Chapter 6

Digital Bricolage

It is perhaps due primarily to Claude Levi-Strauss that the term *bricolage* has entered the common vocabulary among media artists. One possible reason for its use is that Levi-Strauss sought to explain a distinction between the bricoleur, who works with a finite set of "whatever is at hand", and the engineer, who "suboridnates the object for the purpose of a project" [Levi-Strauss, 1962]. This difference is especially value to the media artist, who either works with artists and engineers, or is simultaneously engaged in both practices.

However, Levi-Strauss's concept of the artist is far from a clear cut distinction between bricoleur and scientist. At first, he introduces the lace collar of Elizabeth of Austria painted by Francois Clouet, by which he shows that "art proceeds from a set (object + event) to the *discovery* of its structure." This mythic structure is the synthesis, a bricolage, of the intrinsic properties of size, nature, meaning and form of lace in a pictorial space (whereas the scientist would construct a "specific instrument of the loom" in order to create lace). However, this conclusion is overthrow by the second example of a Tlingit club, in which the structure needs no event as "the monster's position, appearance and expression owe nothing to the historical circumstances in which the artist saw it." Thus, unlike the lace collar, objects of artistic thought may also be constructed without any reliance on the *physical object* of the handy-man. This leads Levi-Strauss to admit: "so it looks as if we have defined only one local and historical form of aesthetic creation and not its fundamental properties." [Levi-Strauss, 1962](p.26).

Levi-Strauss's conclusion is a much more general conception of the artist:

> "We have seen that there are analogies between mythical thought on the theoretical, and 'bricolage' on the practical plane and that artistic creation lies mid-way between science and these two forms of activity." (p.30)

Derrida examines Levi-Strauss and concludes that bricolage occurs at two levels. The first is the physical assemblage of found objects by the handy-man, and the second a more linguistic one of the bricolage of myths and signs brought together to form a coherent visual language. Yet the more abstract form is not easily generalizable:

> "If one calls bricolage the necessity of borrowing one's concepts from the text of a heritage which is more or less coherent or ruined, it must be said that every discourse is bricoleur. The engineer, whom Levi-Strauss opposes to the bricoleur, should be the one to construct the totality of his language, syntax, and lexicon. The notion of the engineer who has supposedly broken with all forms of bricolage is therefore a theological idea." [Derrida, 1978](p.360).

In what sense is the bricolage of the artist distinct from that of the engineer? In the construction of a bridge, for example, there is an aspect of assemblage, an arrangement of parts (I-beams, ties, cables), which is not altogether unlike an assemblage of found objects - they both require a combination and fixture of components. In linguistic terms, the objects of both the artist and engineer come with physical constraints, meanings, and signs, which are accepted by the creator in the process of making. Not all bridges are alike, just as not all works of assembled sculpture are alike. Yet clearly they are unlike one another in many ways.

The present work is concerned with the question: How is artistic bricolage distinct from the scientist or engineer? More specifically, I seek to investigate how the concept of bricolage translates to contemporary digital artists and tools.

(a) Pablo Picasso, *Still Life with Chair Caning*, 1912.

(b) Marcel Duchamp, *Bicycle Wheel*, 1914.

Figure 6.1

It is interesting to note that the introduction of found objects and collage in modern art pre-date Levi-Strauss's use of the term bricolage by nearly fifty years. The precursors of assembled sculptural can be found in Picasso, Duchamp, and the Dadaists. The first collage by Pablo Picasso, *Still Life with Chair Caning* (1911-12), incorporates a piece of real chair caning, and bit of rope, to suggest that a painting may be more than pigment.

Their presence in the work is both real (physical) and abstract, as they are integrated into the overall composition. A later work, *Still Life* (1914), uses the assembled object to a greater degree, while retaining the elements of a Cubist composition.

With the first readymade, a snow shovel entitled *In advance of the broken arm (En prvision du bras cass)* (1915), Marcel Duchamp reduces the elements of a composition to a single, found object. If we define bricolage as a process of assembly, then the readymade is a non-example (being only one), yet the introduction of the indifferent object is the basis for a different kind of assemblage. The "assisted readymade" may be the simplest form of actual bricolage, combining only a few objects, as for example in Duchamp's *Bicycle Wheel* (1914), in which a bicycle wheel is mounted upside down on a wooden stool. The arrangement rethinks the relation between these objects, and points to the important aspect of connection, the joint between them, as an essential function of bricolage.

Dada and Surrealism continued to expand the notion of the assembled object. Dada created upsetting juxtapositions intended to subvert the rationalization of war. Following this, with a deeper attention to the psychological necessity of that irrationality, the Surrealists began to employ systematic means of bricolage, for example in the creation of the Exquisite Corpse. Their arrangement is all the more unexpected because the objects are not logically connected or conceived together, as they are in Picasso's Still Life. Thus, we find in Surrealism the first example of a process-oriented bricolage.

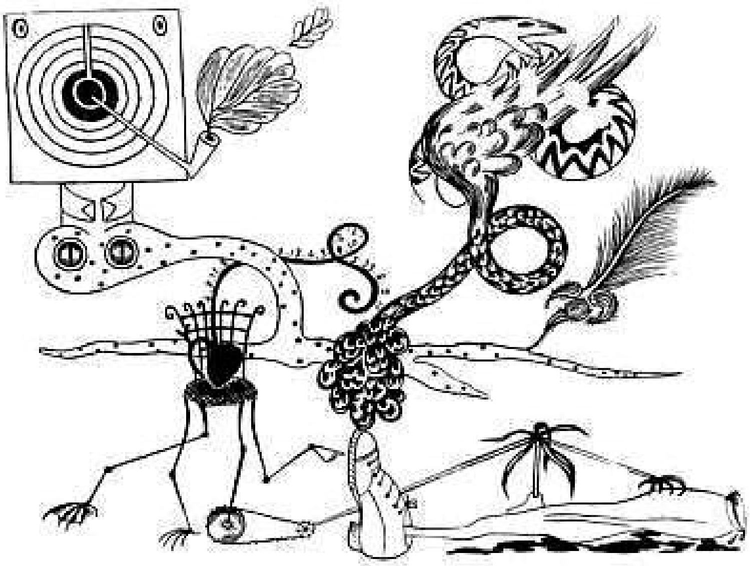


Figure 6.2: Exquisite Corpse, a surrealist drawing combining the images of multiple artists.

The notion of visual art as a collection of objects without any intentional co-relation among them, yet which collectively create a language, is expressed by Apollinaire in the Soirées de Paris.

> "Psychologically it is of no importance that this visible image be composed of fragments of spoken language, for the bond between these fragments is no longer the logic of grammar but an ideographic logic culminating in an order of spatial disposition totally opposed to discursive juxtaposition.. It is the opposite of narration, narration is of all literary forms the one which most requires discursive logic." [Seitz, 1961](p.15)

What are the differences among these artists from the perspective of bricolage? The bricolage of assembled found objects share the feature that they are arrangements of objects which exist as whole units a priori. Even in the case of the Exquisite Corpse, the objects are systematically introduced so that they retain a definite boundary between one another. The term *object bricolage*, covering all these, may be used as a more specific term which builds upon Levi-Strauss's concept of an "arrangement of found objects".

