

Chapter 5

Emergent Behavior: A Functional Analysis of Art

5.1 Background

The analysis of a work of art may address its materiality, its formal qualities, its social context, and its historic background, including the character and intentions of the artist. Works in media art add to this several characteristics which may be analysed separately, such as the social impact of the media employed (effects of media art on society), contextualization in media theory (qualities of the media regardless of the work of art), and the physical, interactive and kinetic aspects of the work. I propose that theories of media art which focus on its formal and functional aspects will help to establish the role of the media artist irrespective of the social signs of the media employed. Although several theories have already been proposed, many of these do not distinguish qualities of media art from its social and cultural influences. While no individual artist, movement or work is separated from this context, there may be *formal aspects* of media

art itself which are unconditioned by the individual artist or social context, which are characteristics of media art in itself as a unique form of expression.

By formal, I do not mean for an analysis of media art to be dispassionate. Roger Fry used the term “emotional elements” to describe the qualities of line, space, volume, mass and color which are now familiar in formal analysis, suggesting that these are the basic elements which the artist may manipulate to create emotion [Fry, 1926]. This is also not to suggest that emotion is a required aspect of media art, since the artist is free to use these elements toward scientific or algorithmic ends, wherein the creative choices are less emotive and more conceptually driven. A formal theory may help to describe media arts substantively on an individual basis, rather than on a mass-social basis, with media defined as a form of expression rather than as a form of control or influence (although it operates as both). The criticisms of media introduced by the appropriation of the image are a sign of our times, and like all artists the media artist is in constant struggle with these forces. A formal theory of media art would place these larger social experiences in proper context with the basic, fundamental practice of making in media arts.

Due to the newness of media arts, theories of its development are on-going. Lev Manovich, for example, provides insightful connections between cinema and media arts, wherein he describes how avante-garde cinema “anticipates the convergence” of media, and was critical in its development [Manovich, 2001](p.25). He makes important observations on the nature of the screen in both film and graphics, and in comparing

a Jacquard loom, the punchcard, and the film reel, each of which hold media in different ways. Many of the discussions that take place in the Language of New Media follow a media theorist perspective on the destructive role of media in the context of contemporary society.

However, it is important to recognize that the modern dystopian view of media initiated by Marshal McLuhan is not the only social theory of media. Hans Magnus Enzenberger is an author, writer and poet whose views are directly aimed at the media industry:

“The new media are oriented toward action, not contemplation; towards the present, not tradition. Their attitude to time is completely opposed to that of bourgeois culture, which aspires to possession, that is to extension in time, best of all, to eternity. The media produce no objects that can be hoarded and auctioned. They do away completely with ‘intellectual property’ and liquidate the ‘heritage’, that is to say, the class-specific handing-on of nonmaterial capital.. It is wrong to regard media equipment as mere means of consumption. It is always, in principle, also means of production and, indeed, since it is in the hands of the masses, socialized means of production.” [Enzenberger, 1974](p.266)

In this view, media art is seen as a liberating force. Whether media itself is capable of eliminating intellectual property remains to be seen as current struggles with digital content continue online. However, it is clear that media art is not entirely immune to possession, especially in the culture of the art institution and museum. Nonetheless, there is the beginnings of an idea here that digital media not only makes copies in the mode of Walter Benjamin [Benjamin, 1936], it generates, and this is a different form of production.

While Manovich provides a starting point for new media in art via cinema (others such as kinematic sculpture are not explored), cinema itself is not able to fully grasp media art, and he turns to the language of computer science:

“New media may look like media, but this is only the surface.. To understand new media, we need to turn to computer science. It is there we may expect to find the new terms, categories, and operations that characterize new media.” [Manovich, 2001](p.48)

The choice of categories which Manovich adopts - numerical representation, modularity, automation, variability and transcoding are not clearly justified as the selection of these terms over others in computer science appears somewhat arbitrary. For example, why are *algorithm* or *program* not included in this list? The concept of computability is central to computer science, but also not present here. By what criteria are these terms selected to be a basic theory of media arts?

More critically, the theory often falls short of the real practices of media artists. Manovich, for example, describes the media artist as a manipulator, or knob turner.

“Although photomontage became an established practice of Dadaists, Surrealists, and Constructivists in the 1920s, and Pop artists in the 1960s, the creation from scratch, as exemplified by painting and drawing, nevertheless remained the main operation of modern art. In contrast, electronic art from its very beginning was based on a new principle: modification of an already existing signal.. In the 1960s, video artists began to build video synthesizers based on the same principle. The artist was no longer a romantic genius generating a new world purely out of his imagination; he became a technician turning a knob here, pressing a switch there an accessory to the machine.” [Manovich, 2001](p.126)

The modern artist in this context is glorified for genuine creation, while the media artist is a button pusher. This observation is incorrect in two ways. First, the concept

of “creation from scratch” in painting is itself a myth. The modern artist introduces a contextual, cultural and personal history at the onset of each painting, so the only sense in which the traditional artists creates from scratch is in the literal sense of a blank canvas. If this is the intended meaning, then the majority of media artists begin with an equally blank slate, a program with zero lines of code, yet to be written. The idea that the media artist “modifies a signal”, may be applied to a particular group of artists who work with digital signals (DSP), but there are many types of media artist. The idea that the artists use tools which have a history can be equally applied to painting since the canvas and brush are themselves historic objects.

Consider another example, in which the discussion turns to the applications used by media artists Photoshop, Macromedia Director, QuickTime, etc.

“New media users are similarly asked to select from predefined menus of choices when using software to create documents or access various Internet services. All in all, selecting from a library or menu of predefined elements or choices is a key operation for both professional producers of new media and end users.”
[Manovich, 2001]

Although media artists often use tools, the concept that selection from an extensive library or menu is a “key operation” fails to address basic practice. The digital applications considered by Manovich are those most common in the commercial world, where productivity is of greater importance. The conceptual artist in media arts, however, rarely uses such tools, and often actively refuses them, in favor of the more basic task of programming. Programming differs greatly from application end use in that the purity, and simplicity of the code is essential to its success.

In a more recent article, Manovich recognizes the uniquely dynamic aspect of algorithmic and generative art, and introduces the scientific term *complexity* to describe them:

“This unique exhibition [Abstraction Now] presented in Vienna in 2003 included an approximately equal number of software-driven and more ‘traditiona’ abstraction works. Thus it created an environment for thinking about software-driven abstraction within the larger context of modern and contemporary art. I decided to test my hypothesis by systematically visiting every online work in the exhibition in the order in which they were presented on the website.. My experiment worked even better than I expected since almost all pieces in the online component of the show follow the aesthetics of complexity, invoking complex systems in the natural world more often and more literally than I had anticipated.” [Manovich, 2007]

To place this in historic terms, Manovich is observing in these works that the practice of media arts has evolved primarily from programming and science rather than from film. However, the term “complexity” is one which was used mostly in the 1960s to describe dynamic, non-linear systems which were beyond closed mathematical formalism. The first mathematical object to be described in this way was the fractal, developed as a science of the natural world [Mandelbrot, 1982]. Manovich suggests this is the current state of media arts:

“The patterns of lines suggest an inherent complexity to the world that is not reducible to some geometric phenotype.”

While the word “complexity” adequately describes these natural inspirations (they are complex both in form and function), I think there is something deeper to media arts which also seeks to abstract the outwardly natural appearance, just as the modern artists have done.

