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ANOTHER PERSPECTIVE

Optical Illusion and Visual Ambiguities in Contemporary Art

By Silvia Minguzzi

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Professor Patricia Coronel
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1. Introduction

Perspective projection distortion is the inevitable misrepresentation of three-dimensional space when drawn or "projected" onto a 2-dimensional surface. It is impossible to accurately depict 3D reality on a 2D plane.

The main focus of this paper is to research how the new technologies pushed the boundaries of perspective projection distortion in the digital art world. I will explore contemporary artists' work like William Kentridge's anamorphic animation, lights and shadows installations by Kumi Yamashita, Felice Varini's optical art, and Amon Tobin's stage performances. This paper will focus on a few selected artists in order to illuminate noticeable contrasts that have occurred over time in the realm of digital art. To address the various mediums, techniques and methods within this broad subject would be a staggering task. This is why only a few key subjects will be addressed.

One subject will be to analyze how methods of visualization in digital art have evolved, since this aspect is directly responsible for the perception and aesthetic value of the majority of digitally displayed mediums.

We need a new approach to linear perspective that relates it to the more general development of projection methods, and yet something more than that provided by nineteenth century historians of mathematics and science who were searching for the origins of descriptive geometry. It is not just a question of how the laws were discovered. Needed is a history of how these laws became recognized as being independent from Euclidean theories of vision: a history of how laws of projection and theories of vision were and were not applied to the visual arts.

Such a history will need to emphasize that the Renaissance fascination with projection, that included linear perspective and anamorphosis, did not push artists into becoming mechanical copiers of nature. Indeed it led gradually to a distinction between technical drawing and what we now term fine art.

2. Perspective, Projection, Anamorphosis and Vision

Perspective systems are designed to construct pictures that, when viewed, produce in the trained viewer the experience of depicted objects that match perceivable objects. Space perception theorists have written about how our capacities to see are constrained by the perspective system that we use, that is, by our way of depicting what we see.¹

In the arts, the methods of depiction are of significant importance as they are the means

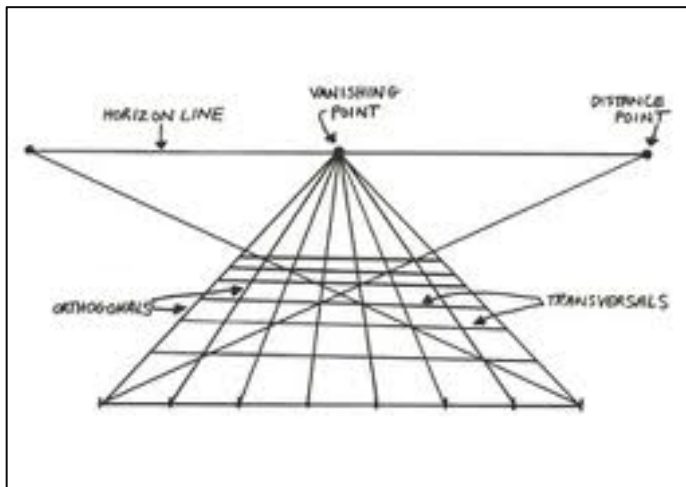


Figure 1, Filippo Brunelleschi, Linear Perspective. Drawing by Silvia Minguzzi, 2013.

of expression and description of imaginary worlds. Artists and designers engage in story telling and offer a glimpse into their fantasy worlds through unique, personal, private, and idiosyncratic visual methods.

Pictorial spaces are constructed through geometrical models. Each model is expressed as a geometrical transformation applied to Cartesian

shapes of the physical environment. These transformations show how shapes are projected in pictorial space.

The usual projections we are accustomed to see in computer graphic are called standard



Figure 3, examples of non-linear perspective: bulge projection. Photo by Silvia Minguzzi, 2013.



Figure 2, examples of non-linear perspective: fisheye projection. Photo by Silvia Minguzzi, 2013.

¹ Terzidis, Kostas and Ali Malkawi. "Distorted Eye." Paper, UCLA and University of Pennsylvania, 2011, 262.

projections: perspective and orthographic (Figure 1). However, there are many other projections we don't ordinarily see called non-linear projections: fisheyes (Figure 2), bulge (Figure 3), panoramas, map projections, etc.

