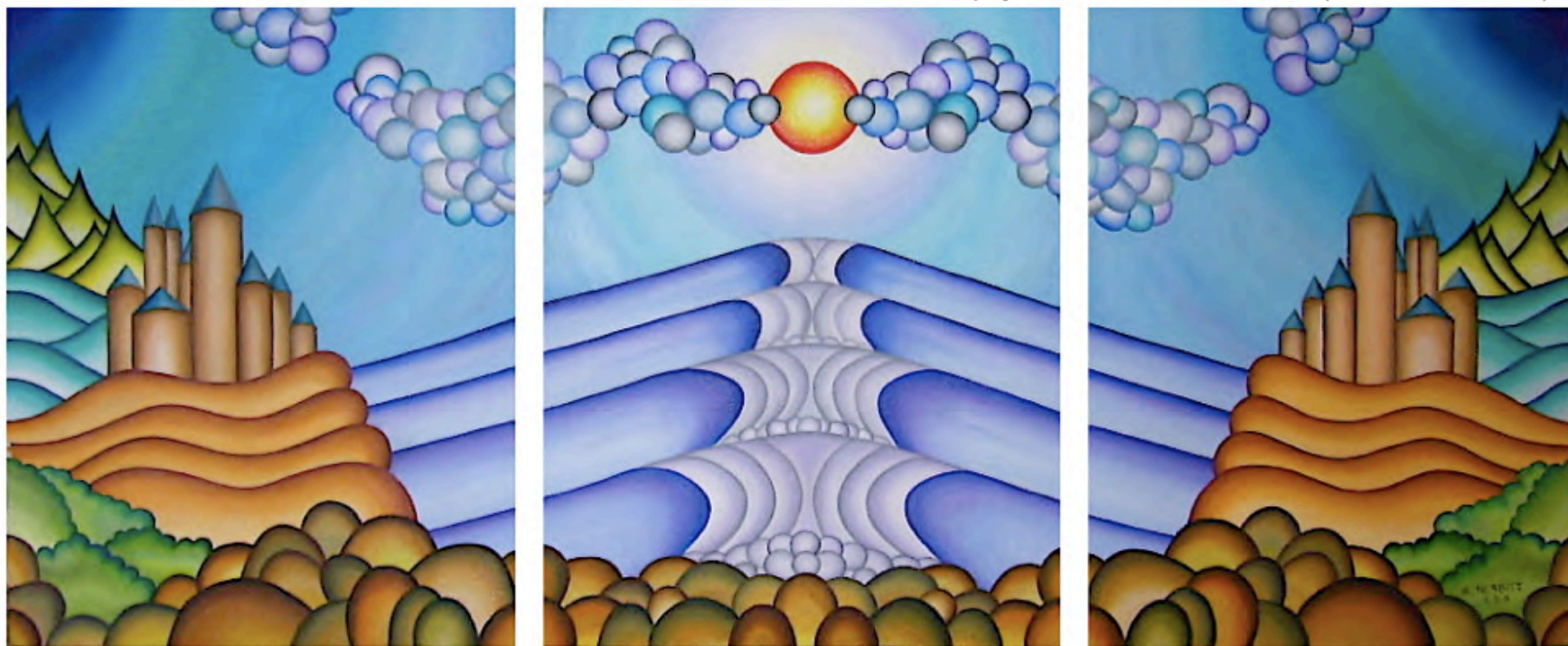


This is a beach called "Symmetry". During my PhD (2000-2003) I looked a lot at patterns in stock market data. This furthered my interests in the field of Complex Systems and I ended up spending a year (2006-2007) in Boston working with physicists. (I came back with this bad pun.) This picture deals with a very different kind of symmetry to the type that concerns physicists. This painting was a test of me gauging my technical ability to make my own kind of symmetry. I tried to paint both sides of the picture as symmetric as possible. As I expected a little human error crept into the process – breaking symmetry.



Visions on the Harbour (2007)

Triptych - Oil on canvas (3 x 380 x 304)



So this is me reflecting on complex systems and the dynamics of my internal thinking. The waves between opposite and disjoint ideas. Coming together and moving apart, like the patterns in stock market data as buyers and sellers try to agree on trade prices. Driven by their fear and greed and acting at multiple time scales. When I paint these types of “brain” waves they are either diverging like this, or shown coming together. (Visions on the Harbour shows the converging waves). I paint these waves a lot; they are on my mind.

There are other common symbols I reuse in this picture. The sun is a new idea - the clouds represent imagination, and the rocks and other landscape elements represent foundations, or less changing natural things. The towers are man-made – symbols of order, preserved knowledge. These might be good or bad. There is no value judgement associated with this, just that opposites exist and there is tension or dynamics between the two. I’ve been painting since about 1974 and these symbols and their interpretation have emerged over time. While I can interpret them I don’t really have a good idea what my subconscious is actually doing. Sometimes, strangers point out things that I hadn’t noticed.



# Palindrome Point (2008)



Original Sketch (2002)



Oil on canvas (300 x 1020)

This picture was based on a real place; a headland on the North Coast of NSW, called “Arrawarra”. The indigenous meaning of Arrawarra is *meeting place*. I surfed here when I was young and went back to write up my PhD. (Some places hold a power for me.) This picture tries to capture a moment in time. Time stands still but the four wave peaks also represent an animated sequence. A wave of time. The picture is about me being in a place and time.