I would suggest the basis of media arts is not its outward complexity, but its inward simplicity which derives fundamentally from *behavior* and process, through the act of programming. The natural world may not be reducible to a geometric phenotype, yet the early modern abstractionists already demonstrated the rational possibility of this through their works - their arts embody this reduction. Similarly, the natural world may be outwardly complex, but modern science explores physical rules which are rational abstractions of the *behavior* of these natural systems. The origin of media arts in practice is found primarily in programming, or early programming collaborations, and the act of programming is itself an abstraction of behavior. Media arts is therefore, like all arts, a combination of science and what Levi-Strauss calls "mythical thinking", an exploration beyond the natural. The essential difference now is that the focus has shifted from an outward expression of forms to an outward expression of behavior, made possible through the dynamic processes of the computer.

Computer science is closely related, yet distinct from the natural sciences, in that its foundations are the mathematics of computation - wherein computation itself is generally not described as "complex" in the same way that organic and natural system are. Computation is the abstraction of intelligence and behavior. The purpose of computational systems is not mimicry like Walter Benjamin's mechanical reproductions, but the embodiment of a dynamic, active, behavioral systems distinct from the human.

I would suggest that the basis of media arts is the formal abstraction of behavior and its implications beyond natural complexity, since otherwise media arts itself is reduced

to a natural science. What does it mean for a point to move perpetually along a perfect circle? This is neither a question of natural science - there is no observed - nor a question of traditional art or film as the motion is indefinite, occurring now, and actively generated. It is a philosophical question but also an aesthetic one. It addresses itself to the nature of behavior beyond the space of believable or observed behaviors in the natural world, to complex, abstract, or pure imagined activity.

5.2 A Functional Theory of Media Arts

A theory of media arts should at its foundation address itself to the needs of the artist. Roger Fry, in developing a formal analysis of art, held a deep appreciation for the emotive capacity of art, and was himself influenced by Leo Tolstoy's article "What is Art?" [Reed, 1996]. It is fascinating that one of the fundamental tools in developing an impartial art critical sense, i.e. formal analysis, originated in such an appreciation for the emotive capacity of art. Jacqueline Falkenheim explores the origins of formal analysis more deeply:

"Fry's choice of component elements in structural design have by now been reissued in various primers of art appreciation. They seem arbitrary, but it would be hard to find alternatives. Again, as in his discussion of the perceptual process, he assumes an identity between the form a work of art takes and man's need to organize his perceptions in a certain way. The partly moral sense that accounts for preoccupation with sensibility and with powerful emotional responses is also probably behind his insistence on this category of physiological necessity." [Falkenheim, 1980](p.96)

Recall that Fry's elements include: 1) Line, 2) Mass, 3) Space, 4) Light, 5) Color, 6) Plane, and that he refers to these as emotional elements in the sense that these are the attributes over which the artist has emotional direction of the viewer. In light of the modern interest in minimalism and algorithmic art it is important to note that the use of representation and emotion is desirable, but not a requirement for Fry, wherein he admits that "if we represent these various elements in simple diagrammatic terms [not in figural terms], this effect upon the emotions is, it must be confessed, very weak." It is rather that these formal elements are at the disposal of the artist, to be utilized in whatever capacity is desired.

What Fry accomplished was a way of looking at art formally in terms of its affect on the viewer, without reference to an external physical object, cultural context, or to the artist's background, and also without reference to any natural study or science. Fry points out that "nearly all these emotional elements of design are connected with essential conditions of our physical existence." Thus the only human links which Fry employs are the universally shared conditions of perception and emotion. Manovich's categories are introduced *for the purpose* of relating them to a cultural context, while Fry's establish art according to perceptual-communicative functions. An important result of this is that these elements help to unify the discipline of art. Anyone can appreciate a dark, bold line as opposed to a weak, thin one. Anyone can experience a heavy, shifting mass as distinct from a flat, expansive one. By speaking of art in terms

of the basic elements available to the artist, Fry shows that art is unified in human experience by these visual elements.

While the affects of new media on consumer culture are great, a theory of media arts should be able to describe what, in particular, a media artist studies without reference to mass culture. In traditional art, Fry shows that the artist at least controls the physical conditions of line, mass, space, light, and color. The research question introduced is: What are the fundamental behavioral elements of media art?

5.3 Motivation

A further outline of the motivations for a formal analysis of media arts may be helpful. As mentioned above, media art theory should distinguish the basic practices of art from the cultural connotations of media. We could rephrase this to say that media theory should help the artist to accomplish meaningful work.

It is always up to the artist to define meaningful work, but at the very least media art theory should not present an overly dystopian outlook of artistic practice based on the cultural impact of the media the artist chooses to use, yet should not discount it either. Rather it should expose the basic principles of art irrespective of their impact or perception, according to the basic elements of the field upon which the artist can build.

The concept of “basic elements” in media arts is particularly challenging due to the fact that media artists work in so many different ways. Artists in information design commonly use Processing, a simple java-based language for dynamic lines and shapes

[Reas and Fry, 2006], or may work with digital signals using Max/MSP/Jitter, a signal-based language which has a particular structure and modality [Puckette, 2002]. Artists working with hardware use found objects, physical devices, and low-level microcontroller languages to provide instruction to that hardware. The requirements of a particular means of art-making demand a tool which is suited to that particular task. This is, of course, due to the fact that media art's tool – even at the level of programming languages – offer affordances particular to a given medium.

One consequence of this tool specialization is that artistic communities in media arts become increasingly clustered around their tools, as it takes significant effort (several years) to become familiar with a different tool. Thus, information artists may be locked into a modality until they are willing to put in the time to learn a different media tool. This weighs heavily in deciding which languages to learn, as these set the particular form the media artist can express and explore.

Thus, another motivation for a formal theory of media arts is to break down the boundaries between tools, and thus between media artist communities. If there are basic elements to media arts then these elements would at least suggest the necessary building blocks for communication among different tools. Ultimately, a formal analysis would also offer a way to analyse and discuss different works of media art in a consistent way, similar to the techniques of formal analysis and critique used in traditional media.

5.4 Methodology

Formal analysis provides the starting point for an investigation into the basic elements of media arts since the aspects of line, mass, space, light, color and composition are also present in works of media art. Yet media artworks are also different from traditional works in several ways. The latter may be produced by a physical machine, a digital interaction, from an algorithm, a database, or from the Internet. The goal, however, is not to enumerate the media of art (its forms) but to find commonality in expression (its formal qualities).

Comparison of a modern work with a media artwork demonstrates the approach, Figure 5.1. The left image is an automatic drawing by Andre Masson (1924), the right a work by the program AARON, a drawing program developed by Harold Cohen.

The image by Masson consists of flowing, undulating curves that transition seamlessly to emergent figures and body part. The curves follow circular paths that at times become hands and arms themselves. Dotted lines appear as though they may distinguish front from back, but at other times may just be dotted lines. The image is punctuated by attracting objects such as eyes or mouths, which appear to draw the moving curves in toward them. No distinct, whole figures are visible, but instead we have the sensation of figure through parts and pieces. The overall effect of the curves and figures produces a continuity of sensation across the plane of the page, but one which is also spatial and contains depth.



(a) Andre Masson, *Automatic drawing*, 1923. Ink on paper.



(b) Harold Cohen, AARON. *Aaron's garden*, 1989. Ink on paper

Figure 5.1

The image by AARON also consists of figures drawn on a plane in which they appear semi-dimensional. A regular motif is used here to create curves depicting rocks

and stones. The figures present themselves as complete bodies, but with occasional disfigurements, while each part of the body is segmented by another line. The continuity of space, a fusing of foreground and background, is achieved rather by the similar width and distance of lines and spaces. The total image presents itself as a complete scene, but one which is flattened in the plane.