2.1 Linear Perspective Projection in Art

No one would deny that the painter has nothing to do with things that are not visible. The painter is concerned solely with representing what can be seen.²
- Leon Battista Alberti, 1435

In the Middle Ages, the period before the Renaissance, most art in Europe featured heavenly figures devoted to the worship of Christ. Because the people in Medieval paintings were citizens of heaven and the artists painting these pictures had never actually seen heaven, the background was left to the imagination and the teachings of the church. Gold backgrounds were very common, as the air in heaven surely must be precious. When people became more interested in the world around them and the ideas of other people rather than heaven and the teachings of Christ and the saints, landscapes and buildings began to show up in paintings. Everyone could see landscapes and buildings everyday so one of the essential artistic problems of the Renaissance became how to paint landscapes and buildings in pictures so that they looked the same as in real life.

In the Renaissance, painters needed to be able to translate the 3dimensional world around them onto the 2-dimensional surface of a painting, called the picture plane. The solution was linear perspective (Figure 1); the idea that converging lines meet at a single vanishing point and all shapes get smaller in all directions with increasing distance from the eye. The discovery of perspective is attributed to the architect Filippo Brunelleschi (1377-1446), who suggested a system that explained how objects shrink in size according to their position and distance from the eye.

² "Alberti". Note Access. <http://www.noteaccess.com/Texts/Alberti>.

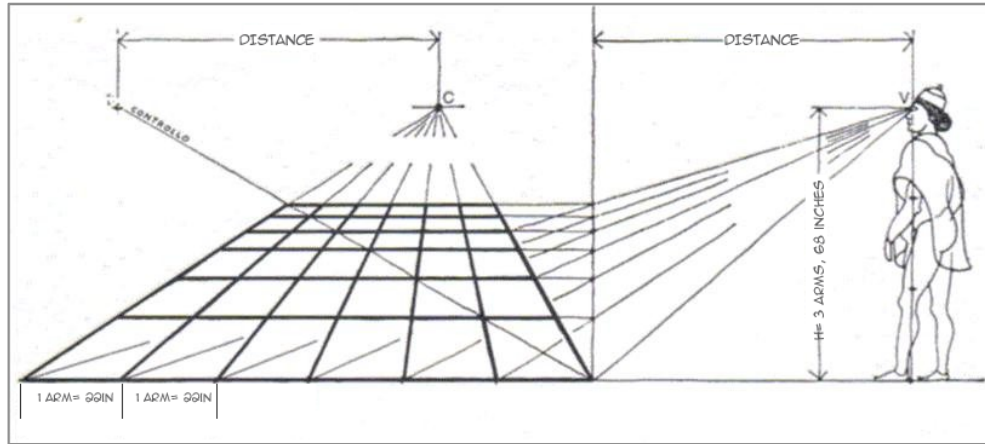


Figure 4, Leon Battista Alberti's Perspective. Drawing by Silvia Minguzzi, 2013.

However, the nature of Brunelleschi's system and date of its discovery remain unclear.

In 1435, Leon Battista Alberti (1404-1472), provided the first theory of what we now call linear perspective in his book, On Painting.³

The impact of this new system of measurement in paintings was enormous and most artists painting in Europe after 1435 were aware of the principles Alberti outlined in his book.

First, an artist created a "floor" (a ground or stage on which figures and objects would be placed) in a painting and drew a receding grid to act as a guide to the relative scale of all other elements within the picture (Figure 4). Alberti suggests relating the size of the floor squares to a viewer's height. This suggestion is important because it reveals an underlying principal of the Renaissance. The act of painting would no longer be to glorify God, as it had been in Medieval Europe. Painting in the Renaissance related instead, to those people looking at the painting.

³ "Alberti". Note Access. <http://www.noteaccess.com/Texts/Alberti>.

2.2 Perspective and Anamorphosis: the French Ambassador

In vain your image comes to meet me
And does not enter me where I am who only shows it
Turning towards me you can find
On the wall of my gaze only your dreamt-of shadow
I am that wretch comparable with mirrors
Than can reflect but cannot see
Like them my eye is empty and like them inhabited
By your absence which makes them blind.⁴
- Contre-chant, Louis Aragon

What is the difference between a regular perspectival painting and an anamorphic one if both contain distortions and both are profitably viewed from the side? In the case of linear perspective, an artist is usually intent on rendering an entire scene spatially. Here distortion of certain parts is an undesired by product.