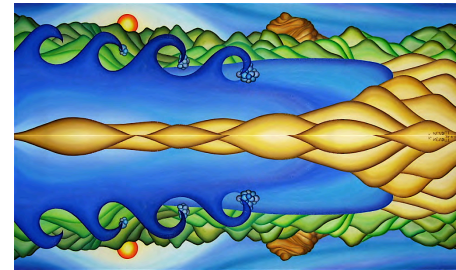
“Arrawarra” is also a palindrome as it spells the same forward or backward. This concept of a palindrome reminded me of the mirror reflections I’d been thinking about and had painted before. In this case rather than paint the reflections I simply imagined them (much quicker but slightly harder). When I conceived this I only considered a mirror reflection about the right edge. The right edge is the place where opposite waves would be meeting. I also had “Information Theory” on my mind and began to think about encoding this symmetric information. I decided I would simply need a single bit (0 or 1) to specify that there was, or was not, symmetry present. If I just assumed symmetry, then I would not need to encode it at all. I think this made some metaphysical sense to me at the time :-)



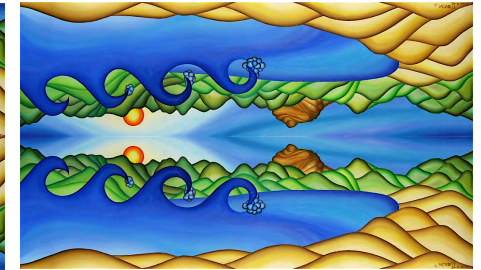
right



left



bottom



top

Later, while painting the picture I realised that in one dimension you could also, just as easily reflect about the left edge. My natural bias had been to imagine the reflection about the right edge. So to more clearly specify the line of symmetry might require two bits of information. One bit to specify symmetry, or not, and another to specify the left or right edge as the line of symmetry. (Or again, I could simply assume symmetry was always present.) Thinking more, say in two dimensions of space, there are four possible lines of reflection. I could reflect about the right, left, top or bottom edge. If you apply two reflections, there are 8 possible combinations (3 bits). But some combinations of reflections commute. For example, left-top produces the same as top-left. This reduces the number of possibilities to four (2 bits). It also shows the danger of thinking too much! So I stopped here and decided the picture did not exist in 3 dimensions.

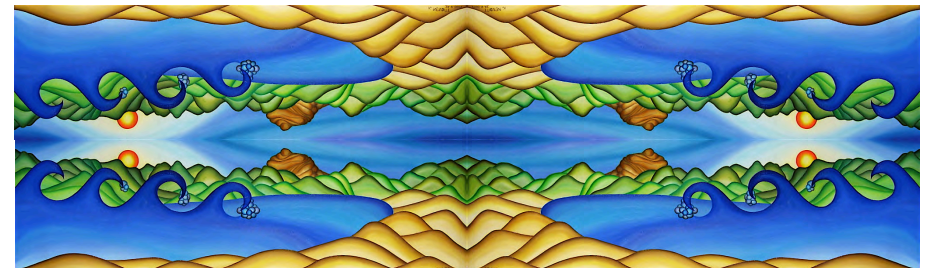
bottom - right

right - bottom



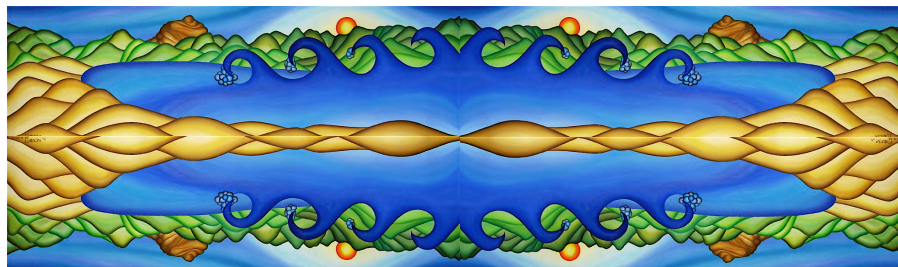
top - right

right - top



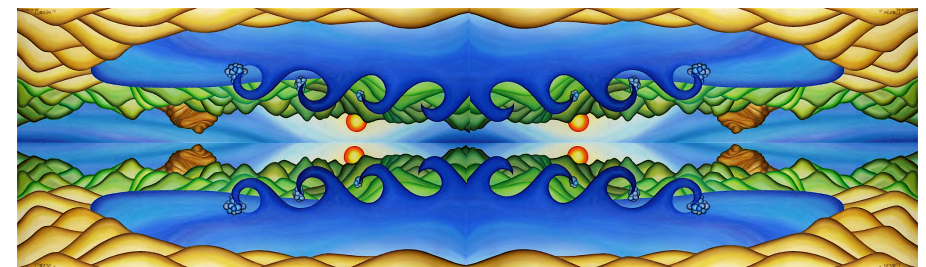
bottom - left

left - bottom



top - left

left - top





# Split Decision (2013)

Original Sketch (2012)