These two formal descriptions of the above works are intended, as Fry sought out, to convey the experience of the work of art on the viewer, their affect on the senses. While Fry's categories deal with spatial structures, he also treated only static images, thus there is no mention of the structure of the artwork as it may have existed in time. Thus, since the viewer primarily observed the finished work, a central problem with formal analysis in media arts is that it fails to account for temporality both prior to and during the display of the work.

This problem was observed by Falkenheim, where she explains that Fry “never succeeded in isolating form from animated subject matter.” [Falkenheim, 1980](p.94). She also describes how Fry's formal analysis was later expanded due to difficulties with Impressionism, which made it necessary to introduce new language for the “description of chromatic structure”.

There is also a purely media artistic aspect which is not captured by a basic formal analysis, and that is the fact that the image by AARON was produced by machine. AARON proceeded to make the above image by following a set of rules encoded by Cohen, which then instructed a plotter to produce the final drawing. The resulting lines

are of a precise thickness, yet could just as easily have been achieved by an accomplished artist.

The method of analysing media art must therefore reside at a deeper level which may be describe as *functional analysis*. That such a level exists in both traditional and new media can be deduced from the fact that any work of art must come into existence over a period of time from the indefinite past to its present completion, and a functional analysis is a consideration of the structures and temporal processes necessary to give rise to its outward form. Functional analysis is a deduction of the prerequisite structures and knowledge needed to produce a given form or motion, its is a study of abstracted behaviors.

It may be argued that an investigation into structure, a naturalistic view of art, is something familiar with artists of any period exposed to science. The Renaissance artists, such as da Vinci, revealed the anatomy of the human body in precise detail. Yet the media artist, existing in a post-abstract period, is not focused solely on observed nature and science alone. AARON is not a precise reflection of nature, it is a styled, abstract set of rules embodying the idea of relation among human body parts. The need for functional analysis is motivated by the fact that behavior and structure can now be expressed externally in machines, bringing a thought process which was historically internal into the physical, and formal, elements of the artwork.

Functional analysis, like formal analysis, does not require a cultural context or artistic history, but it does require a natural history. It consists of the prerequisite elements

one deduces the artist must be familiar with to create a particular form. If the artist draws a human figure, they must be familiar with anatomical structure. If they produce a tree, they must have seen a tree at one point. This analysis can be extended to abstract forms. Like Fry's physically conditioned visual elements, these functional elements are conditioned on the shared experience of natural science.

Consider a functional analysis of the images by Masson. The line is a continuous, uninterrupted line, which shifts between sweeping curves and partial anatomical forms.

Automatic drawing describes the process further:

“Make a void in yourself: the automatic drawing, having its source in the unconscious, must appear like an unpredictable birth. The first graphic apparitions on the paper are pure gesture, rhythm, incantation, and as a result: pure doodles. That is the first phase. In the second phase, the image (which was latent) reclaims its rights. Once the image has appeared, one should stop. This image is merely a vestige, a trace, a bit of debris. It follows that any break between the two phases must be avoided” [Ades, 1994](p.14)

The artist moves over the image using “gesture and rhythm”, and in the second phase to draw the image of a human form - but only pieces of it. This is a functional description of the work because it describes the behaviors necessary to bring about its existence. Although automatic drawing was developed as a Surrealist idea, it is not necessary to introduce the Surrealist context, nor the artist's background, to describe the work at this particular level. The description of the process of automatic drawing alone reveals the underlying behavior, but it contains no mention of the cultural motive for automatic drawing. In scientific terms, we would say that to model automatic drawing (superficially reproduce its behavior), we need at least a rhythmic element and one

which knows human form. The boundary between naturalistic knowledge and historic or contextual knowledge lies between the individual, or social, and the communally observable or scientific.

AARON is also capable of drawing human figures. In this case, the functional analysis is more direct. Cohen has recreated the behavior needed to reproduce human form explicit in AARON. AARON, and therefore Cohen, must know the structure of the human body and the relation of its parts, at least superficially. They must also know the behavior needed to produce a line and a closed shape. The actual line, their shape, thickness and variation, are its formal qualities while the motion and knowledge needed to produce it are its functional qualities. The former is its affect on the viewer, the latter the prerequisite internal processes.

The methodology proposed here for the analysis of art is to examine both traditional and media arts on a functional level: What natural structures, what behaviors, must be necessary in the artist or the machine for this work of art to exist? What are the common classes of processes which emerge? In another way, this analysis may be thought of as a scientific investigation into the structures found in artistic objects. Since art has its origins in nature, there will obviously be a great deal of overlap with natural science. However, art also deals with the fantastic and the abstract. Therefore, these structures cannot be deduced entirely from science. What morphological structures are necessary to produce Salvador Dalis *Metamorphosis of Narcissus*?

In order to determine which structures and behaviors are the most fundamental, it is necessary to look at works across movements in both traditional and new media. An investigation of Russian Suprematism may produce a functional analysis which describes proportion, ratio, and angles among basic shapes but which cannot account for the human figure. Similarly, examining information aesthetics would suggest database structures, arcs, lines and text which are insufficient to describe organic art. The question arises: Are there natural structures beyond Frys elements that are common to all media art forms? What structures or dynamics are needed for a particular type of art?

Functional analysis is the application of natural science to the investigation of behavioral art. My purpose is not to make art into a science - since the emotional qualities of line, shape, space and structure are always at the discretion of the artist - but to show that media arts can be unified with traditional arts in terms of behavior and process, while these processes need not be described in cultural or contextual terms. Media art may be viewed as an extension of traditional art in which not only form, composition and structure are present in the expressed object, but intelligent behaviors themselves are placed into the external world as active elements.

5.5 Studies

In the preceding examples, Andre Masson and Harold Cohen's AARON, the behavioral steps employed by the artists were both available to us. In order for a functional theory of media to be useful, we must inquire what kind of deductions can be made when

these behaviors are not known in advance. This is often the case: while an artist might describe the philosophical approach of a new technique, they may withhold the details of its execution. In media arts, some artists choose to make their program code open, exposing its behavior, while others choose to withhold it as the primary representation of the artist's creative product.

5.5.1 Jean Pierre Hebert

The next example, *Fractured Landscape* (2004), was created by Jean Pierre Hebert, an artist in the same group as Harold Cohen, Figure 5.2. Many artists worked in the same way, by constructing their own pen and ink plotting devices, and writing computer algorithms to produce images. This work was created in the same way.

A careful look reveals the image to be made with a criss-cross of unbroken lines that extend from one side of the image to another. Above this level, the image resembles a sheet of crumpled paper or a geological landscape with mountains and valleys. As the title implies, a 'fracturing' of the landscape appears to cross the surface from the upper left to the bottom right. The experience is very much like a physical, yet not entirely real, deformed surface.



Figure 5.2: Jean Pierre Hebert, *Fractured Landscape*, 2004. 20x18 in.

Functionally, the first behavior implied is clearly the ability to draw continuous lines in different shapes and directions. What others may be derived? While we do not know precisely how the rippling surface was created, we can deduce that the most natural explanation is as a collection of wave forms (sine functions) which have the known property of creating waves. There are other behaviors which can achieve the same

effect, such as creating a rough surface and then smoothing it, so this image suggests a number of closely related behaviors which are known to produce a wave-like appearance. It is clear that Hebert was familiar with at least one technique for creating ripples.

On top of this, the geometry appears to be deformed to the right, very much like the process of translational fracturing which takes place in geology. The natural process is an additive one, in which an existing form (ridges and valleys), are sheared sideways by another force. This is exactly the same behavior observed in this artwork, so we might infer that an additional sideways motion was concatenated with the first.