This arrangement found objects, while most closely related to Levi-Strauss's 'bricoleur', is only the most obvious type of bricolage. In *automatic drawings*, like those of Andre Masson, the boundaries between figure and ground are not clear. In this case, the bricolage is not between assmebled objects, but a conceptual one with free physical boundaries. While the found object can exists as a static form, independent of process, the automatic drawing cannot. It is a *process bricolage*, whose free play occurs at the deeper level of motion upon which structure is dependent.

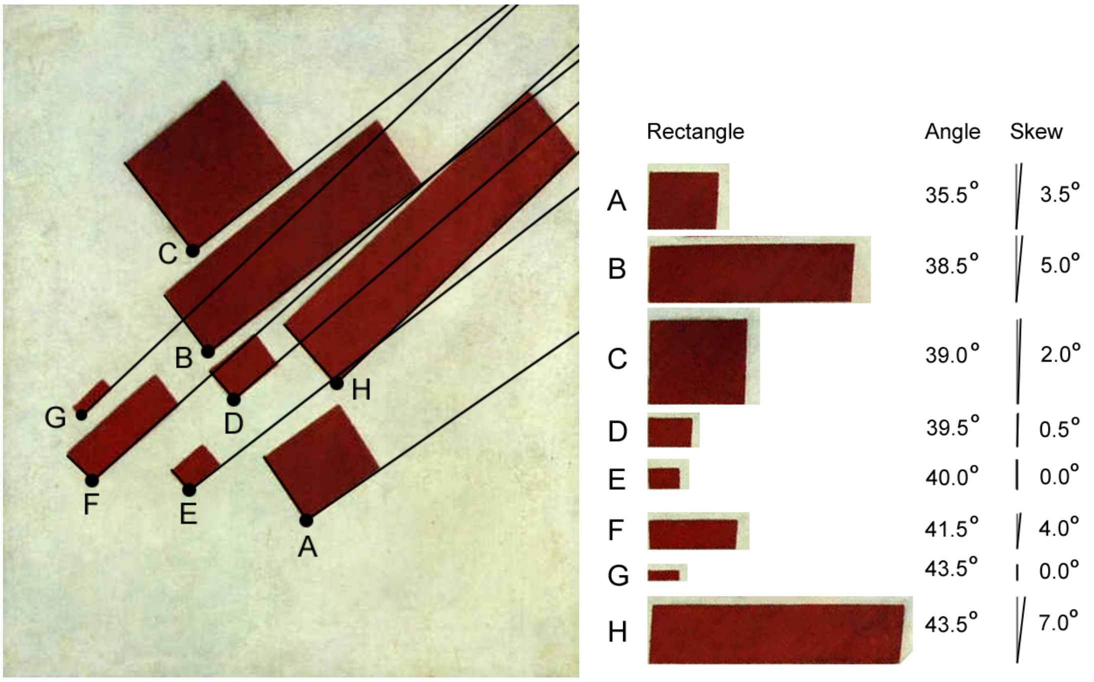
6.0.1 Parametric Spaces

Figure 6.3: Kazimir Malevich, *Eight Red Rectangles*, 1915.

When working with found, physical objects, it is straight forward to see how bricolage for the Dadaists is a guided, yet unplanned manipulation of elements. However, not all avante-garde artists worked with the physical or recognizable object. The abstract form, described by Kasimir Malevich, is that which is of "essential value" to the artist - line, shape, color - the intellectual objects of the artist, rather than the outwardly perceived object. *Eight Red Rectangles* (1915) is an example in which the play of objects is purely conceptual:

> "For the public (the majority of people) Rembrandt represents the normal in painting; Rembrandt is therefore the 'decisive standpoint' from which a pictorial norm is evaluated. Cubism, to the public, is abnormal because it contains a new additional element - it signifies a new state of affairs in the compositional relationship of the straight line to the curve - a new norm." [Malevich, 1959]

Is there any way in which *Eight Red Rectangles* might be viewed as a form of bricolage? It is not bricoleur in the sense that one tinkers with the hand, but there is a conscious arrangement and placement of forms which suggests the artists choose this particular layout. Due to the simplicity of the shapes, we can engage in a more detailed investigation by analysing the position and orientation of the rectangles. By undoing the rotation as shown in Figure 6.4, a closer look reveals that rectangles have different rations, and are not exactly rectangular. Thus, a set of five parameters is needed to specify each shape: position, orientation, width, height and skew. The angles are all very nearly forty degrees, within five degrees. Skew describes the deviation of each shape from being a true rectangle. Interestingly, those rectangles which are closest to forty degrees are nearest to being true rectangles, while those farthest from forty degrees are the least rectangular (with the exception of G).



(a) Analysis of positions and angles in *Eight Red Rectangles.*

(b) List of rectangle parameters of angle and skew. Measured by undoing the rectangle rotations.

Figure 6.4

These five parameters describe a language of rectangles of different sizes, shapes and positions, and support what Stephen Bann describes as a "meta-linguistic code" [Bann, 1980](p.125). This code is, according to Bann, the deconstruction of art and reconstruction of a new visual form which builds art up from basic principles as meta-linguistic code. It is interesting that word 'code' is used, as it does not refer to programming code, but to the visual grammar of the work of art. It implies not only a single work, but a whole class of objects, a language, with a similar form and meaning.

In mathematics, a class of objects with a similar structure may be described by a *function*. Consider the simple equation:

$$f(x) = asin(bx)$$

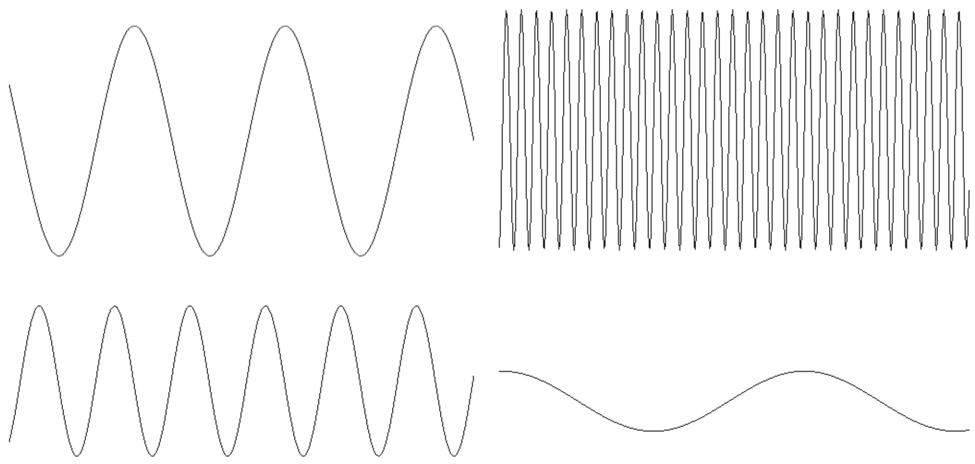


Figure 6.5: Sin waves with different frequencies and amplitudes can be described by two parameters, a and b, in the equation $y = asin(bx)$.

This is a one-dimensional function with two parameters, a and b. If we remove a and b altogether, we have the simple sine function - a single object. By introducing the parameters a and b, we can create a class of functions all of which have the same essential structure. These are shown in Figure 6.5. Notice that each of the functions appear as a sine function, although their frequency and amplitudes differ in each case.

If we compare these functions to *Eight Red Rectangles* there are several similarities. The structure of the each shape is unchanged. There is a finite set of parameters which describe not only these specific examples, but an entire class of shapes described by the parameters from which the artist has chosen to show a specific set through an arrangement, placement, or slight modification each shape.