The term anamorphosis is often used loosely to refer to distortion in general. It is more appropriately used to refer to those cases where distortion is a desired effect. In anamorphosis an artist usually limits himself to a single object and deliberately projects it (or changes its scale) so that it is deformed or even unrecognizable when viewed from directly in front. Sometimes such objects are integrated into an otherwise normal scene, as for example, with Holbein's skull in The French Ambassadors. When viewed from directly in front as in Figure 5, the painting seems perfectly normal, except for a strange, elongated object, which seems to float above the floor. If we change our viewpoint to one at an oblique angle at the extreme right of the painting as in Figure 6, the object is seen as a human skull. The main point is that there is no single correct viewpoint for this painting.

⁴ Quoted in Jacques Lacan, The Four Fundamentals of Psychoanalysis (New York: W.W. Norton and Company, 1981), p. 17.

French title: Le Seminaire de Jacques Lacan, Livre XI, 'Les quatre concepts fondamentaux de la psychanalyse' (Editions du Seuil, 1973). The original French reads as follows:

Vainement ton image arrive a ma rencontre
Et ne m'entre ou je suis qui seulement la montre
Toi te tournant vers moi tu ne saurais trouver
Au mur de mon regard que on ombre revee
Je suis ce malheureux comparable aux miroirs
Qui peuvent reflechir mais ne peuvent pas voir
Comme eux mon oeil est vide et comme eux habite
De l'absence de toi qui fait sa cecite.



Figure 5, Hans Holbein the Younger, Jean de Dinteville and Georges de Selve (The French Ambassadors), oil on oak, 81X82 in. 1533. National Gallery, London.

Frequently the deformed object dominates and is surrounded by regular perspectival landscapes. These theoretical considerations not only exemplify a wider anamorphic intrigue of The French Ambassadors, but also serve here as first steps to considering anamorphosis itself as a not only a way of seeing, but also the dynamic embedded in the theoretical decoy. For primarily we see that The French Ambassadors embodies a relation between the recognizability of *trompe l'oeil* effect and meaningless stain.

The French Ambassadors then is an example of the intersection between the two pictorial denominations of representation and abstraction. Holbein's Ambassadors conflates two points-of-view into a single surface in a manner that also visually highlights their

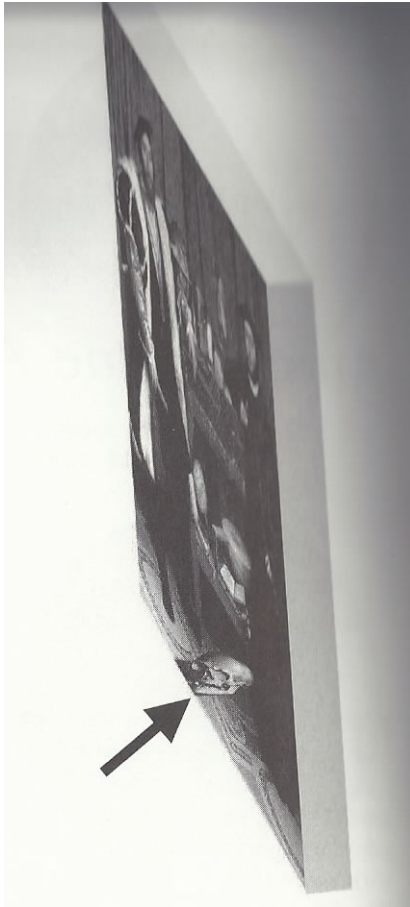


Figure 6, the side view from the viewpoint for the skull. From Mark Frantz and Annalisa Crannel, *Viewpoints, Mathematical Perspective and Fractal Geometry in Art*. 2011.

separation and distinction. It anticipates the traditional perpendicularity, filling as it does, the front-on pictorial space with all manner of precisely rendered representations and symbols. But The French Ambassadors also disrupts that clarity with an unrecognizable "stain".

This visually incorrect disruption is one location of the anamorphic potential, and as such its correct point-of-view is hidden elsewhere.

Once found, this elsewhere reveals its pictorial intentionality. That is, once the beholder correctly locates the second axial point-of-view, the un-interpretable stain emerges into visibility. What was hidden within unclear distortion now appears in clarity – the stain appears as a skull. This second position puts the viewer approximately seven feet to the left of the painting's frame, and virtually parallel with the wall. Now, looking slightly down to the "intransigent" mark, it appears to lift off the surface into pictorial legibility.⁵

Anamorphosis started being considered and alternative to linear perspective. In the exploration of anamorphosis in cases involving complex projection planes, practical incentives again played a role. Artists tended to paint landscapes, scenes and buildings in accordance with linear perspective and then paint individual objects within this context in accordance with optical adjustments methods.