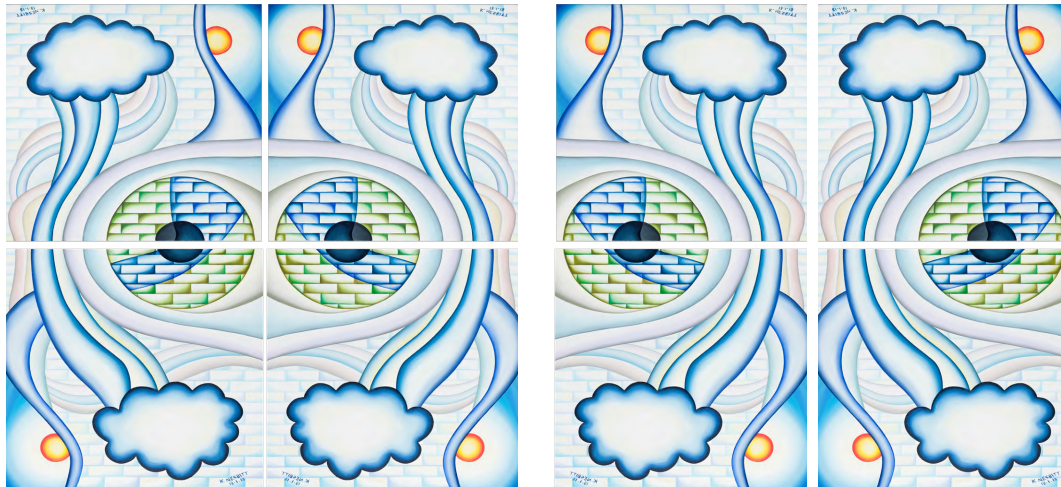
What the previous picture illustrates is how a simple pattern, like recursive symmetric reflections, can produce complexity. If you apply four levels of recursion you will quickly find it hard to keep track of possibilities. This picture is also about symmetry, but a higher level. It is about binary decision making in a bistable cognitive process. There are two states that are incompatible. The two possible choices can't exist together as they are inverses of each other – so they are disconnected. Yet they are also connected by their symmetric relationship. A decision may alternate between the two possibilities but once a decision is made the systems must collapse to one state. This is a fairly conscious attempt at an abstract representation of Simplicity.

The decision making process I think most about is the creative one. The order I make these decisions does not commute. Again, the symbols that occur in the picture are things that I have regularly painted. The sun is a new idea. The bricks and building shapes represent rational, logical, man-made foundations. The clouds are more emotional, fluid concepts that shape the imagination. The eye is intuition; the sub-conscious. For me, it can also be represented as a window or a tunnel.



Ride on Wave of Magic (1979)

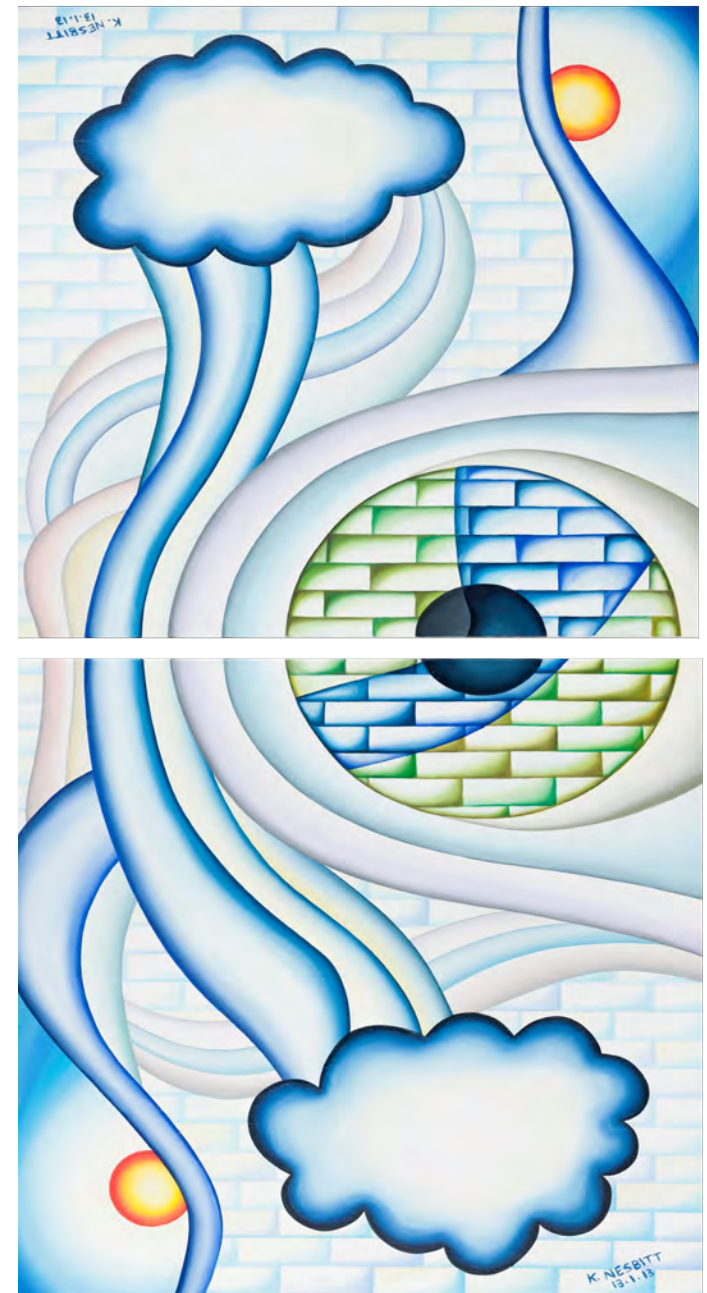
Like Red, Blue, Black it is not clear how to hang this abstract picture? It has no defined up or down. There is no left or right. It suggests symmetry, but is not symmetric. Although I have painted these two quarters of the picture, like Palindrome Point, there is also a missing half. This extra half can be imagined by either reflecting on the left or right edge.