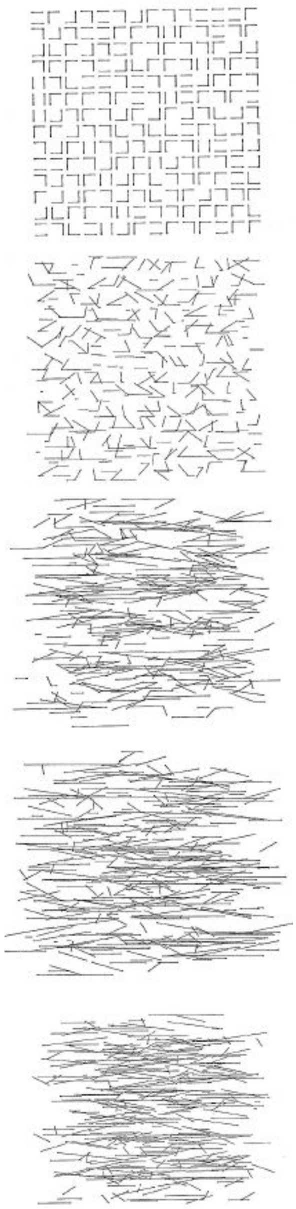


Figure 6.6: Vera Molnar, *5 images out of the '196 squares series'*, 1975.

The concept of *parametric bricolage* could be introduced to describe this play of parameters within an infinite class described by a fixed structure. The idea of 'tweaking parameters' can be found in other fields, such electronic music, in which the shape and form of sound waves are modified to produce different pitches and timbres in synthesized musical tones. In the case of the visual arts, parametric bricolage describes a class of objects of similar form which may be scale, oriented, or modified in relation to one another. The term bricolage is appropriate here because the choice of parameters also describes a found object, one which is selected out of the infinite range of available objects and arrangements of the same form.

The works of algorist Vera Molnar may be described in a similar way:

> “The images I 'create' consist of a combination of simple geometric elements. I develop a picture by means of a series of small probing steps, altering the dimensions, the pro-

> portions and number of elements, their density and their form, one by one in a systematic way in order to guess what kind of formal modification challenges the change in the perception of my picture: perception being the basis of aesthetic reaction." [Leavitt, 1976]

In general, many abstract artworks might be generated by selecting a structure and varying is parameters. The work of Piet Mondrian, such as *Composition with Yellow, Blue and Red* (1937-42), also have this quality of choice within a fixed structure. A useful starting point for a digital bricolage may thus be found in mathematics. Tilings are another example in which the arrangement of the position and orientation of few shapes fill a surface in arbitrarily complex ways. This is a liberal extension of the original idea of bricolage, with the primary difference being that the found objects are abstract, highly constrained mathematical shapes. At this level, the distinction between artist and engineer disappears. The artist may arranges the tiles, according to their color (sign) into abstract mosaics, or may be an engineer attempting to find the perfect tiling of a particular surface (no holes).

6.0.2 Algebraic Form

Not all algorithmic works of art can be described by parametric changes in simple structures. Early mathematical artists such as Ben Laposky employed analog hardware, oscilloscopes, to generate combinations of harmonic functions as in Figure 6.7. The artist literally adjusts the parameters of the form with dials that modify frequency and shape. However, unlike *Eight Red Rectangles*, these numeric changes do not determine the form of multiple discrete shapes, but modify the entire *form* of the a single object over time.

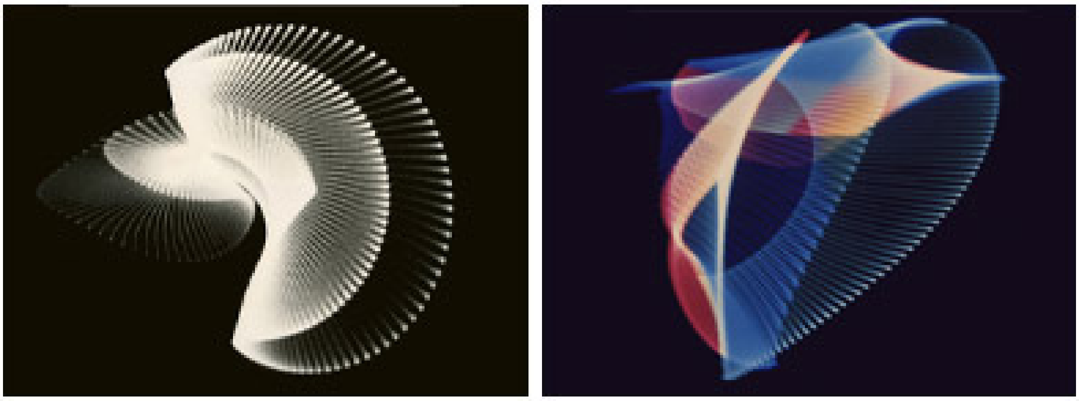


Figure 6.7: Ben Laposky, *Oscillons*, 1957.

Cyberflower Duet, by Roman Verostko, consists of a single, continuous form made of fine lines created with a plotter. This work cannot be analysed as a collection of disjoint shapes and must be described as a whole, yet the form itself defies such a description because it does not conform to any single recognizable shape. What is this object? A formal analysis might describe the image as a highly structured wave or flower, relying on references to everyday objects to hypothesize its effect on the viewer. One familiar with mathematics may be able to deduce that the curves found in the artwork closely resemble sine waves and that the resulting form is possibly a summation of several wave forms combined together into a single function, but this is largely a deductive guess (theory).

It is interesting to consider the symbolic meaning of these forms. On the one hand, the lack of a representational object helps to disassociate the viewer from the constructed reality of the found object. The image defies classical description. However, in our

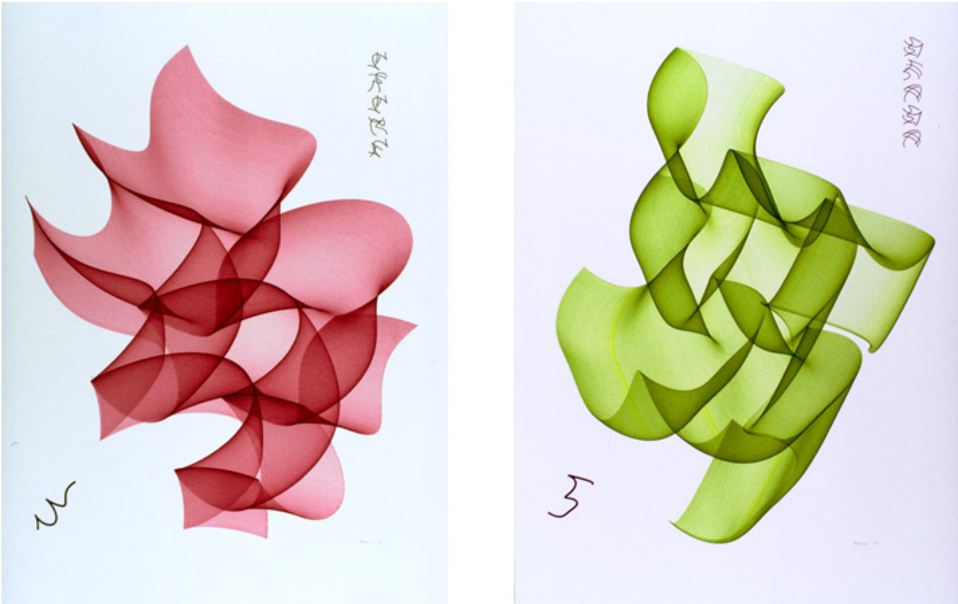


Figure 6.8: Roman Verostko, *Cyberflower Duet*, 2002.

increasingly scientific society these forms may be recognizable to those more familiar with the language of mathematics. Their sinusoid shape reveals a different kind of myth which is internalized rather than externalized. Even algorithmic art may operate subjectively as the perception of mystery depends on the familiarity of the viewer with the visual language being conveyed. What appears to one person as a trivial form may appear to another as a puzzle.