Although linear perspective theoretically introduces the possibility of a uniform treatment of space, painting practice continues to be much more complex. Compromises are made in the case of objects below, above and off to the side. Sometimes these compromises are made in accordance with a theory of vision and sometimes not. There is no necessary connection between theory of representation, practice of representation, theory of vision

⁵ Marc, Franz and Annalisa Crannel. *Viewpoints: Mathematical Perspective and fractal Geometry in Art*. Princeton: University Press, 2011, 84-87.

and actual visual experience.

It is certainly possible to impune certain motives for sketching the arguments above--- as well as discussing certain works and not others. While anamorphosis serves as the formal device that links a heterogeneous body of material, two assumptions have guided this eccentric observer in the construction of art experiences which are at once aesthetic and critically based: first, to render an observer self-aware and conscious of the processes by which meaning is constructed; and, second, to acknowledge the central role the identity and capacities of the observer have in determining the nature of the art experience. It is to these goals that the concept of anamorphosis must be subordinated.

The importance of anamorphosis, then, is not as an alternative to the way we experience works--that is, like the latest video game or clothes for the emperor--but as a metaphor for accepting information from unfamiliar places and unexpected sources. The eccentric observer is one who acknowledges the limitations of a static, homolographic world-view and embraces instead a dynamic unfolding process encompassing a field of light and texture shot through with expressions of personality and specificity.

This process could serve at least two purposes: to undermine a certain ideology of vision that continues to dominate the way we look at artwork and to celebrate (rather than suppress) the idiosyncratic nature of our own point of view.

2.3 Non linear Perspective Projection computer graphics and in Art

Robert P. Kelso Sr. from Louisiana Tech University defines distortion in perspective projection as the difference between normal vision and the emulation of normal vision by graphics of photography.⁶ He concludes that there is no remedy available to correct for the intrinsic distortion in perspective projection. Therefore, all standard, perspective projection images are necessarily distorted.

Nonlinear projection has been used widely in art beginning with cave art and continuing until the present day. It is a current area of research in computer graphics and provides a meeting place between science and art.⁷ In this paper, I begin by examining several cases of how and when artists choose to use nonlinear projection as opposed to perspective projection in their creation.

Projection is an interesting meeting point between art and science. The scientific approach to projection is to view it as the mathematical reduction of dimension and organization of the reduced dimension's space.⁸ From here formulae, geometries, and spaces are theorized and derived. Artistically projection is a means of organizing space, relationships between objects, and the observer's presence in an image.

But let's try to analyze some different kind of non-linear projections, starting with the description that David Hockney gives. He examines a variety of evidence that leads him to conclude that many artists used concave mirrors and later lenses to construct images from the early fifteenth century and onward. While these primitive lenses would allow artists to paint from a moving image in bright light conditions a key limitation was the small size of the projected images. In general these images could be no larger than 30 cm across.⁹ As a consequence if an artist wished to create a larger image the artists would either have to try

⁶ Kelso, Robert. "Distortion in Perspective Projection." Paper, Engineering Design Graphic Journal, Louisiana Tech University, 2008, 27.

⁷ Brosz, John and Carpendale Sheelagh, Samavati, Faramarz and Wang Hao, and Dunning Alan. "Art and Nonlinear Projection", Department of Computer science, University of Calgary, Alberta College of Art and Design. 2008.

⁸ Brosz et al, 2009.

⁹ Hockney, David. *Secret Knowledge: Rediscovering the Lost Techniques of the Old Masters*. Viking Studio, 2nd edition, 2006.

to repaint the image larger without aid of projection, or project the scene a piece at a time and then blend the pieces together into a unified whole. It seems quite clear that this type of non-linear projection performed by artists is the inspiration for the multi-camera projection systems.