Two possible missing lines of symmetry

So this is my creative, binary, decision-making process. At each step of the process I make a single decision. It's a non-commutative process. It's symmetric, but the opposite choice is never really lost – it's the entangled opposite of the selected idea. I suspect this is the stuff of nightmares; waking wondering if I made the wrong choice.

This is a fairly direct borrowing of concepts from physics. (I read a book about using ideas from Quantum-like ideas as a metaphor for cognition.) Its a powerful metaphor and it makes me reflect on non-classical models of probability. My concepts are vectors in a multidimensional feature space.

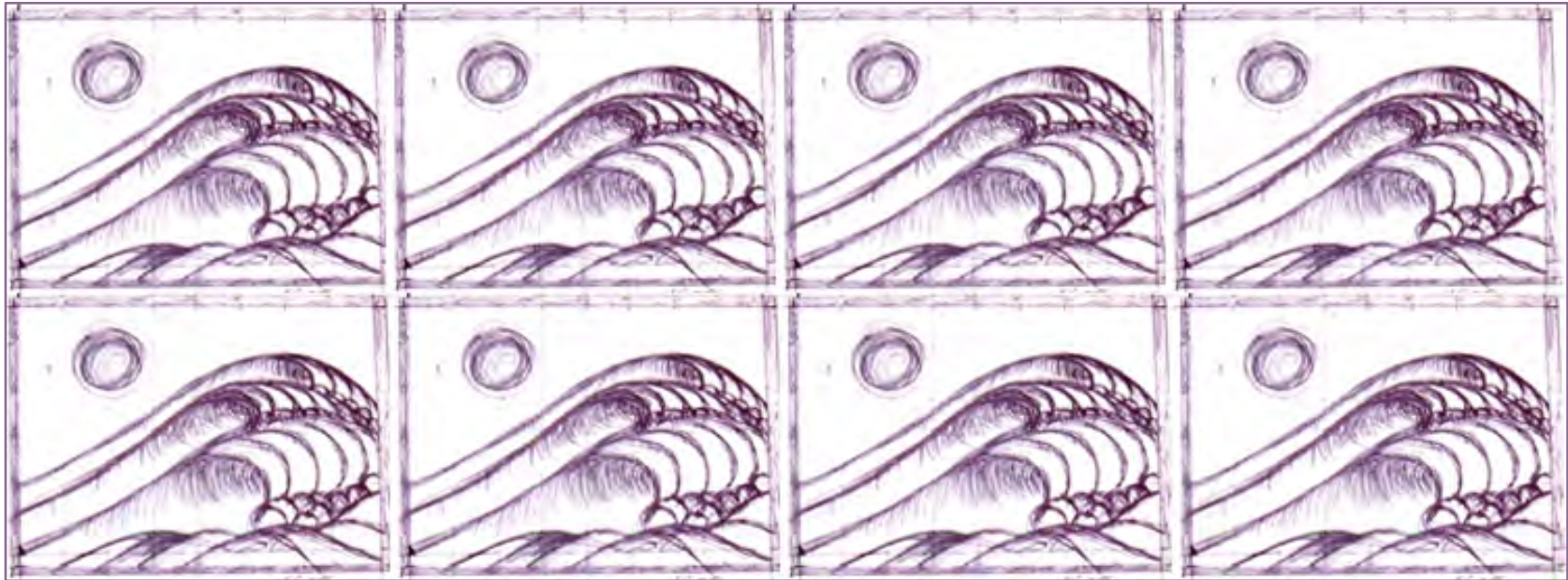


Diptych - Oil on canvas (2 x 480 x 480)