How is it possible that simple algorithms can lead to forms which are indescribable even to their creator? One possible answer may be found in the mathematics of *algebra.* An Arabic invention put forward by the mathematician Muhammad ibn Mũsã al-Khwãrizmĩ (780-850), algebra is the study of unknown variables in arithmetic expressions. The simple functions described in the preceeding section are the essence of geometric structure because they define fixed shapes. Algebra allows this structure to vary by expressing a combination of such functions, for example:

$$f(x) = asin(bx) + ccos(dx) + .. + etan(fx)$$

There is still only a one independent variable, x, so this is a one-dimensional function which can be interpreted as a single curve, yet it cannot be visually described as a simple function as it is composed of several terms. In general, mathematicians solve problems. However, the contribution of al-Khwãrizmĩ was not only to solve problems, but to describe an entire class of objects which are interesting in and of themselves:

> "If one considers al-Khwãrizmĩ's declarations, the position that he gives these chapters, and finally the autonomy conferred on each, it appears that the author wished to undertake the study of algebraic calculation for its own sake, that is, the properties of binomials and trinomials considered in the preceding section of the book. However rudimentary it may seem, this study nevertheless represents the first attempt at algebraic calculation *per se*, since the elements of this arithmetic do not simply emerge in the course of solving different problems, but provide the subject of relatively autonomous chapters." p. 14, [Rashed, 1994]

Like the parameters of simple functions ($asin(bx)$), the class of algebraic functions also defines an infinite set. Yet this set is much broader and more complex than those of a fixed function since there can be not only an infinite number of *terms*, but also an infinite *choice of functions*. Thus a different kind of bricolage is needed to define a choice of structures which leads to a single form, yet these choices are still generally discrete ones. In Cyberflower duet, it is likely that Roman Verotsko selected specific fundamental functions from which to build the final shape. The mathematical analysis of algebra is perhaps the only way to understand certain algorithmic works. Unlike a physical object there is no distinction here between the inner structure of an object and its outward form. The inner structure is that which is directly revealed in the work, so it must be understood through the processes that created it.

6.0.3 Algorithm

The ultimate form of mathematical expression is the computer program, or algorithm. It has been proven, in the Church-Turing thesis, that any machine which can compute a program is mathematically equivalent to any other machine which can. Thus, the computer itself represents the greatest degree of freedom in formalized expression, while the differences among programs and languages are only in terms of how easy or hard it is to describe or compute different results.

A key difference between an algorithm and an algebra, for the discussion of artistic expressiveness, is that algorithms have available to them logical operations and memory. The use of memory is particular important because it allows a single program to express many structures and to create new structures on demand. Whereas a basic function is a single structure with a fixed shape (many parameters), and an algebra defines a single structure with complex shapes (many functions), an algorithm can evaluate or generate many such structures.

Rule systems (L-systems), evolutionary algorithms and most computer simulations all share the property of being able to generate new structures while the program is

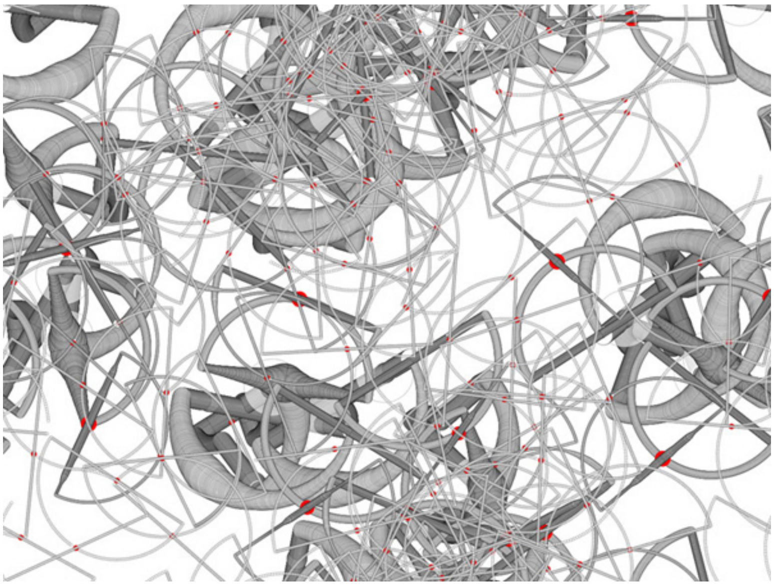


Figure 6.9: Lia, *O.I.G.C.*, 2007.

running. The fractal is the simplest example, which creates a new structure via a substitution of a single element with two or more additional ones. Generative works by the Austrialian artist Lia, Figure 6.9, produce novel structures using the Processing software. More complex processes, such as evolutionary algorithms, create entire population of structures and then invite these structures to compete in order to survive into the next generation of a simulated reproductive cycle. Each of these structures may be described by the earlier functional or algebraic principles described earlier.

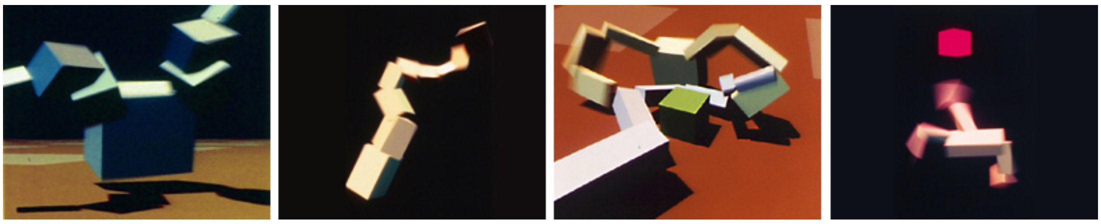


Figure 6.10: Karl Sims, *Evolved Virtual Creatures*, 1994.

The work of Karl Sims, *Evolved Virtual Creatures* in Figure 6.10, uses a combination of evolutionary algorithms and simulation to create virtual creatures composed of simple geometric shapes that are able to learn how to jump, swim, and run [Sims, 1994]. Bricolage occurs on two levels here. The artist first makes a particular selection of the rules which will guide the generation of new creatures. Later, the program itself makes a selection of the specific shape, size and arrangement of blocks used to compose each creature. The program then tests its choices against the artists rules to determine which will survive.

Up to this point, the description of bicolage in algorithmic art has proceeded in a series of steps of increasingly larger scope, with each step introducing a greater degree of possibility. Yet at each level the space of choices is infinity. How can there be a degree of infinites? This was resolved by Georg Cantor, who showed that the infinity of curves in the plane are greater than the infinity of real numbers, and this itself is greater than the infinity of integers. Thus infinite variety can be described in terms of degree [Gamov, 1988]. Each space of exploration in form, arrangement, surface, and structure is infinite in itself, while also being part of a larger infinity.

The application of this idea to the concept of bricolage explains how there can be many different, unique ways in which bricolage may occur while each retains the ability to select a particular form among a set of possibilities. *Algorithmic bricolage* is the selection of a set of parameters, functions, or programs from among the infinite varieties available. Like found objects, these programs each have their own unique expression, but it is one which is not tied to a particular human metaphor.