Just as raw data describes direct observation, formal analysis describes what one sees. Similarly, as natural science can on occasion only infer inexact rules, functional analysis may only offer inexact behavioral deductions. An interesting test would be to see if the deductions above match the actual algorithms employed by Jean Pierre Hebert.



Figure 5.3: Piet Mondrian, *Composition with Lines*, 1917 (left). Michael Noll, *Computer Composition with Lines*, 1966 (right).

Another valuable test would be construct models of art which attempt to match real works. A very interesting comparison of this type was performed by Michael Noll in relation to Piet Mondrian, Figure 5.3. Poll developed a system to mimic the placement of vertical and horizontal lines of Mondrian's *Composition with Lines*. He found that a majority of both public and professional viewers of art could not make a distinction, and since the computerized version is non-emotive, draws the conclusion that "the results of this experiment would seem to raise some doubts about the importance of the artist's milieu and emotional behavior in communicating through the art object. But then again, many present-day estheticians do not subscribe to such definitions of art, and some even question whether art can be attributed any defining properties." [Noll, 1966]

While algorithmic art is generally less concerned with creating emotional content, it is nonetheless a series of visual choices made by a human being embedded in culture. Engaging in a functional analysis, Michael Noll removes this choice from his own computer generations by borrowing the choices made by Piet Mondrian. This explains how functional analysis can be separated from the artist since it begins with reference to an object of study in which many subjective choices have already been made. In the creation of *Composition with Lines*, Piet Mondrian has developed the first instance of images of this form, and thus invokes his own human choices in these decisions. If emotion is equivalent to biases in human choice, then all art must be subject to at least some degree of emotion since choice cannot be eliminated when create a work of art from nothing.

5.5.2 Yves Tanguy

Functional analysis should be applicable not only to media arts, but to all art forms, since the art object always comes into being through some process. In media arts, that process is outwardly expressed in the machine itself, embodied in the computer program. In traditional arts, that process is internal to the artist. Since artists are embedded in the world, however, their processes must have similar abstract principles which unify them.



Figure 5.4: Yves Tanguy, *Multiplication of the Arcs*, 1954.

Multiplication of the Arcs (1954), by Yves Tanguy, is unique for a Surrealist work in that it contains a repetitive, generative element while at the same time consists of body-

like forms (Figure 5.4). Several things can be observed immediately. The presence of the horizon, and geometric figures, suggests a three-dimensional space and depth. Within this space, a repetition of organic forms is built up in layers, interspersed with prismatic structures. The overall impression is one of a multiplicity of shape, a world of objects each self-similar to one another.

The presence of the prism blocks suggests an awareness of abstract geometric form, the concept of right angles and construction of planes. More interestingly, the other forms seem as if they were naturally grown as layers of stone or landscape. The process this suggests may be one of slicing a whole object into sections, as it appears to be with the foreground rock-like objects, or it may be one in which a form is progressively built-up as a series of regions drawn as closed curves. Tanguy upholds the space by making these forms overlap and cast shadows.

Based on these observations, it is not difficult to imagine a system for making similar forms: a procedural model of three-dimensional objects created using slices and regions. Of course there are some processes in the image which defy this first analysis, such as the placement of objects in relation to one another (a series of large stones to the right is placed near two lightly colored regions bounded on the top by a prism). While the analysis may be continually refined to achieve the same kind of language present in this work, it is not the goal to reproduce the *Multiplication of the Arcs* exactly. As a digital process the analysis describes a range of activities which may form the basic elements of a vocabulary in media arts.

The forms created by Tanguy suggest a meta-principle of sculptural form. These forms appear both as bodily shapes but also as mathematical abstractions with a particular structure. The structures directly express the process by which they were produced, and although we may not know the process exactly, we can deduce the principles of this behavior.

5.5.3 Salvador Dali

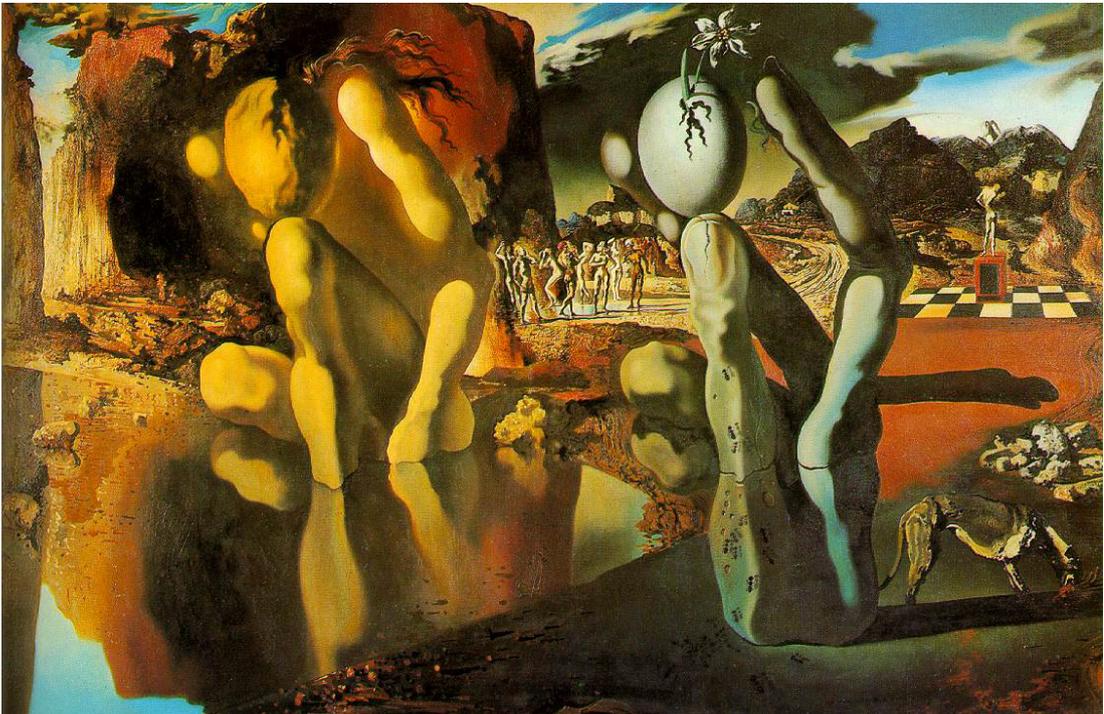


Figure 5.5: Salvador Dali, *The Metamorphosis of Narcissus*, 1954.

Unlike the early Surrealists, Salvador Dali dealt more directly with the figural form as a representational object. While Dali is often the first point of reference for the surreal image in casual discussion, in many ways he represents the anti-thesis of the Surrealist

goals [Greeley, 2006](p.65). Greeley shows that Dali was aware of, and intentionally engaged the issues of narcissism, greed, and desire, with a conscious effort to understand and study them:

“Dalí addressed the theme of narcissism most prominently in his 1937 painting, the *Metamorphosis of Narcissus*, which he took with him to meet Freud in 1938. The painting, a meditation on alienation and homoeroticism among other things, shows Narcissus turned to stone through the treachery of his own misguided passion. Dali seems to have conceptualized alienation in Freudian rather than Lacanian terms as being separated from a whole sense of self, or the conscious being separated from the unconscious.” [Greeley, 2006]

Narcissism is approached directly by Dali in *The Metamorphosis of Narcissus*, Figure 5.5. The description by Greeley above explains the issues Dali addresses on a psychological level. Yet, obviously, there are several intermediate steps between this psychology and the forms that appear on canvas. Function analysis resides between the high level of emotion and psychological process, and the lowest level of the actual forms created. Between the idea for the work, and the brush arriving on the canvas, what other steps are occurring? A slightly closer level is approached in Dali’s description of the Paranoiac-Critic Method, the technique employed:

“Theoretically, and individual gifted with a sufficient degree of [induced paranoia] can - according to his desire - see the form of an object taken from reality change successively, just as in the case of voluntary hallucination but with the more ominous

particularity, in the destructive sense, that the diverse forms that the object can take will be controllable and recognizable by everyone, once the paranoid has simply indicated them.” [Greeley, 2006](p.58)

A formal analysis describes the form of the image and its affect on the viewer. An art-historic analysis seeks to uncover the motives, ideas, and philosophies of the artist. Dali enters the ‘paranoic’ state, and then through some unexplained process, translates this into figures, shapes, and light. The intermediate process is a naturalistic one: how shall I depict Narcissus? how shall I depict his stone image? The decision to express a narrative form in figurative terms introduces a representational elements which the original Surrealists objected to, and which itself contains functional processes.