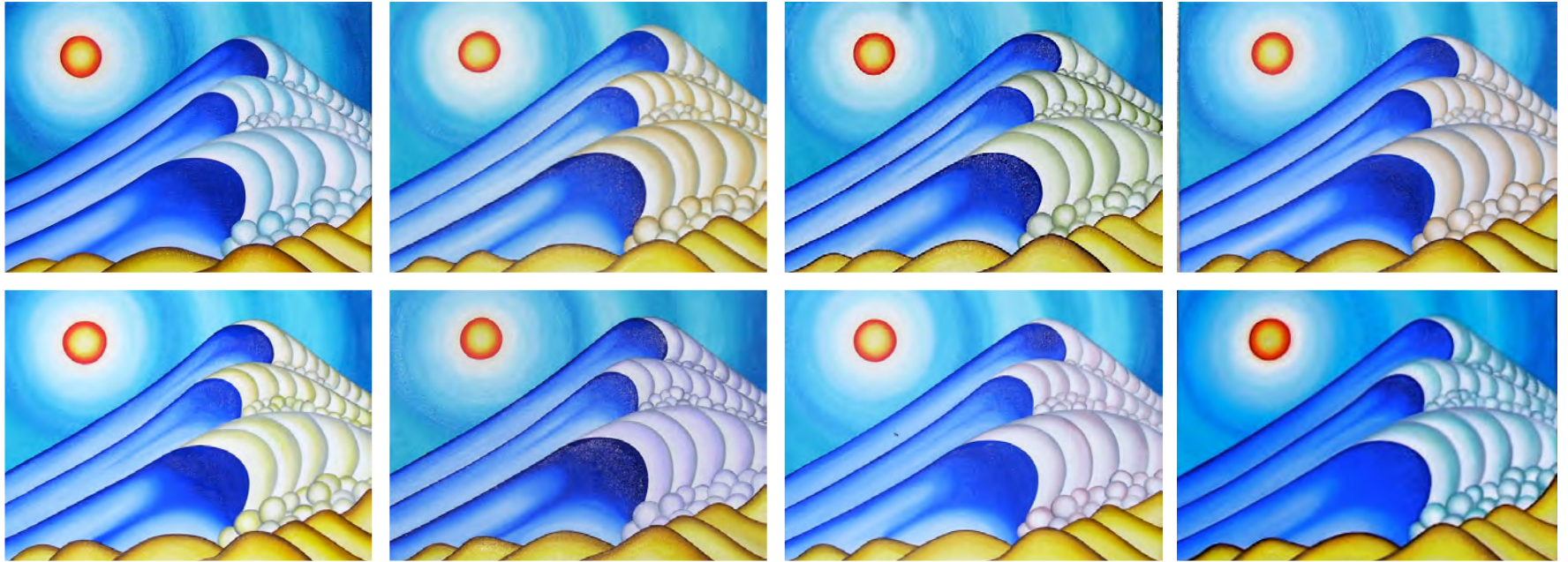
# Jailbreak Eight (2007)

Original Sketch (2007)



Returning from my post doc year in Boston I stopped at the Maldives to go surfing (It snows in Boston). In the Maldives there is a sunny surf spot called Jailbreaks. The waves break on a coral reef and so there is an almost perfect repetition to the form of the waves. This place reminded me of the recurring patterns of my own thoughts. I seemed to be finding the same shape, the same design pattern in everything. It was a bit like being in a jail, stuck with one pattern (*Simplicity*) and only finding minor variations. So I set out to paint 8 pictures of my mind waves. Reflecting on repeating waves and recurring structures of thought, the same idea I was constantly creating.

This picture, like Palindrome Point and Symmetry Breaking, were part of the View3 – Windows exhibit. A very interesting thing about windows is that you can be outside looking in or inside looking out. There are two, symmetric observer positions that can be considered. This pattern, adopting two opposite observers on the system state is the familiar form of the *Simplicity* pattern that consumes me. A window is another framing for the discontinuity between two opposite parts.



The notion of a repeating idea is also what I would call a design pattern. A single solution that can be applied to solve many problems from quite different domains. For me, *Simplicity* is like this, an abstraction I can use it to frame quite different problems of perception and cognition. It helps me understand the complexity of things, especially where opposite viewpoints are required.

You may have noticed that the number 8 has, for some reason, also taken on an importance of itself. This picture is about categories or groups with 8 elements (each with different foam colours). This group is closed. It's been quite a while since I studied Group Theory but at some stage I mean to revisit the various mathematical groups of order 8. For my personal sanity I also need to get a better grasp of isomorphisms – equal forms or shapes with an inverse mapping.