> "It seems that the possibility of a number of geometries proposed by Lobachevsky, Bolyai, Reimann and Gauss was another allegory, for the Cubists, of the possibility of individual freedom. For these geometries were true, not by virtue of the mind of God, of direct intuition, of nature or of any other 'necessity', but simply by virtue of the lack of internal contradiction." p.70, [Adelmann and Compton, 1980]

6.1 Mathematics and Art

The word bricolage invokes the notion of free play, which is present in many other disciplines beside art. In dance, for example, there is a composition of motions, while in poetry it is a combination of words. Furthermore, aside from free play, the word bricolage suggests a potential combinatorial arrangement of a multitude of 'objects' which is made possible by their sheer number. The idea of *combination*, I believe, is central to the concept of bricolage, because it explains how the space of possible outcomes can be much greater than the small number of objects from which they are composed. In engineering a few simple elements, columns and beams can be used to create a huge range of structures.

There are many ways in which mathematics and art may be related. A few of these are related here:

1. Math *in* art - The idea of math in art is most easily observed in the Renaissance, where perspective geometry, ratio, and number enter into the pictoral space but remain hidden relative to the presence of the representational or figurative object. In many

cultures, including Egyptian and Buddhist art, proportion enters into the image in a significant way. The essence of math in art is that the mathematics is not immediately visible, but structures the outcome of the image.

2. Math *and* art - The works of M.C. Escher are the best example of math and art. In this case, the mathematics itself is brought to the forefront, and made into an object of the composition. The composition may use mathematics to feature other objects or themes, but always in such a way that the mathematics remains visible. Agnes Denes is another artist whose works have this quality.

3. Math *from* art - Manfred Mohr, a generative artist, provides a distinction between the algorist and mathematical art (the next category): "My artwork is always the result of a calculation. At the same time, however, it is not a mathematical art, but rather an experience of my artistic experience." In this case, math from art denotes the creation of new algebraic expressions or rules which are themselves a mathematics derived from the artistic process. The objects are mathematical, but also aesthetic.

4. Math *as* art - This category is what would be described as mathematical art. In this case the mathematical object itself *is* the art. This is mathematics in its pure beauty, in which only the presentation is touched by the artist, and the object is otherwise unmodified. The Platonic solids and the Mandelbrot Set are a familiar examples. Often the presentation consists only of differences in color or rendering.

5. Math *for* art - Another way in which art can depend on mathematics is indirectly through its application. Unlike 'math from art', here the artist has no access to the

mathematical object, but that object influences the artistic outcome nonetheless. The pixelation of the image in digital media is a broad example. More specific examples include the use of particular processes, such as filtering, to achieve a certain result. While the camera is one example, art created using any digital tool is heavily influence by the underlying mathematics.

6. Math *of* art - This last category is not a means of making, but the idea of analysing art itself using mathematics. Recently, a team of physicists have shown that paintings by Jackson Pollock can be described using fractal concepts, even though the concept of fractals was not likely to be a conscious part of Pollock's work [Taylor, 1999]. The idea of analysing art via mathematics is the basis of *functional analysis* introduced in the previous chapter.

Of the above relations, three are artistic processes (#1, #2, #3) in which the artist intentionally incorporates math into art in some way. Number four is math itself, presented as art (#4). The fifth is the implication of math entering the tools of the artist, and the last is a method of analysing art using mathematical methods.

Mathematical combination suggests that digital bricolage is a manipulation of abstract shapes, puzzle-making, which does does not require a physically found object. The Tangram is a Chinese puzzle in which seven specific pieces are rearranged to form different shapes, without overlapping and by using all seven. This puzzle is most similar to the parametric bricolage describe above, since the shapes do not change. When used

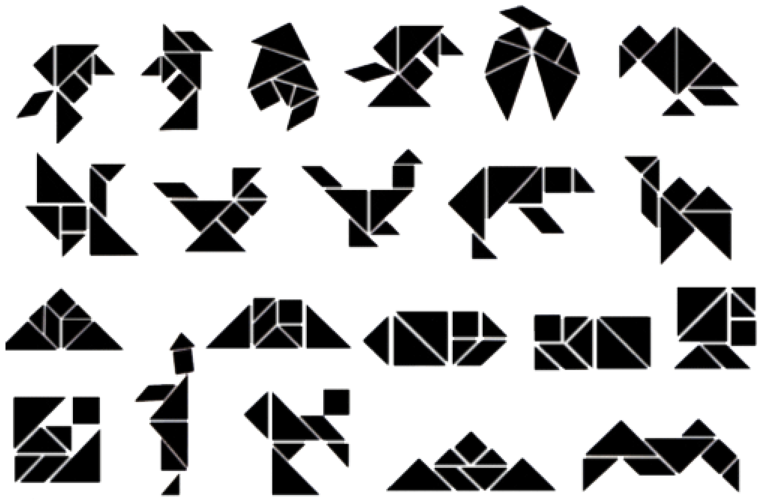


Figure 6.11: Tangram, a Chinese puzzle in which a fixed set of shapes are rearranged to create different pictograms.

to create representational aesthetic images, as the Tangram puzzle calls for, it is a form of math in art. Yet as an abstract process it is also a form of math as art.

6.2 Assemblage and the Video Game

Figure 6.12: Joseph Cornell, *Cockatoo and Corks*, 1948.

It is intriguing to consider the difference between algorithmic bricolage of the 1960s and 1970s to found object bricolage of the artists of sculptural assemblage, a later movement derived from the early modern avante-garde. The found object is unlike the mathematical object in that is posses tactility, materiality, and physical context. It can have a form which is a symbol of some naturally based form or idea. A doll, or a stuffed animal, may be used in physical assemblage, as in Joseph Cornell's *Cockatoo and Corks* (1948). A unique difference between these types of bricolage is thus largely a matter of the types of objects which are selected. Is the selection among mathematical abstractions, or chosen from physically-based natural forms?

Figure 6.13: Louise Nevelson, *Royal Tide I*, 1960.

It is possible that the physical object may itself be an abstract shape, or made abstract. *Royal Tide I* (1960), by Louise Nevelson, composes generic objects such as door knobs, mouldings, cylinders, and bits of wood by placing them inside arrangements of regular boxes, all of which are painted gold. Pol Bury, *107 Balls of 6 Different Volumes* (1959), creates even more abstract sculptures by placing spheres and cylinders in unique configurations. The only difference between these and an idealized mathematical counterpart are in their materiality, surface, and texture.

Algorithmic art is only one form of media art, however. Examples of object bricolage exist in the digital world and are more common in computer games than in media arts, possibly because of the additional programming needed to bring virtual "objects" into a digital space. Two games, Katamari Damacy and Little Big Planet, are considered here because they have been specifically chosen by the gaming community to exemplify a new style of game making in which reference to the found object is a central aspect of the game's design [Bell, 2004].

Figure 6.14: Namco, *Katamari Damacy*, 2004.