The forms of Narcissus are human, so Dali draws on his experience of human anatomy. However, parts are replaced by other parts (the leg with a thumb), so one process in use is the substitution of one form for another. Another process employed is that of illusion, or more specifically light behaving in space in ways which are unnatural, such as the transparency of the stone torso. A more subtle one is a replication in the identity of visual form, whereby the reflection of the left figure appears as an inverted stone base supporting the leg of the right figure. This last behavior is particularly subtle because it involves the design and placement of a three-dimensional form according to the two-dimensional image of another completed portion of the painting. The process is used again in the hair, which is replaced by a flower of the same shape. Other pro-

cesses include the use of geometric grids, knowledge of landscapes (terrain), and Dali's trademark of placing small divets, cracks, and creases in stones and objects.

A huge number of elements of real-world behavior - anatomy, figure, landscape, light - are be combined with an equally large number of behaviors which have no physical counterpart - illusion, part substitution, floating, and visual similarity. Dali's works thus represent a wide range in technical ability, which collectively serve his larger conceptual purpose. The processes employed are both physical, natural ones and unnatural illusions.

The processes employed by Dali are available to every artist, while it is the goal of the artist to balance the play of these processes against the goals of the work. Functional analysis reveals the processes themselves. These processes do not guarantee a particular form or a particular effect on the viewer (formal analysis studies this), since the artist must used them appropriately. Nor does their selection guarantee a particular view or philosophy at a higher level. They are simply the range of active practices available to the artist, which in terms of media arts may be translated into digital processes. The processes studied here mediate, or translate, an idea into particular observed forms and lines. In the classical arts, these processes were studied as a natural science with the study of anatomy and figure central among them, with which Dali is obviously familiar. Yet in the *Metamorphosis of Narcissus* we also see a number of processes which are not typical, which must be described as illusionist or procedural. Many of the confusions surrounding the public conception of the term 'surreal' may have to do with a conflation

of the more abstract intellectual goals of breaking the illusion of painting, which Dali goes against by upholding a representational space, with the use non-real, abstract processes which all the Surrealists employed.

5.5.4 Michael Rees

Although it would appear from the preceding example by Dali that functional analysis can be simplified by observing the various visual devices employed by the artist, such as the use of part substitution or mirroring, it is not always possible to identify a specific process from the work of art itself. Abstract art, sculpture, and media arts make this more apparent.

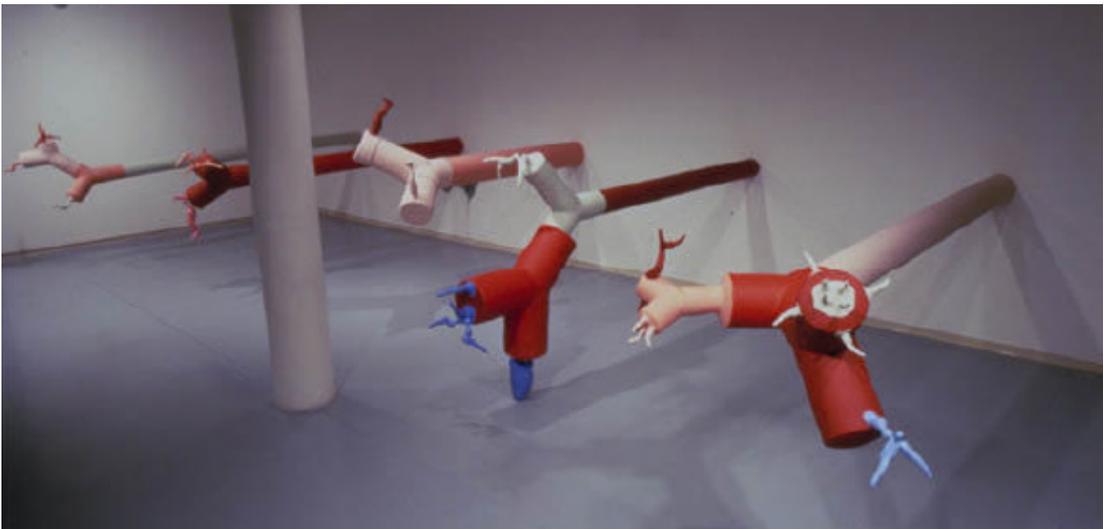


Figure 5.6: Michael Rees, *Artificial Sculpture*, 1999.

Michael Rees was one of the first sculptors to employ rapid prototyping (computerized machining) in the creation of his works. His early works, such as *Artificial Sculpture*

in Figure 5.6, appear to the eye as unusual, and abstract branching cylindrical forms terminating in a rather unexpected bodily form - a bulbous foot or a hand.

“In his Artificial Sculpture exhibit, Rees presents us with rhizome Y-branches with program designed protuberances, cantilevered out at different lengths, angles, and weights from a constructed wall in all their density of traditional sculpture, juxtaposing them to the floating computer design grid on the facing wall which produced the pieces.”

[Murphy, 2000]

Only once the behavioral aspect of the work is understood can the work be appreciated for what it is attempting:

“Rees collaborator, the artist and designer Chris Burnett, describes it as an ‘abstract machine for the production of virtual bodies.’ Fifteen typing vowels produces anatomies, whereas soft consonants produce bodies and hard consonants connectors between them.”

[Murphy, 2000]

The sculpture thus operates as a literal translator of language into anatomical form. Yet this raises many other questions. How do these forms enter into the machine? How are they selected? What is the relationship between a particular letter and the forms produced? How are they connected? How do the forms enter back into the physical world? A single process can introduce many other formalist questions, each of which can only be answered with another sub-processes which remains hidden. Rees reveals some of this process to us in his own writing:

”In short letters and words typed into the keyboard produce discrete objects or combinations of these objects. Words create objects. The library of objects available to the user is based upon work of mine from the early 90s. Objects are repeatable by inputting the same characters or words, and exchangeable in that the user can switch between words or objects... Different letters of the keyboard work as follows: vowels are equivalent to anatomies, hard consonants are connectors, soft consonants are bodies.”
[Rees, 1999]

Other questions are raised. How does Rees determine the angle between a base form and an attached body?

An analysis of the work, combined with what behavioral information is provided, suggests a number of non-intuitive, modern processes employed by Rees: 1. Digitization - Scanning and importing of a physical form into the machine 2. Modeling - Representation and storage of the final three-dimensional form by machine 3. Transcoding - Translation of a word or text from a literary form into a set of geometric instructions and operations 4. Generative Functions - Decisions, which cannot be produced by translation alone, on the angle and scale of the object in relation to the base object. 5. Rapid Prototyping - Output of the sculpture as a physical form using computerized machining techniques.