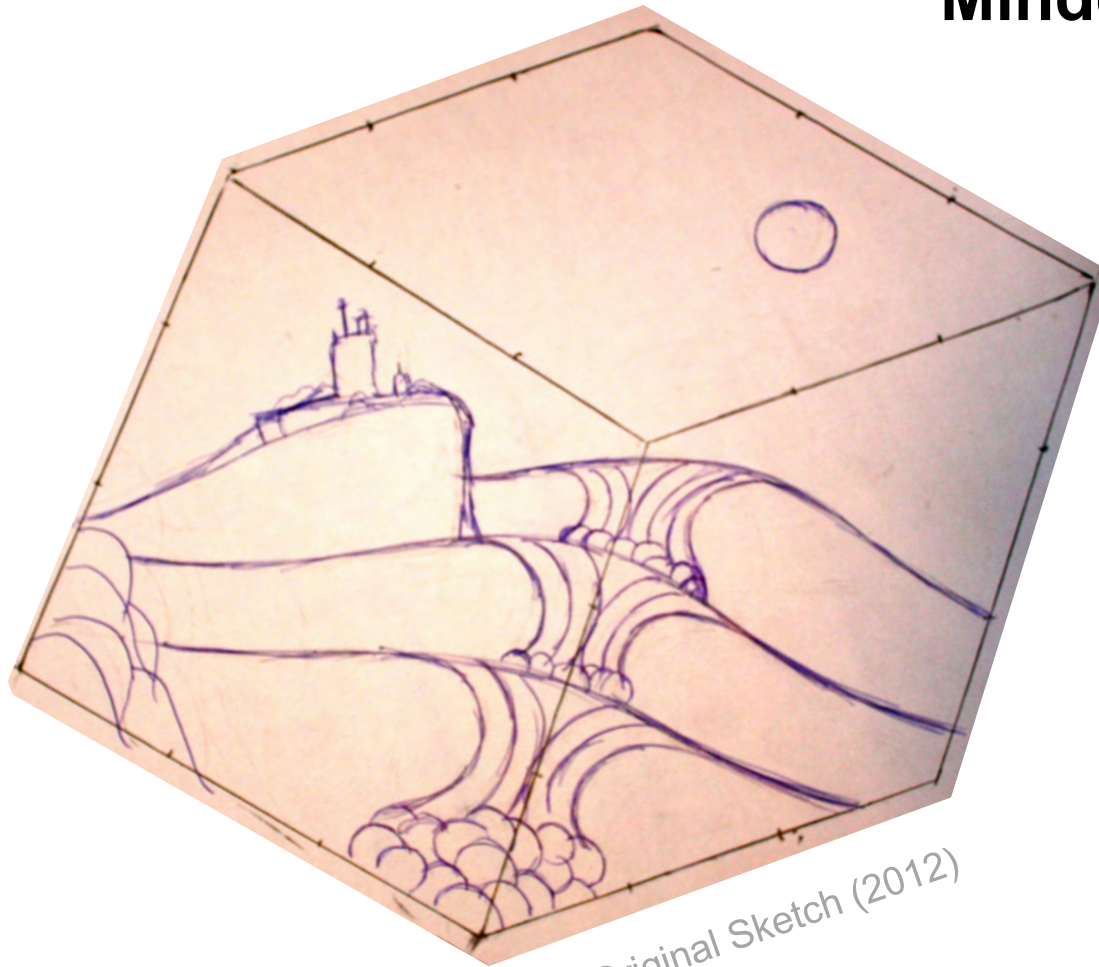
I've just mentioned my insanity, and previously mentioned classical versus non-classical models of probability. So it may not surprise you to read that I also wonder if this picture could represent 8 possible states, or, if there are no real states only waves.



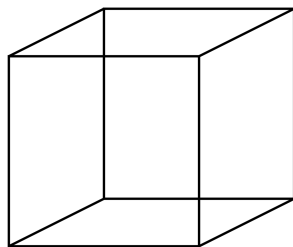
# Minecraft – Lighthouse (?)

Here is my homage to the Necker cube. A return to something I first looked at in “More than One Way” at the start of my PhD in 1999.

The Necker cube is a bistable, or ambiguous, perceptual system. There are two possible perceptions of this figure. However, only one state can be perceived at any moment. There are a number of other examples of such bistable perceptual systems, including figure/ground problems such as the face/vase figure associated with gestalt psychology. The yin yang symbol (when drawn correctly) also provides a bistable figure/ground system. I’m quite interested in the dynamics of these disjoint states.



Original Sketch (2012)



Necker cube



Face/Vase



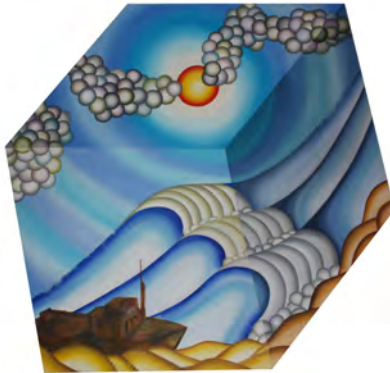
Yin Yang  
(correct orientation)



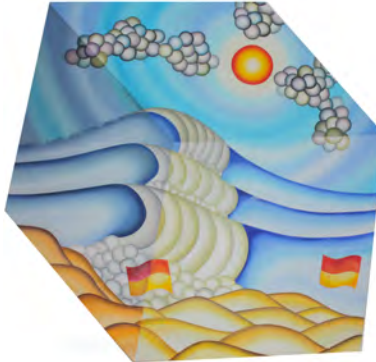
More Than One Way (1999)