Ernest Watson is instead interested in what he defines as Creative Perspective, or techniques used by illustrators to create perspective projections as well as to modify them for various purposes. He calls such modified projections, creative perspective and notes that an artist who uses "...perspective creatively [can] bend it to his uses rather than be limited always to strict conformity".¹⁰

These manipulations are used to allow the viewer to see structures that should be hidden, changing the scene (usually by manipulating vanishing points) to improve its overall composition, allow the viewpoint to shift to more closely recreate human visual experience, and lastly make the illustrations more dramatic and interesting. Manipulating the projection allows illustrators to present objects in precisely away that they feel will have the desired impact.

Finally I want to give a fast overall of the research that computer scientists Brosz, Carpendale, Samavati, Wang and Dunning are developing around what they define as flexible projections in computer graphic and in art.

Flexible Projection is unusual as it approaches projection, a rendering technique, with modeling tools. The primary concept of Flexible Projection is in defining the viewing volume (the 3D volume that will appear in the 2D image) as a parametric volume $Q(u;v;t)$. This volume is defined so that the parameters $u;v;$ and correspond to the width, height, and depth positions that will result in the projected image. This volume can be stretched and reshaped to affect the projection and consequently the image.¹¹

What they are saying is that in a standard perspective projection the volumes are views by an eye position near surface and far surface as in Figure 7. In the flexible projection they introduce a variation that can be obtained by altering the interpolation between surfaces.

¹⁰ Watson, Ernest W. *How to Use Creative Perspective*. Van Nostrand Reinhold Company, 1955.

¹¹ Brosz et al, 2008.

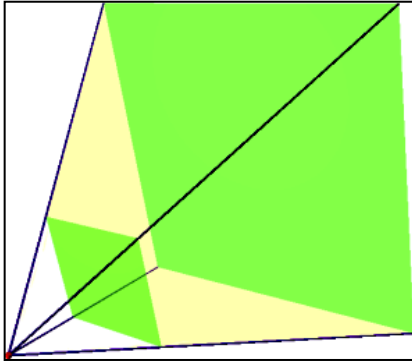


Figure 7, A perspective projection's viewing volume. The viewing volume is bounded by the near and far planes (green) and the sides of the frustum (yellow). From Brosz et al, *Art and Non-linear Projection*, 2008.

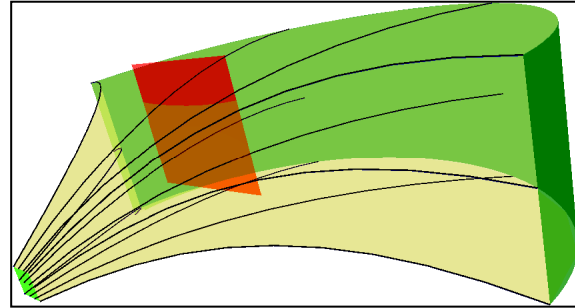


Figure 8, The viewing volume of a Flexible Projection. The volume is shown in yellow, the green surfaces are the near and far surfaces, the red surface controls the curviness of the volume, and the lines shown projectors within the volume. From Brosz et al, *Art and Non-linear Projection*, 2008.

For instance, by adding surface(s) between the near and far surfaces we can use Bezier curves to interpolate between the surfaces obtaining greater control over the volume as is shown in Figure 8.

Using a flexible projection in art can be useful in applying these distortions for two reasons. The first is that the distortion could be adjusted to affect different depths of the scene differently; as a result the background of the scene could feature a different sort of distortion than the foreground. Another interesting aspect is that the flexible projections can be animated by moving the projection surfaces over time.¹² This adds an extra impression of change to the projection.

¹² Brosz et al, 2008.

2.4 Effect of developing technology in relation to specific styles of Digital Art

The evolution of computer technology has visibly affected most aspects of our lives; it is perhaps one of the most fascinating mediums to be adapted for a creative purpose.

Is technology changing art? In an interview posted on Curiosity.com on Sept 26th 2011, John Maeda, president of the Rhode Island School of Design answers saying:

I think that computers and the advancedness of computers hasn't changed art very much. It's enabled more to happen. Again, that counts a bit more. Better resolution, longer lengths, more color variety, but all in all it's the same thing. It's what experience can I deliver to you that is provocative, that can change how you think. How can I, the art piece, change your relationship -- not to me, but to something else or to the world? That question has nothing to do with technology at all. I would say that if it wasn't for the computer, my art wouldn't be known because my art is so linked to it. It's how it's defined. I made art with the computer, writing computer programs. I made things that could morph and change and if it wasn't for the Internet maybe a thousand people would know about it. Or like when I walk into MOMA, and that work I made as I sat on the second floor of my flat in Tokyo on a small ironing board with my Macintosh and between my legs I'm typing or whatever. Sat with a fan because it's very hot in Japan, the little piece of code I made is living in a museum now. I find that very odd, interesting, very fortunate, very lucky.¹³