While some of these are categories suggested by Manovich (transcoding), many of them are processes which are still being explored and developed. The essence of media art, therefore, does not reside in any particular process but in behavior in general, the

transitions between them, and the state of the art object as it moves from process to process. The media artist understands process by investigating it directly and by inventing new processes, such as the translation from poetry to body, which are not obviously revealed by science or by engineering alone.

5.5.5 Ratatouille, Pixar



Figure 5.7: Pixar, *Ratatouille*, 2007.

A functional theory should be able to unify many forms of art. *Ratatouille*, a film by Pixar (Figure 5.7), follows from a long traditional in animation which extends back to Walt Disney. Many of the large animation studios, such as Pixar, Dreamworks and

Bluesky, have a history which directly connects to Walt Disney. John Lasseter, for example, is an animator and founding member of Pixar who was originally employed by Disney. With goals of commercial consumption, films by animation studios are often viewed as the anti-thesis of the goals of the Surrealists to subvert appropriation of the image in consumer culture. Regardless of these large differences in cultural motivation, which have been studied extensively by media theorists, it will be instructive to see how a function analysis of digital film compares to traditional and new media artworks.

A key difference between the individual media artist and the company is that while the conceptual idea for a film is not socialized (it resides within the power structure of the company and market), the technique and methods of production are socialized within the community of the company. Although this is generally not accessible to the public, this has the effect of exposing the processes of art-making within the studio community. The techniques described here are not specific to any studio, but common to the industry itself.

The this image shows a swarm of rats running along a city street. With human-like manic expressions, they appear to scramble and run as an organic collective. There is a clear understanding of the anatomy of rats, but one which has been transposed into a more human posture. Functionally, the system upholds the tradition of animation in which the essential object is the body in motion, one of the key contributions of the Walt Disney legacy. The joints of the body follow natural laws of motion, respond to

external forces, are moved by the body according to shared processes, such as walking gait, and individual features such as personality.

At a microscopic level, each rat is covered in fur which responds naturally to wind, body, and light. Fur itself is an object whose behavior has been extensively studied in computer graphics. The challenge to the artist in this case is partly one of sheer magnitude, with over 50 million hairs in a single frame. From a conceptual perspective, this may seem like an issue of scale only, but it also introduces changes in workflow. How does one groom a virtual rodent? How does one prevent them from all looking identical?

At the macroscopic level, the rodents move together as a swarm, but also with an individual personality and motion unique to each. Further study reveals that only foreground characters may be directly manipulated by an animator, while the larger background swarm is itself moved according to procedural rules. Processes for collective behavior, crowd simulation, are used to automatically inform the motion of large numbers of rodent. Each one chooses its own path and motion, but in reference to the group, and in reference to a set of default motions created by an animator.

Collectively, *Ratatouille* is as ambitious as Dali in the level and depth of natural behaviours which it mimics. In essence, every feature of a human-like figure is simulated from the physical motion of individual hairs, to the motion of the body, to the character and quality of expressions, to the collective motion of the swarm. *Ratatouille*, and films like it, thus represent a very specific set of formal behaviors which are related to the

human figure, but which themselves contain such a huge amount of detail as to offer indefinite exploration. Human behavior itself is an unbounded field at present, as our present understanding of intelligence is limited.

Thus it is possible for functional processes to be both limited in scope in one way, but also infinite in another. The transition in art from representation to process opened the way for art to become an unlimited discovery of all aspects of behavior, both real and imagined. The range of behaviors which are covered in breadth through abstract, organic, and media arts, are covered in depth through the singular study of the human form. The combination of these two suggests a huge range of behaviors which are largely unexplored. How might Jean Pierre Hebert's fractured landscapes appear after another hundred years of geological research and simulation?

The relationship between the history of digital film and new media arts also emphasizes another distinction among digital artists. To study the anatomy of imaginary figures, as Michael Reas does, is different from a study of detailed motions of the human figure. The former behavior seeks to abstract structure itself, while the latter seeks to explore behavior within a particular structure. The motion of a figure need not be realistic, as it is not natural for a rat to move like a human, yet the restriction to rat anatomy constrains the available behaviors. To convey believable characters, Pixar chooses motions which correspond to human behaviour, thus restricting the behavior to plausible-human-motions-on-a-rodent-anatomy. This motion is not 'realistic', but its form is closer to real than Michael Rees's Putti.

This analysis suggest there is no single boundary between real and imagined behaviours. A human moving as a human is realistic, a rat moving as human is semi-real, a rat moving like a dragon is less real, while an amorphous, unidentified anatomy moving in any way is least “real”. Our conception of reality is conditions by our outward experiences yet the possible behaviours and structures between the real and imagined are continuous.

At present a large amount of human effort and money is spent in developing a narrow set of behaviours in digital film relative to the space of potential forms. Even within the range of human forms, however, the possible behaviours are infinite. Although the space of the imagination is infinitely more vast, this focus is due in part to the consumer goals of film, to the narrative quality of commercial film-making, but also very clearly to the privileged status which human beings place on the observed world. As Roger Fry states, the human form has a unique status as an emotional element in our visual language due to the fact this is the level of our own existence and relation with other beings.

5.5.6 Life Species II

It is becoming increasingly common to see scientific processes translated directly into the media art object. In these cases, the basic process is known ahead of time as a scientific theory and may be augmented, adapted, or modified by the artist. When scientific processes are modified in this way they retain many of the qualities of the

science which revealed them. While not a universal view, some artists believe that the scientific approach helps to reveal the true nature of art by eliminating the content which manipulates the viewers emotions, thus revealing the underlying structure of art. Whereas functional analysis relies on a scientific approach to understand art (and is thus a reflective act), this view goes further in proposing that works of art are created, or designed, according to scientific principles.

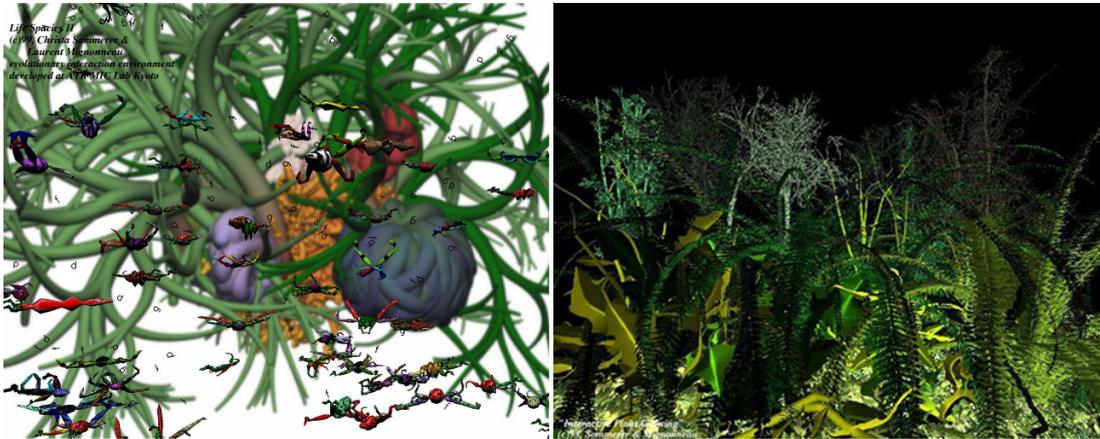


Figure 5.8: Christa Sommerer & Laurent Mignonneau, *Life Species II*, 1999 (left). *Interactive Plant Growing*, 1992 (right).