Katamari Damacy, a game by the Japanese company Namco, in which the player is a sphere which rolls over and accumulates random collections of unusual objects. A description of the game shows its playfulness:

> "You're this little star guy, see. And your pops.. Well, he's a comically abusive alcoholic. Anyway, he's the King of the Cosmos, right? He goes on this wicked bender and manages to break a lot of stars. Now that's not any kind of good, so he tosses you a Katamari, or little-sticky-ball-thing for the layman.. There's no magic or psychic powers or laser beams or mutant scoropions that can only be killed with the gem of power. I'm talking about collecting cats and thumbtacks, and some people, and then an octopus and maybe Godzilla or something." [Sulic, 2004]

A key aspect of Katamari Damacy is its shift away from the shooting style of other games. While other games do away with the shooting metaphor, Katamari Damacy does so in a unique way which uses the idea of collection to its greatest extent. The player is not a "character", but an object capable of assemblage. The game aspect is revealed in the fact that the artist does not choose the arrangement or placement of the collected objects, as this is done by the player. Thus, the resulting objects tend to be haphazard, amorphous, masses of random objects chosen by the player rather than carefully composed, specifically considered arrangements, of the artist to convey a particular message.

Figure 6.15: Media Molecule, *LittleBigPlanet*, 2008.

LittleBigPlanet, created by Mark Healy and Dave Smith of Media Molecule (published by Sony), is another game in which a bricolage of found objects is central to the design. The player first creates a character, which is a Rag doll put together from scraps of cloth, buttons and other parts. The Rag doll then makes it way through levels composed of found objects which react and interact with the doll according to their unique physical properties. The breadth of the game is remarkable, as each level may introduce a theme with found objects brought in to support that theme. These objects have a materiality and particular detail which contributes to the sense of a discovered plaything. Players may ultimately create their own worlds by introducing their own found objects.

While Katamari Damacy introduces objects that represent things from everyday life put together by the player using the Katamari ball, the world of LittleBigPlanet includes objects which were found and assembled by the games designers. As the artists describe, these objects were inspired from found objects in the physical worlds, which were then translated into virtual objects to be assembled by both the games developers and the player. The world of LittleBigPlant is one which is made richer primarily by the community of players and world-builders which support it and continually add to it.

The objects of Katamari Damacy and LittleBigPlanet have a playfulness similar to Joseph Cornell's assembled boxes, although their arrangement in the game is much more random and unexpected, due in part to the involvement of the player. Another important difference is the element of time. An interactive video game takes place over time, which continually takes the player away from the single object and onto different ones. A sculpture, however, is experienced over time and this time is spent in appreciating the physical details of the assembled object.

The physically found object is also unique in that it is embedded in the context of the natural world. Thus, a virtual found object must be either a physical object which was digitized into the virtual space (a digitization which creates a momentary snapshot of the object, like the games above), or it must be the small part of a complete entire virtual universe created by a designer or a community. Real found objects contain a history which describes their present state, wherein a rag doll may have gone through many owners, or a toy may have been used to the point of ruin. The world of Second Life is perhaps a better analog to the physical found object, since one discovers the virtual objects through the virtual world (rather than being led through levels), and these objects continue to change. However, the objects of Second Life are largely created as complete units, and the types of transformations they are capable of going through are not nearly as complex as real world changes.

Found object bricolage in digital media is thus still very different from its physical counterpart. Both involve three-dimensional forms, yet the digital versions are fixed snapshots in time (the objects cannot evolve, erode or weather). The joints and connections, and the unique physical properties of found objects (cut, join, weld), are also more limited in the digital space. Finally, the range of virtual found objects available are based only on those which have been digitized at some point in the past by a 3D modeler. Collectively, the digital object is ultimately a simulation of the real world object, yet this implies that there is a wide range of possibility not yet explored in digital media. These observations suggest that a bricolage of the digital object is one in which the objects are capable of merging, combining, eroding, weathering, and being handed down - the environment, physical processes, and human interactions surrounding the object being equally important to its construction as the object itself. The potential future of the digital found object is thus open for novel experimentation. Regardless of their differences, the assemblage of found objects is a form bricolage taking place by artists in both physical and digital media.

6.3 Engineering and the Technical Artist

I have been speaking thus far of the many practical ways in which bricolage may occur. Yet the original use of the term by Levi-Strauss resides on the level of language. In this context, a generalization would be that the engineer is possibly less concerned with the signs of the object than the artist since the goal of the engineer is to achieve some project. The civil engineer, for example, who constructs bridges from a set of pre-established components towards a known goal, is distinct from the sculptor who remains always aware of the sign-meaning of introduced found objects. It is in this sense that Levi-Strauss may be interpreted directly as say that bricolage is a "rearrangement of fixed signs" for the artist, while it is a "subordination of sign" for the engineer.

However, if the engineer is a Formula-1 engine designer who is sensitive to shape, material, and overall integration, and the artist is an algorist who manipulates mathematical equations with the intention of avoiding signified meaning, then the situation is reversed. The engineer is intimately concerned with the language constructed from the signs of the engine components in that the engine becomes an intentional object of functional beauty, and the artist is constructing a visual system of un-signed, abstract forms. In terms of language-making, perhaps it is best to say there is a continuum of experience between the artist and the engineer in how one can approach meaning in ones' work.

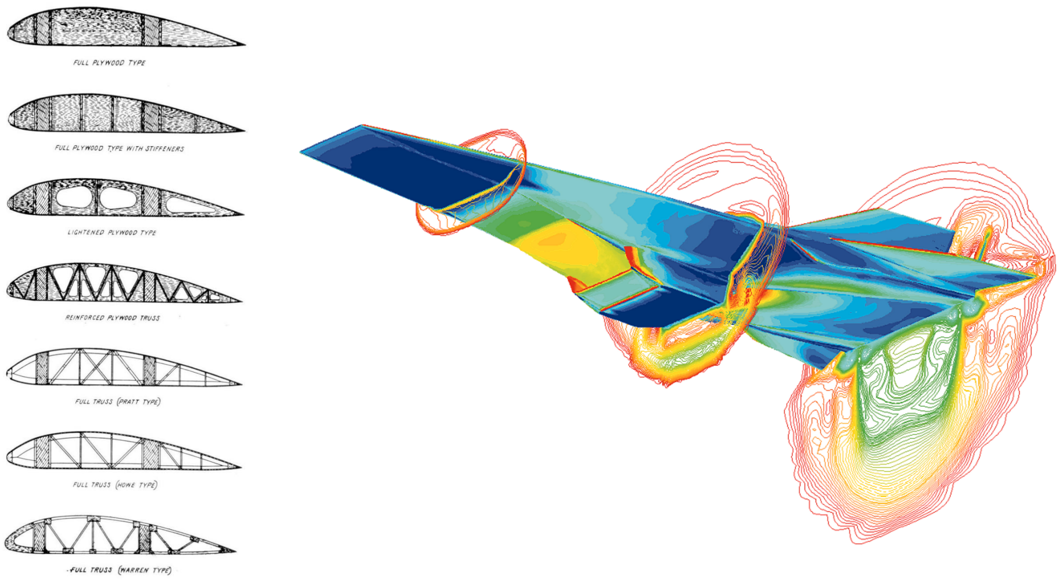
Yet the goal of the engineer is distinct from the artist in that the former intends to construct or to invent a solution to a specific physical problem, whereas the later seeks to build new meaning from a historicity of images and signs. Levi-Strauss suggests the bricoleur "limits himself to a fixed set of objects/signs", but is careful not to place an such limits on the artist or engineer. Both are capable of limiting their signs to a particular, well-defined set, such as the artist who works only with algebraic forms and the engineer who works with only columns and beams. Or, both are able to extend their language, where the artist modifies a sculpted block of wood into a new form and the engineer invents a novel shape for a structural beam.