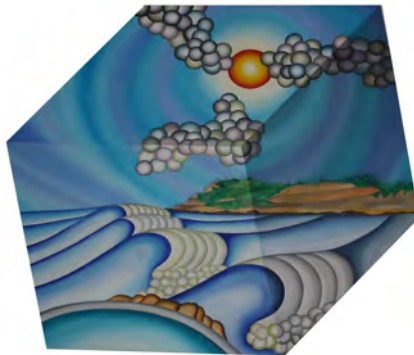
Minecraft – Shipwreck



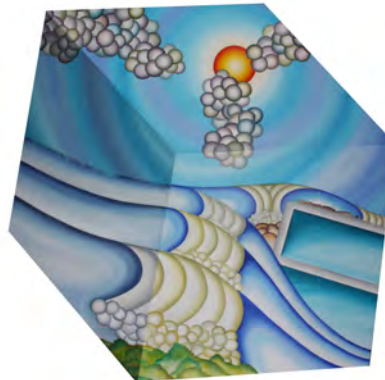
Minecraft – Flags



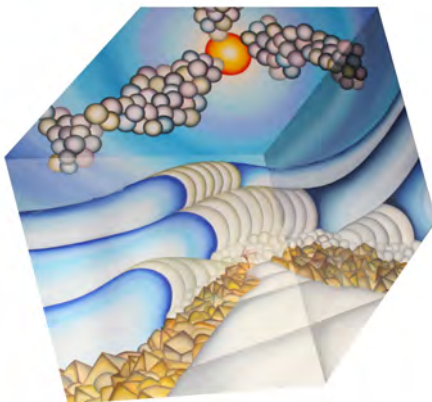
Minecraft – Pool



Minecraft – Baths



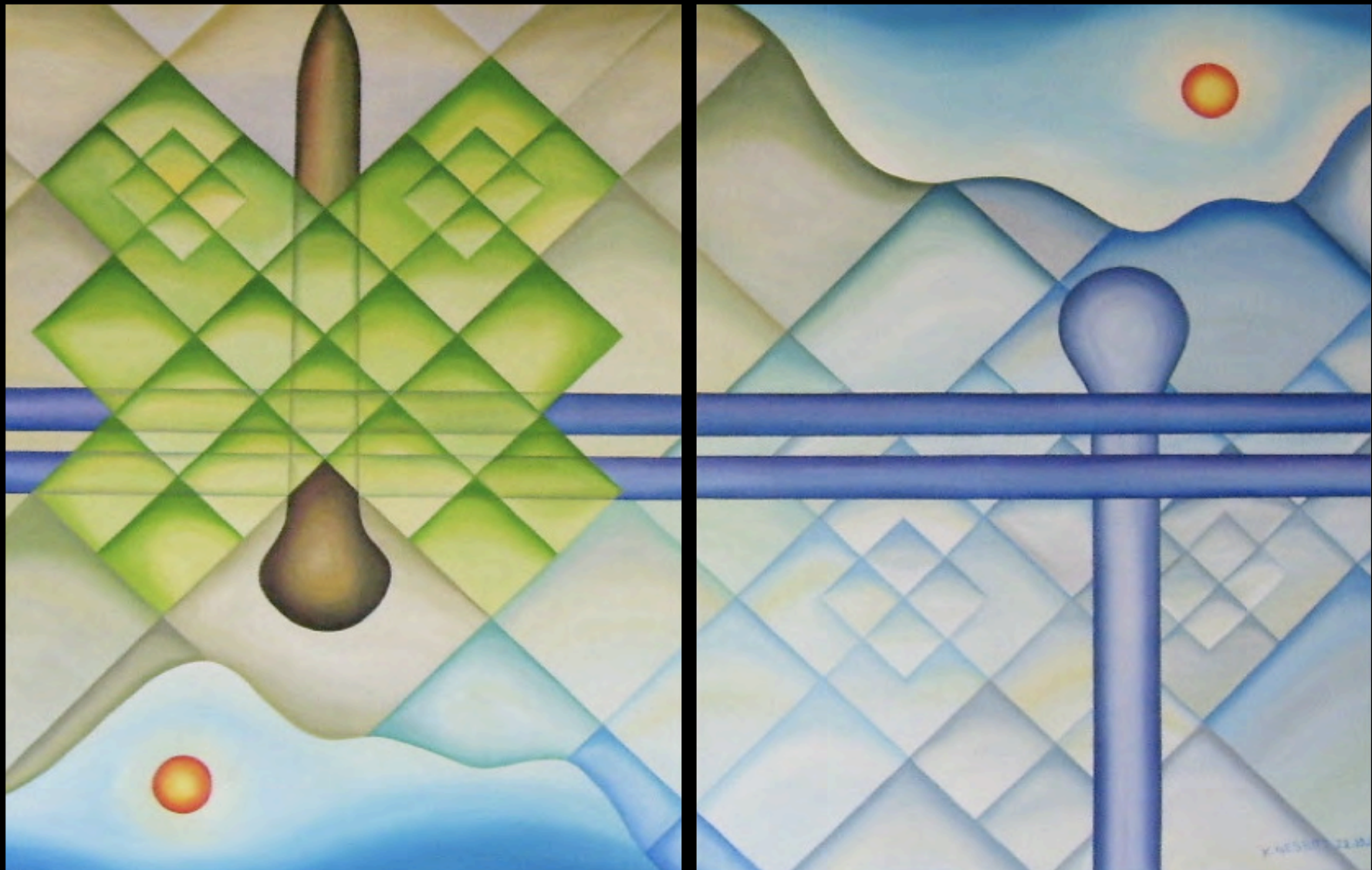
Minecraft – Harbour



Minecraft – Lighthouse  
(Work in progress) Oil on canvas (~800 x ~800)



In this picture, I'm also thinking about the alternating waves of reality and imagination, themselves two opposite states. This is a series of 6 works in progress. They are all being painted for the next View3 exhibit (wherever and whenever that will be). They show hints of the Newcastle coastline. Not to be confused with the real landscape, they are pictures in my mind. Nor should you confuse the waves with any real ocean. These are waves of thought, diverging, alternating states of the real and imaginary in my mind. More pictures of my *Simplicity*. Oceans and icons from my personal creative thinking – my mindcraft..