On the other side Bruce Wands,¹⁴ explains that digital technologies have had, and continue to have, a profound effect on contemporary art and culture. Contemporary artists are using the Internet as a new art museum, and adopting digital tools and techniques as part of their creative process.¹⁵

This is probably one of the most interesting passages of Wands' theory. New technologies are not used by contemporary artists only for the distribution and advertisement of their work, but in the creative process.

I stand with him when he underlines that the impact of internet and social media which allow for the creation and exchange of user-generated content and provide a structure for

¹³ "Is technology changing art?" Curiosity: Art and Architecture. Last modified September 2011. Accessed on March 19 2013. <http://curiosity.discovery.com/question/technology-changing-art>

¹⁴ Bruce Wands is Chair of the MFA Computer Art Department, Director of Computer Education at the School of Visual Arts, New York.

¹⁵ Wands, Bruce. *Art of the Digital Age*. New York, Thames & Hudson, 2006, 10-11.

people to get organized, exchange and collaborate is just part of the technological effect in art.¹⁶ The computer had enabled artists to create works, new types of work, never before possible: intricate images that could not be created by hand; sculptures formed in 3-dimensional databases rather than in stone or metal; interactive installations that involve internet participation from around the globe, and virtual worlds within which artificial life forms live and die. The art experience extends now to homes, cybercafés and any public or private space where there is an Internet access or a local area network.

I can see at least 3 important fields where the evolution of new technology impacted art. The first is visual art in general: modern technology has transformed traditional art forms such as painting, sculpting and drawing, allowing artists to utilize digital technologies in the production of their pieces. The second is the digital consumption of art, since technology has also impacted the way that art is consumed. From the visual arts to music, technology has allowed art to become mobile and instantly accessible around the world, providing greater exposure for today's artists and paying homage to artists of the past. And finally the third is art history appreciation: the availability of art in digital form provides greater access for students and lifelong learners to study and experience art from the vast and varying time periods throughout history.

My question at this point of my research is can digital art ever achieve the same prestige status as traditional art? These issues in the realm of digital technology equally affect both the artists and the viewers. Regardless of the medium an artist decides to use, the true value lies in how we define art.

¹⁶ Wands, 2006, 206-209.

3. Contemporary Art at a Turning Point

Contemporary art is at the turning-point paradox. As arts realm of continual newness approaches its age of retirement, so to its inevitable historicization hides in plain sight. This unfolds a model of turning-point potential: the decoy. Modeled on the ordinary folk art object – with its capacity to be more than it appears – the decoy is initially elaborated through the concept of surplus-potential.¹⁷

Further, the decoys axial nature – to turn from one point-of-view to another – is then overlaid with the genre of anamorphic art. So to, the concept of the decoys central anamorphic-axis is articulated in its capacity to distort or clarify what hides in plain sight. Decoys emerge precisely for the reason that they are not what they appear to be.

More than ever now through the use of computer tools and visualization techniques, art and architecture find themselves in a position to rediscover and challenge their traditional methods of depiction. Designers are presented with tools that allow them to manipulate the overall order, organization, and representation of their forms, thus replacing a single design with a range of designs. New emphasis is placed on curvature and proportion. A challenging point is the fact that this new aesthetics is about the unknown, the unpredictable, and the unforeseeable. It requires the cooperation of two brains: that of the human and the computer, for without one another it is impossible to plan or execute imaginary design spaces. Most of all, they lead to the creation of computational schemes, which are available for experimentation, analysis or play across disciplines. Dynamic design space contributes to our understanding of aesthetics and creates a new dimension of how it may change our perception. It also brings up a social point: who is the creator? How will it change our perception if science and mathematics can mold into the creative process?

Let's try to investigate the work of 4 contemporary artists (William Kentridge, Felice Varini, Kumi Yamashita and Amon Tobin) to understand how right now contemporary visual art is dealing with the effect of developing technology. Those artists are all interested in distorted projections; they are using different media and using distortion to push a different message or a different research.

¹⁷ Proctor, Yogi. "The Turning Point, Dissertation." PhD Diss., California Institute of the Arts, School of Critical Studies, 2010, iii.