Where might we find a real difference in bricolage between the artist and the engineer? The structural column and beam, and the engine block, whether they are borrowed from the past or invented anew, express a functional goal whose intention is to solve a specific physical problem. For the scientist, the goal is more abstract since the problem and its solution are both unknown in the process of discovery, but the scientist is equally restricted to observation and analysis of the physical world. In practice, the tools of the engineer and the scientist always exist in relation to the constraints of the physical world.

6.3.1 Simulation

Simulation is a key part of the engineering process. Prior to the invention of computers, simulation consisted of an engineer developing a solution to a problem and then testing the result against the real world limits of the physical world. Engineering bricolage, in this case, consists of a series of refinements, adjustments, and reinventions to arrive at the desired outcome. The individual parameters of a material may be modified, such as an objects density or hardness. Its shape and structure may change, its physical form. Or its relation and connection to other parts may change, its assemblage. Each of these transformations might be related to the sequence of mathematical stages described earlier, with the variety of infinite possibilities increasing at each level. Yet the difference with mathematics is that these structures must exist physically, to be tried and tested in the natural world.

With the invention of computers, it is no longer necessary to physically try every single design. This greatly increases the range of ideas that can be tested, and reduces their cost. Computer simulation is the farthest extension of *engineering bricolage* because it represents not only the object but attempts to simulate the real world itself, without actually involving the real world. The design of a wing is a classic example of an engineering problem solved through simulation. An engineered wing is similar to a boat in that it has ribs and spars which give it strength. Yet it must also conform to a specific shape in order to provide lift.



(a) Structures for wing cross-sections.

(b) Fluid simulation of air flow over an experimental wing structure, the X-43A supersonic jet. Image by NASA.

Figure 6.16

The design of a wing involves a number of material parts, which may be selected based on shape and strength, and also the arrangement of those parts in such a way that the features of the wing have the desired properties. Ultimately, the testing of a wing takes place in the real world, but may be made more efficient using simulations which move the wing through a synthetic fluid (virtual air), applying it to all the forces it might expect to see in the real world (according to the accuracy of the simulation).

Bricolage in digital simulation, in the design of a wing, is therefore much more like a dialog with the natural world than the mathematical bricolage described earlier. Objects such as the wing spars are not only selected, they are shaped, tested, broken, and adjusted in relation to a physical model. They are not atomic, mathematical abstractions, but complete shapes with materiality. Yet simulation is also unlike the physical engineer in that radically different types of objects may be tested. This could be described as a *bricolage of simulation*, similar to the parameter and structural changes of the algorists, and similar to bricolage of found objects, but different from both in that objects and processes reside between physicality and abstraction: they are not true abstractions because they have shape and (simulated) material property, and they are not true found objects because they have no physical history or materiality.

To modify a real object, its material properties or its shape, it is necessary to introduce another physical process: heat may change its density, after melting an additive may change its hardness, or bending may change its shape. The simulated object, however, can be changed in form and shape *directly*, as numbers. Its simulated material properties can be selected much like the parameters of an abstracted function or algebra mentioned earlier. Simulation bricolage is therefore not only a process of assembly and arrangement of objects, it is the selection of an object in the context of an environment which mimics aspects of the real world.

6.3.2 Technical Artists

The term technical artist is found most commonly in the film industry, and refers to someone who uses digital tools to create animated characters or effects. It is instructive to look at a common processes employed by technical artists. The CGSociety is an online gathering place for both novice and professional digital artists, and frequently features tutorials for model making.

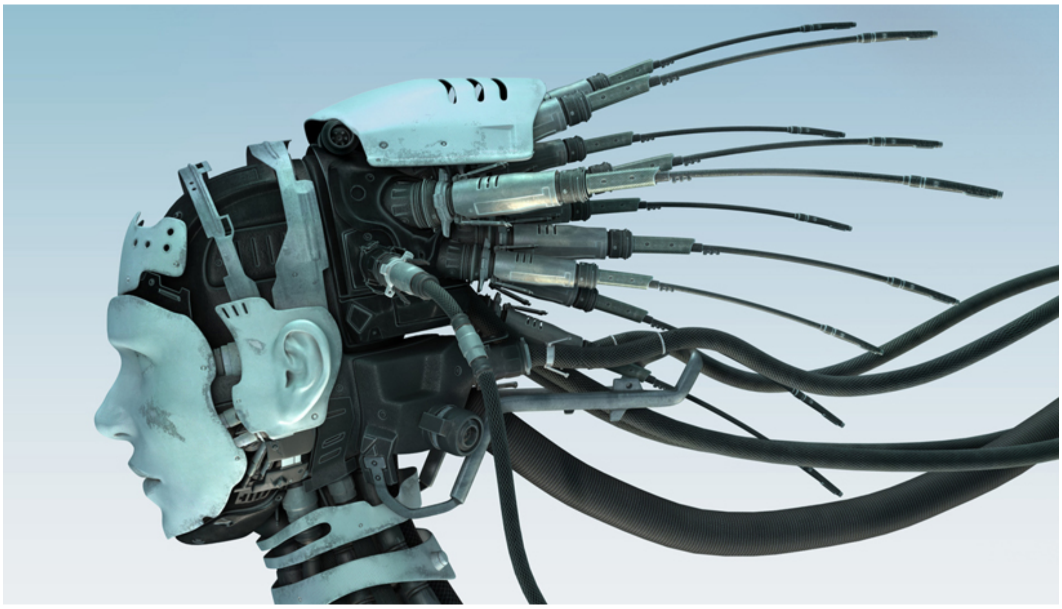


Figure 6.17: Fausto di Martini, *Cybergirl Project*, 2006

Faustino de Martini is a technical artist born in Brazil who began working for the game company Blizzard Entertainment as a Lead Modeler. His work is reviewed here as an example of the workflow that commonly takes place in this industry. While there are many artists featured in CGSociety, many of which use the computer as a digital paintbrush, as a modeler Martini must be able to work from an original concept to a completed virtual three-dimensional model. As with many technical artists, his inspirations are drawn from many different sources.

> "De Martini loves detail, and attempts to incorporate a rich tapestry of polys, textures, and emotion into his work. Trying to come up with a fresh design is one of his challenges. 'I think my inspiration went through a period of evolution.

> When I began working in 3D I would be inspired by other artists work, but after I joined Blizzard, I started looking at real reference like human anatomy for characters, and when I work in my high tech designs, Im constantly looking at real mechanical and industrial design. Of course I still look at other artists work for inspiration but for overall direction of design, not so much for the nuts and bolts and things like that. I realize that when you start looking too much at other artists work you start getting a translation that they were inspired by. When you translate that onto your own work you start to lose a little bit of what the design was based on." [Dunlop, 2008]

The bricolage which takes place here is a borrowing, combining, and brining together existing images of the art object itself, taking signs from earlier masters and from other disciplines, and combining them into a single work. The result is an assemblage of borrowed meanings which reference existing signs in the sense described by Levi-Strauss.