Strange Attractors (2007)





Simplicity (2004), mosaic, (2 x ~480 x ~480)



**symmetry breaking**

**palindrome point**

**jailbreak eight**

**fluid dynamics**

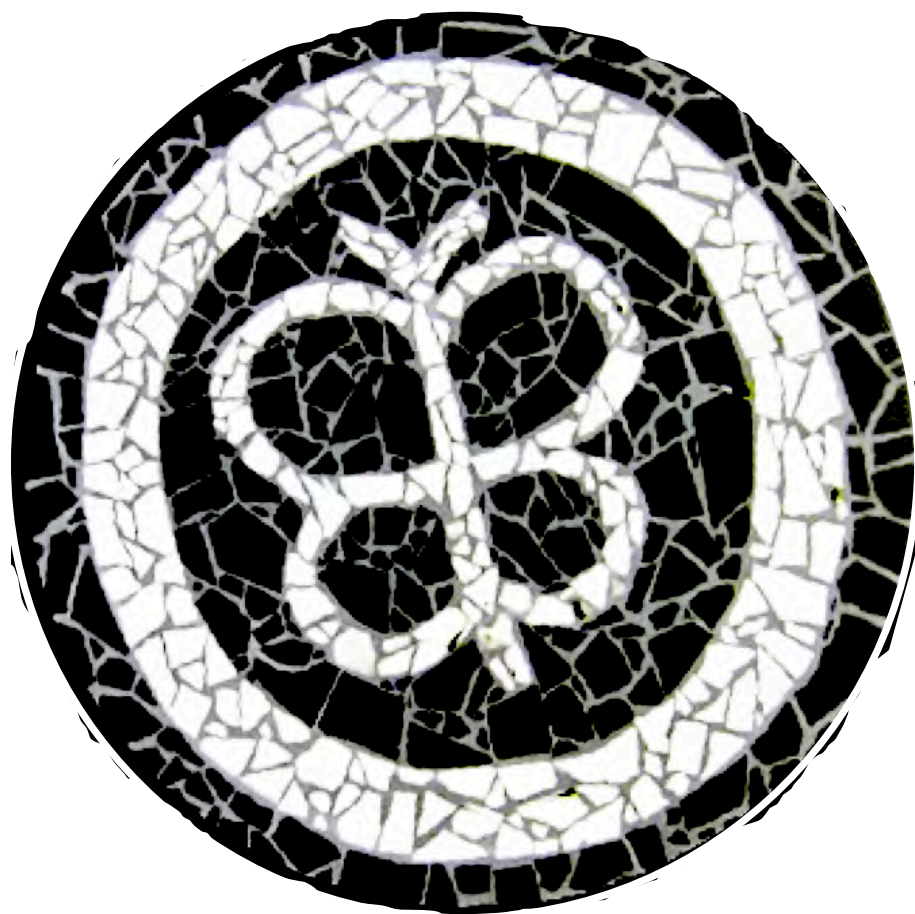
**mindcraft -- lighthouse**

**butterfly, dragonfly**

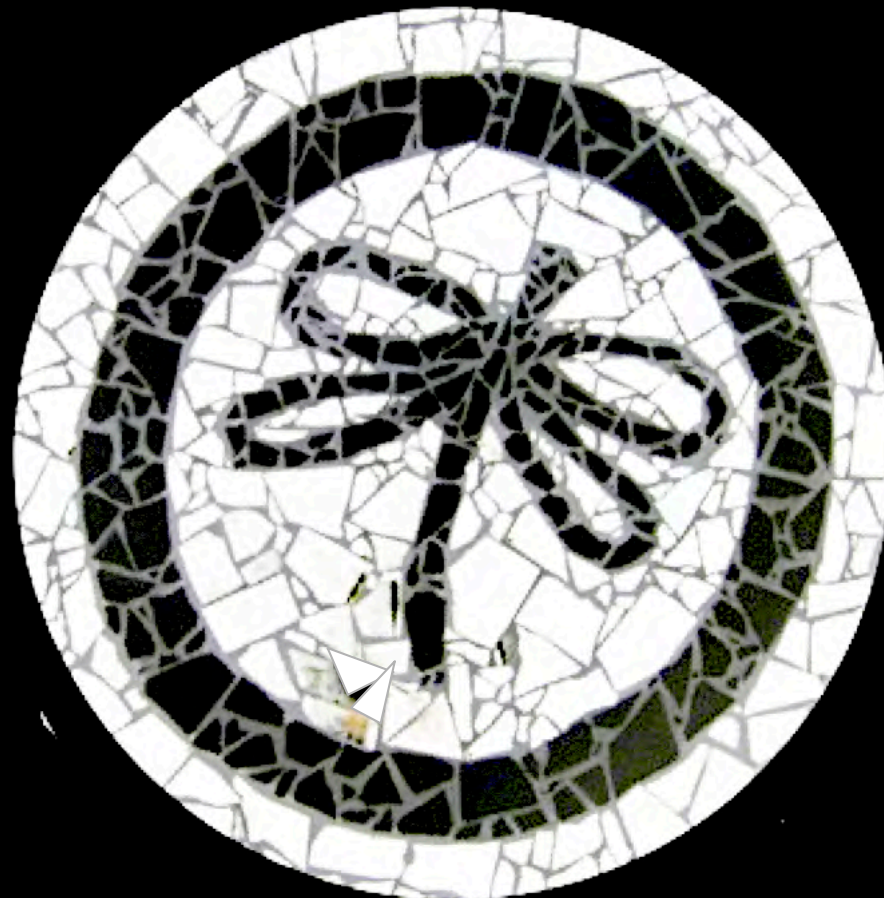
**red, blue, black**

**mirror image**

**split decision**



**simplicity**



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