3.1 William Kentridge. What Will Come (has already come)

The anamorphic film, What Will Come (has already come) (2007), which is about the Italian-Ethiopian war of the 1930s, works on the principle that what is distorted in the projection gets corrected in the viewer's seeing of it in a mirror. So the distortion is the correction and the original is the distorted.¹⁸
- William Kentridge



Figure 9, William Kentridge, What Will Come (has already come), 2007, steel table, cylindrical steel mirror, 35mm animated film transferred to video, 8:40 min, 41 1/4 x 48 x 48 (Courtesy Norton Museum of Art).

I decided to focus my research on one of the exhibition by William Kentridge¹⁹ called

¹⁸ Featured in ART21, PBS, Art in the Twenty-First Century, Season 5 (2009), Compassion.

¹⁹ William Kentridge was born in Johannesburg, South Africa, in 1955. He attended the University of the Witwatersrand, Johannesburg (1973–76), Johannesburg Art Foundation (1976–78), and studied mime and theater at *L'École Internationale de Théâtre Jacques Lecoq*, Paris (1981–82). Having witnessed first-hand one of the twentieth century's most contentious struggles – the dissolution of apartheid – Kentridge brings the ambiguity and subtlety of personal experience to public subjects that are most often framed in narrowly defined terms. Using film, drawing, sculpture, animation, and performance, he transmutes sobering political events into powerful poetic allegories. In a now-signature technique, Kentridge photographs his charcoal

What Will Come (has already come) I was lucky to see this January in Rio De Janeiro, Brazil.

The main work of the exhibition, the filmic anamorphosis What Will Come (Figure 9), draws on the idea of the picture puzzle that originated in the sixteenth century. Kentridge translates this play with perception that operates with distorted images that can only be deciphered from a certain angle to his film.²⁰

The technique of cylinder mirror anamorphosis he employs is a special form of anamorphosis that is based on the addition of a further level of perception. It is not enough to change one's point of view but a special seeing machine is essential to decode the picture: a cylindrical mirror with a certain radius that reflects the distorted image, "straightening" it "optically." Producing such complicated distorted pictures requires a profound knowledge of mathematical rules and optical foundations. Relying on a special graphic grid, the preparatory sketch is transferred to the anamorphic mode segment by segment, and the



Figure 10, Drawing for What Will Come (has already come). Two Heads, 2007, Charcoal on paper, cold rolled steel table and mirrored steel cylinder, Paper diameter: 47 1/4 inches, Cylinder higher: 11 1/2 inches, diameter: 6 1/2 inches. © Art21, Inc. 2010.

curvature of the mirror that is to correct the distortion has to be precisely calculated.

William Kentridge avoids these down-to-earth exercises by looking into a mirror while drawing, positioning his hands and arms on the desk as usual instead of basing his work on mathematical calculations. What he draws he sees in the mirror and not on the sheet in front of him. An unusual drawing process already precedes the unusual perception that the viewer is confronted with later.

drawings and paper collages over time, recording scenes as they evolve. Working without a script or storyboard, he plots out each animated film, preserving every addition and erasure. Aware of myriad ways in which we construct the world by looking, Kentridge uses stereoscopic viewers and creates optical illusions with anamorphic projection, to extend his drawings-in-time into three dimensions ("William Kentridge." PBS. <http://www.pbs.org/art21/artists/william-kentridge>).

²⁰ Watch Video a - "William Kentridge, What Will Come, Animated Film Installation," and Video b - "William Kentridge, What Will Come - has already come."

As in the past, present anamorphosis also initiate a discourse on the subject of seeing because they not only entertain the viewer with their optical attractions but also encourage reflections on the relativity of visual perception. In this sophisticated play of projection, reflection, and transformation involving different forms and sceneries, Kentridge relates to subjects such as colonialism, fascism, and tyranny.

Without offering a definite plot, he intersperses his film with narrative and visual fragments. A gas mask points at the Abyssinian War of 1935/6, for example, in which the Italian fascists, with Hitler's support, annexed Ethiopia by force and 275,000 Ethiopians lost their lives. The soundtrack, an Italian marching song of the fascists under Mussolini, speaks of a little black face, "Facetta Nera," a beautiful small Abyssinia to be kissed by the sun of Rome. A composition by Dmitri Shostakovich based on a Jewish song that Kentridge also uses echoes the exodus of Ethiopian Jews to Israel after the great famine of 1984/5.