Life Species II, 1999, is a work by Christa Sommerer and Laurent Mignonneau. It represents the culmination in a series of works exploring the expression of biological processes in interactive art. In descriptions of the work, they rely on a definition of complexity which is specific to the sciences and contains certain features:

”Although there is no exact definition of what a Complex System is, there is now an understanding that, when a set of evolving autonomous particles or agents interact, the resulting global system displays emergent collective properties, evolution and

critical behavior that have universal characteristics. These agents or particles may be complex molecules, cells, living organisms, animal groups, human societies, industrial firms, competing technologies, etc. All of them are aggregates of matter, energy, and information that display the following characteristics. They: - couple to each other - learn, adapt and organize - mutate and evolve - expand their diversity - react to their neighbours and to external control - explore their options - replicate - organize a hierarchy of higher-order structures” [Sommerer and Mignonneau, 2001]

Life Species II embodies the concepts of complexity by incorporating organic plants that can grow, evolve and mutate. Similar to Michael Rees’s *Artificial Sculpture*, the user uses a textual interface to encode changes to the system. In an earlier work, *Interactive Plant Growing*, users interact by perturbing the system to change the way plants grow. Thus, while the fundamental behaviour is derived from biological evolution the interactive element is determined by the artist. The resulting forms closely resembled plant, but ones with distinctively different structures than real plants.

The term ‘complexity’ is worth discussing. Sommerer and Mignonneau survey several modern definitions of complexity in a search of a unifying view, concluding that “there is in fact no unified Complex Systems Theory or a ‘manual’ for how to create complex systems as such.” While Manovich clearly intends for the term complexity to be applied to the whole of media art as a theory, it is unclear if Sommerer and Mignonneau view complexity as a general theme for media art. In general, complexity does not necessarily apply to all media art works. For example, a harmonic system produced by

a sum of sins can produce convincingly complex images that defy generic description, but do not incorporate the qualities of "variety", "dependency" or "chaos". Many other works in media art, such as Michael Rees's *Putto*, do not employ complexity theory but still exhibit a quality which is difficult to describe. It may be more appropriate to say that complex is a particular type of behaviour which is exhibit by life, and which may be simulated.

The unique aspect of *Life Species II* and *Interactive Plant Growing* is the link created between the interactive participant and the living system. Although complex systems have been explored previously by Mandelbrot, William Latham, Karl Sims, and others, *Life Species II* and *Interactive Plant Growing* introduce processes whereby the viewer interactively constructs objects within the complex system, in the former case through a translation of text to simulated entity, and in the second via a translation from a sketched for to simulated entity. These processes are unique because they allow the participant to insert objects into the simulation, which then undergo complex processes.

In several ways these processes deviate from real science. The complex system is itself a simulation, and thus an abstracted model of living biology. The artist thus focuses our attention on certain features of the virtual world depending on which portions of the simulation received the most attention in development. The interactive involvement of the user is also unnatural, since we normal interact with plants through physical touch. In *Interactive Plant Growing*, touch causes changes in growth parameters, which is not normally something we can influence in nature [Mignonneau and Sommerer, 2005]. In

Life Spacies II, text changes the form of the simulation, which is even further from expected reality.

These examples emphasize that even in biological, nano, or organic media art there are creative decisions which contribute to our reading of the work as art rather than science. These decisions not only illustrate science in a unique way, they change our perception of reality itself through the introduction of non-natural processes.

When examining any work of art, and especially those that reference scientific processes, it is necessary to consider not only the explicit references to processes but also the ways in which those processes deviate from reality. This is because a simulation is not simply a scale-reduced version of reality: it can be constructed to emphasize or de-emphasize certain aspects of reality over others. Those features which are emphasized, such as branching structure of plants in Life Spacies II, are decisions made by the artists which focus the resulting behaviours toward a particular expression. Functionally, while these behaviours show many of the features of complex systems, and give the viewer an experience of science, there is no single model or interpretation of complex natural processes so the experience is ultimately one mediated by the artist. The processes go beyond science via the ways in which they translate the viewer's experience.

5.6 Functional Elements of Media Art

Collectively the works examined here were chosen in order to search for possible abstractions across the whole of traditional and media arts. The objects studied could not

possible represent the entire field, but describe a surprisingly large range of behaviours.

These are collected and summarized in the following table in no particular order:

- Construction - Construction on first principles: drawing lines, circles, angles
- Spatial Transform - Abstract bending, translating, twisting, and rotating.
- Sweep Transform - Lofting, extrusion, pressing, solids of revolution
- Harmonics - Behaviors based on waves, harmonics and chords.
- Collection - Creating sets of similar objects by property, shape, or some feature.
- Assemblage - Arrangements, placements, and combinations of objects
- Substitution - Replacement of one thing with another
- Signal/Image processes - Blur, filter, average, warp, and other signal processes.
- Perceptual processes - Projective geometry, illusion of space.
- Light & shadow - Movement of light through reflection, shadows, etc.
- Plastic interactions - Motions of painting, sculpture, and drawing.
- Particle processes - Abstractions of splitting, merging, and combining of point objects, or of compound structures.
- Material processes - Bending, twisting, cutting, pressing and shearing of an object.
- Physical simulation - Rigid physical interactions between multiple objects
- Unnatural physics - Anti-gravty, transportation, levitation, infinite energy.
- Natural processes - Geophysical, biological, chemical changes in form and structure.
- Animal/Human Motion - Motions of the body: eating, sleeping, walking, grasping, swimming, etc.
- Animal/Human Behavior - Decision making, problem solving, path finding.
- Crowd Behavior - Flocking, swarms, and the collective motion of groups
- Evolution - Structural mutation, recombination, and growth

- Storage - Placing a structure into a more permanent media
- Encoding - Translation to another structure with changing its meaning (e.g. fluid particles to fluid volume)
- Transcoding - Transformation of a structure from one form to another (e.g. poetry to form)
- Input - Generation of structure or motion from an external input device
- Output - Creation of a physical object using an output device

It would be impossible to create a single taxonomy to organize the above behaviours, as they cover many disciplines, modalities, and levels of abstraction. They are presented instead as a limited collection of all possible processes, some of which are common to objects of art created thus far. One of the reasons that art is so difficult to tie to a particular movement beyond the post-modern period (after 1970s) may be due to the fact that Conceptual art, combined with structuralism, opened the door for art to include any type of process and thus extended its range to all sciences and to all potential activity. Beginning with Duchamp's readymade, which demonstrated that any object (structure) may be art, conceptual art takes this to the point that any process may also be art.

Several observations can be made of the above list. First, many of these processes may exist in a work of art simultaneously on different scales. For example, the works in *Ratatouille* simulate fur at a mesoscopic level, character behaviour at a macroscopic level, and crowd behaviors at a metascopic level ¹. These levels can also be observed in

¹The term mesoscopic is introduced to describe the scale between atomic and everyday life, at which forms are present, beyond particles but not yet as recognizable objects. Metascopic refers to an organizational scale larger than the individual, that is groups and collections of the common object.

the other works of art. Figure 5.9 shows an analysis of behaviour according to scale for the works examined.

Work	Microscopic	Mesoscopic	Macroscopic	Metascopic
Savaldor Dali	painting (physical)	n/a	anatomy, substitution, light	illusion, figural composition
Yves Tanguy	painting (physical)	slicing, regions	object placement, shadow	composition
Jean Pierre Hebert	line construction	ripples, waves	material process (fracture)	n/a
Michael Rees	input/ouput, CNC	assembly, collection	transcoding, morphology	poetry
Ratatoullie	digital geometry	physical simulation	animal motion and behavior	crowd behavior
Interactive Plant Growing	digital geometry, video projection	growth simulation	plant anatomy, growth, touch	evolution, reproduction

Figure 5.9: Scales at which different behaviours may operate in a work of art.