Two clear phases are present. In the first stage, the artist brings together inspirational material, references, and signs which are resolved into a final composition through sketching (in this case, digital sketching). In the second stage, the artist finally makes use of the computer as a conceptual tool to carefully translate the design into an invented reality through detailed technical manipulations:

> "De Martini uses the Wacom Cintiq 21 to sketch out a loose concept in Photoshop, creating lots of thumbnails to get a good silhouette before refining the designs. Lately, he has been creating low poly cages for the silhouette and using Photoshop to add the detail. 'This is helpful to get me half way with what I want for the overall mass of the character.' From there he creates the high poly model, using Mudbox, 3DS Max, Brazil, and Mental Ray." [1] [Dunlop, 2008]

[1] The Wacom Cintiq 21 is a 21" digital tablet by Wacom that integrates an LCD screen so the user can sketch in a natural way over a digital image. Mudbox is a 3D sculpting tool by Autodesk. 3D Studio MAX is a major animation package by Autodesk. Brazil r/s and Mental Ray are high-quality rendering system by the companies SplutterFish and Mental Images respectively.

The moments in which it could be said the artist is working as a bricoleur, in which the signs are collected, recombined, and merged, generally take place entirely in the first stage with the more classical method of sketching (in this case, digital drawing). This is true of nearly all the featured artists on CGSociety. The primary means of solving the creative problem occurs through a mastery of representational drawing. It is important to note that this workflow, bricolage through sketching, is successful here because the final outcome is representational composition, but could not work for the conceptual, algorithmic or generative artists discussed earlier because the latter objects must be discovered, that is they cannot be pre-imagined since even their intermediate form is unknown until the work comes together.

The reuse of existing meanings is common in industry-produced art, Martini himself acknowledges that a continual reuse of meaning is not necessarily the best approach:

> "To me, I think there are so many more creative things that we could be doing. Look at the Japanese or Chinese entertainment industry. They have a lot of Manga and interesting characters and stories that could create very powerful work, but our tendency is to reuse the same ideas." [Dunlop, 2008]

After the conceptual stage, the final stage is primarily a technical one. During this period, the process is one of translating the resolved design into a realistic three-dimensional model which upholds the digital space and light in which the character will exist. The sketch becomes a 'reference', and while the finished object may differ it generally seeks to uphold the mood and character of the reference sketch. Problems resolved in this stage include modeling of anatomical details, surface painting, rigging (in the case of animation), and lighting. The technical artist seeks to create a plausible reality in which the character may exist, thus this final stage is most similar to the bricolage of simulation described earlier. The 3D modeling tools are designed to enable a search for a form which responds properly - in material, surface and mass - to a simulated physical and illumated environment.

It is easier to understand now how commercial modeling tools such as Maya, Houdini and 3D Studio MAX have developed and the kind of bricolage they support. They are not designed as tools for conceptual bricolage, as the creative idea for the work is largely resolved through sketching which takes place before hand. Instead their purpose is to *enable* the artist in a form of engineering bricolage in which a nearly completed idea is translated into a physically simulated, dynamic model. This virtual world may be partly unexpected, but maintains a semi-plausible and identifiable narrative space. For the conceptual or media artist which seeks to discovery new behaviours and structures themselves sketching before hand is not practical as the result is not a static object, and the world in which it exists is not known ahead of time, so the desired interaction is one in which behaviours are constructed rather than objects and surfaces.

For the technical artist, based on historic periods of representational art, the aspects of bricolage in which the meaning-sign of the work are resolved occur essentially before the object enters into the digital space. The work then undergoes a transformation in which it is engineered into a simulated reality in which the character or scene is able to speak, walking, react, animate or be illuminated in a dynamic virtual world. Although

3D artists may also use digital tools directly for creative exploration, these interaction are based primarily in traditional drawing, painting and sculpture workflows rather than post-twentieth century art techniques which include found objects, conceptual processes, behavioural combinations, and mathematical discovery. While the entire range of meaning-making in art is much larger, the technical artist represents a common, and unique, post-modern approach to creating images.

6.4 Digital Bricolage

The essence of bricolage is choice. For the sculptor, this may be a choice of which found object to use. For the minimalist, it may be a choice of arrangement or size of simple forms. For the algorist, it is a choice of a parameter, a function, or an algorithm. For the simulation engineer, it is a choice of three-dimensional shapes and simulated material properties. For the technical artist, it is a choice of forms and surfaces in relation to a plausible reality.

What is digital bricolage? It is tempting to define bricolage in terms of the different classes of engagement explored here. However, while this might work for certain works, it does not fully account for the works of the early avante-garde or of many other types of modern art. *Still Life with Chair Caning*, Figure 6.1, is more than a mere assemblage of found objects. It is a collection of physical objects in relation to a collection of hand-drawn forms such that the whole is a balanced composition:

"Picasso juggles reality and abstraction in two media and at four different levels or ratios" p.9,[Seitz, 1961]

Picasso is not directly borrowing from other artist or from a legacy of representation, but takes pieces of our living reality and recomposes them into an entirely new image-form. The resulting object is unlike any other, it is both two and three-dimensional, existing in this world while drawing us into the pictorial one in constructs.

Figure 6.18: Diego Rivera, *Desembarco de Espaoles en Veracruz*, 1951. Fresco. Palacio Nacional, Ciudad de Mxico.

A mural painting by Diego Rivera entitled *Desembarco de Espaoles en Veracruz* is shown in Figure 6.18. The image depicts the Spanish conquest of Mexico of 1519. In a single image, Rivera uses a flattened perspective to compresses a tumultuous and complex time into a single, complete space. The scene is set in the Mexican landscape, but is completely filled with figures. With precision and balance, Rivera uses two dimensional space to open and closes physical spaces in order to create distinct impressions. Different perspectives are used in different areas so that overall image could not possibly exist in a virtual, simulated world, and yet each local scene is a coherent three-dimensional space in which activity takes place. Strong lines in the image, expressed as spears, staffs and logs, connect the distinct narratives into a complete whole. In one image Rivera reveals the atrocities and brutalization of an entire people. Even the figures respond an enforce the distortion of space, where one eye of the figure at the upper left appears in profile while the other is frontal.

Although it may be possible to mimic Rivera's style with digital painting, it is questionable whether any digital technology which a assumes a three-dimensional, perspective, simulated world could achieve the same coherent composition using animation, partly because Rivera intentionally uses the flat two dimensional language of mural painting in combination with localized spaces to solve visual challenges. Nonetheless, it may be beneficial to begin to consider alternatives to animated space which break from the classical metaphors that are currently implicit in many digital tools. What might an animation tool reveal in which the world moves through a mathematically distorted space?

There can be no universal definition of creativity. However, what these works share perhaps is the lack of a single preconceived approach or notion of how the work will finally come together and a break from the established ways of looking at space and time. The surrealists actively sought to avoid these predefined spaces in art. The algorists intentionally restrict their forms to mathematical formulae by creative choice, but also had no idea what would be discovered. While its possible to build a tool to support a mathematical mode of working, or in fact any particular method, tools defined this way unnecessarily restrict other artists by requiring that mode of operation. What exists as a creative constraint for one group becomes an inherent constraint when a technique is translated into a generic tool.

Artists seek to incorporate many unique behaviours while balancing and unifying the forces generated in the process into a single, coherent work of art. Digital bricolage could then be defined as the assembly, discovery, combination, or exploration of both real and virtual objects using a combination of processes that may span many different styles of art on multiple scales, with meanings that may be signed, or which may have no prior connotation, using digital tools which externalize these processes. It is the ability to explore new behaviours, both hand-crafted or invented structures, with a visual language that is expressively greater than any existing component within the language, and in which there are as few assumed constraints as possible. In so much as technique is defined as the way in which an artist resolves an idea into a form, digital bricolage is the ability of the machine to allow us to invent new techniques from collections of pre-existing ones.