The approach considered here contains many elements and terms borrowed from science. This is understandable since a functional analysis is very similar to a scientific analysis, it is an investigation of the processes employed in the generation of a form. However, it is important to emphasize the primary difference is that many of these behaviours are abstract or unobserved in reality, present only in works of art or in the imagination. Although the complexity of behaviour in the real world is immense, the space of all *possible* behaviours is much greater still than those observed. The reason that a scientific approach can be made to an aesthetic object is due to the fact that natural science is typically defined as an "a process of deduction in relation to the

observed world.” If we replace the ”observed world” with the art object, we have a functional analysis which examines the imagined world.

A close investigation of the above processes also reveals that they may be defined in relation to very simple structures. Consider a set of points in space. Whether their motion is abstract, harmonic, representative of the joints of a form (human), flock-like, atomic or chemical (moving according to physical laws), or input from a physical device (points tracked from a camera), these behaviours may all be considered as differences in the way a set of point move in space. Of course, there are many processes such as bending, which are changes to a physical structure (not just one point). However, if we consider an object as a mathematical collection of points which define a surface then bending itself may also be a motion of a set of points.

Other behaviours do not operate on points, but on spaces, volumes, or specific structures. Waves may ripple through a continuous space affecting every point. In discrete terms, we may say that ever point in the space is affected according to the process. A volume of space may express the transport of light (global illumination), the motion of waves (sound), the motion of a fluid (gas), or the growth of a crystal (cellular life).

The theory of art proposed here is an open ended one in which the revelation of behaviour and structure are continuous and on-going. There is no universal set of ideas or processes which describe the field, just as in anthropology there is no structure to which all cultures adhere. There are, however, common features which can be observed.

The visible structures of art are points, lines, curves, surfaces, images, and volumes, and each structure may have additional properties, or may be in motion. These objects represent the total space of expression while different behaviours transmute among them. The boundary between physical and digital is inconsequential, as interactive art may be described as a transcoding from a physical volume (real world), to an image (the camera), to a detected object (the virtual point). It is a series of processes which crosses the physical boundary. By inconsequential, I mean irrelevant from the perspective of process, although on the level of social meaning and practical implementation, interaction carries many connotations and constraints.

Functional analysis is presented as one technique for the understanding of media arts which helps to reveal these underlying processes. As one analyses a work of art, there is no absolute measure of success as this is a process of revealing structures only as deeply as the artwork and supporting materials permit. In many cases, such as in automatic drawing, the artistic processes are accessible to us. This is also true of algorithmic works in which the code has been made available. In other works, the processes may not be available but we can deduce certain aspects of process from the work itself. Functional analysis can be described as the goal of deducing process at different levels in the creation of art.

Whereas Roger Fry's elements express the visual form of art, functional analysis helps to unify art according to structure and process. This unification is an outcome of the shared structures deduced from the analysis of many different works across different

movements. We ask the question: if the operations of traditional and media art encompass the behaviours above, what are its operands? What are structures which are being manipulated in the development of an artist's technique. Euclidean geometry provides a foundation in space with the notion of points and lines. This is extended through analysis to include sound, image and interaction. Although the relation between structure and function is still largely a mystery from the perspective of the consciousness of the artist, these fundamental objects help to define a basis for a comparative analysis of media art.

One of the benefits of this analysis is that it suggests new strategies for organizing digital tools for media artists. Current tools typically expresses a particular set of inherent constraints which are codified in the design of the tool. Many of the most advanced tools are direct outcomes of the film industry and thus focus on specific behaviours tailored to highly specialized task. Even among tools designed for media artists, such as Processing and Max/MSP, these are designed around particular constraints, or are so generic in their design (complete programming languages with few libraries), that they limit the range of behaviours and structures that might be explored. However, the range of potential processes, and their combinations, is truly immense. Art has only in the past century opened itself to creative processes outside traditional practices and it only the currently available tools for digital artists which prevent us from access these other possibilities.

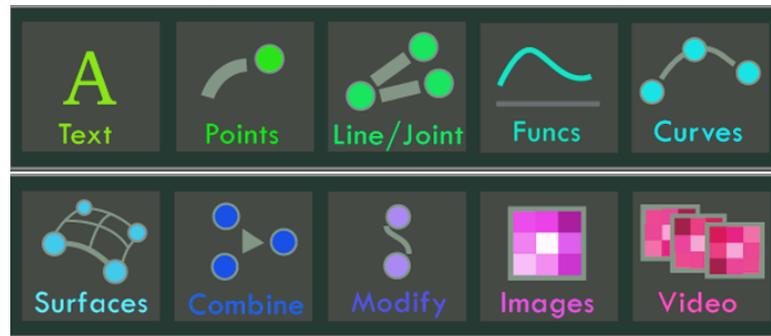


Figure 5.10: Top-level tool bar in LUNA, showing the basic geometric categories which may be generated from a much larger set of behaviors.

In the development of LUNA, the tool created in conjunction with this thesis, this theory is incorporated in a central way into the tool. In traditional tools for digital modelers, such as Maya and Houdini, objects in the tool bar express the range of available objects, and are typically categorized according to generic processes or workflows: rendering, modeling, character animation, physical simulation (effects). These workflows are suited particularly to the needs of commercial film production and often defy workflows in the media arts. In LUNA, the tool bars are a two-level system in which the primary tool bar is a small, finite set of the abstracted structures (Figure 5.10). This basic types include: text, points, lines, functions, curves, surfaces, volumes, images, video and data. The second-level bar is an infinite set which expresses all the available behaviors for generating that particular structure. Points, for example, may move according to a physical system, or they may be derived by scattering points on a surface. Although the range of behaviors is infinite, the user of the digital tool can be guaranteed what kind of structure they are working with at a particular moment.

This new taxonomy is perhaps better suited to media art since it reflects a basic relationship between structure and function, instead of a particular workflow oriented toward film. While the number of behaviours (processes) may expand indefinitely, and particular tools enable the specialization of certain behaviours, they share a common structure. These structures indirectly allow for new forms of communication, through the tool, between artists working with different types of media. An artist working in interactive art produces a physical motion. Instead of hard-wiring this motion to a particular visual outcome, the artist may conceptually treat the video interaction as a process which transforms the image of a real body into an abstract set of “points”, and these points may then be used to drive other forms of media art such as generative or organic systems. In this way the structures help to unify disparate practices since they provide a means to communicate structure between different creative processes.

The structures revealed here suggest a natural starting point for a consistent view of media arts on the level of practice. Drawing, painting, sculpture and photography are historically distinguished primarily due to differences in media and process. However, with the advent of media art, media and process are no longer fixed points. The theory of media arts proposed places the mathematical object - on which process operates - as the most basic element from which to develop new methods of critique, analysis, and tool development. This emphasis is critically different from Manovich as it shifts the focus from the media of art, the device on which it executes or acts, to focus on the conceptual objects on which ideas fundamentally operate. Behaviour, in all its forms,

is the principle on which works of media art are developed and created. Functional analysis allows us to examine the processes employed in particular works and to abstract the structural elements of expression available to the artist. These structural elements are not social or cultural, but deduced from a scientific study of function across many different objects of art. They define the perceptual space of art regardless of process, media, or goal. Science assists in the process of functional analysis to deduce these generally available structures, but our ability to use, recombine, generate, and create new forms is open to the exploration of conceptual and imagined realities not bound to any physical observation.