If only by allusion, the artist touches on the subject of not ending losses of place through elements of his soundtrack and the visual motifs of his work. Though the background is quite different, Kentridge also comes from an African Jewish family. What Will Come shows the artist in a Janus-faced structure (Figure 10) inextricably linked at his spine with an African male's head.

Kentridge is interested in machines that make you aware of the process of seeing and aware of what you do when you construct the world by looking. This is interesting in it but more as a broad-based metaphor for how we understand the world.

When we look through a stereoscopic viewer (Figure 11) we are self aware that you have two completely flat images, and it is our brain that is constructing the illusion of 3 dimensional depths. And that is very clear when you are looking at a stereographic viewer. What is not very obvious is that what our eyes are doing in real life everyday: our retina in receiving two flat images and our brain is combining them into this illusion of depth, and it does it so well that we believe in it. We don't see in depth, we are constructing in depth.



Figure 11, William Kentridge. Double Vision, 2007. Set of 8 stereoscopic cards, colophon wood box and stereoscope; dimensions variable, each card 7 x 3 1/2 in. Edition of 25. Copyright and courtesy of William Kentridge. © Art21, Inc. 2010.

The activity of seeing, or the work that we do in seeing... is a philosophical point about epistemology... it is about not understanding ourselves as merely passive receivers, or objects of manipulation, but people who are actively involved in constructing our world the whole time... ²¹

According to Kentridge one of the aspects of doing the film or the drawings was learning the grammar of the transformations that happen when you go from a flat surface to the curved mirror. So, for example, to draw a straight line is relatively complicated because every straight line is in fact a curve, whereas every straight line that you draw becomes a parabola.

²¹ "William Kentridge Fragile Identities, University of Brighton Gallery and The Regency Town House, Brighton." Independent, 2007. <http://www.independent.co.uk/arts-entertainment/theatre-dance/reviews/william-kentridge--fragile-identities-university-of-brighton-gallery-and-the-regency-town-house-brighton-763465.html>.



Figure 12, William Kentridge. *What Will Come (has already come)*, 2007, installation view, 16th Biennale of Sydney, Australia. William Kentridge: *Anything Is Possible*, production still, 2010. © Art21, Inc. 2010.

So when we see the anamorphic drawing and its correction in the mirror (Figure 12), what we are very aware of is how our brain is constructing what appears to be a perfect circle, when we know in fact it's not a perfect circle. It's a completely disgusting kidney shape. We believe we are simply seeing depth rather than constructing depth out of two flat images. So, again, it's both about the phenomenon and the wow factor – but more about the agency we have, whether we like it or not, to make sense of the world. William Kentridge asks:

How does one find a way of not necessarily illustrating the society that one lives in, but allowing what happens there to be part of the work?²²

Shooting without a script when making his animations, Kentridge's experimental method demonstrates thinking with one's hands and proposes an understanding of the world as process rather than as fact.

²² "William Kentridge *Fragile Identities*, University of Brighton Gallery and The Regency Town House, Brighton." *Independent*, 2007. <http://www.independent.co.uk/arts-entertainment/theatre-dance/reviews/william-kentridge--fragile-identities-university-of-brighton-gallery-and-the-regency-town-house-brighton-763465.html>.

3.2 Kumi Yamashita: Animated Shadows

I sculpt shadow with light or sometimes light with shadow, but both function in essentially the same manner. I take objects and carve and place them in relation to a single light source. The complete artwork is therefore comprised of both the material (the solid objects) and the immaterial (the light or shadow).²³
- Kumi Yamashita



Figure 13, Kumi Yamashita, *City View*, 2003, H250, W500, D5cm. Aluminum numbers, single light source, shadow. Commissioned by Namba Parks Tower, Osaka Japan. Kumi Yamashita, 2012, <http://www.kumiyamashita.com>.

When viewing Kumi Yamashita's²⁴ ingenious art, we confront our simple notion that solid predicts shadows. The artist in her work wants to question all our expectation, so she starts challenging the predictable relationship between solids and their shadows.

From simple beginnings, she invites us to reassess the unpredictable relationship between what we expect to see and our actual perception. Much of Kumi Yamashita's artwork is constructed with everyday things such as alphabets and numbers (Figure 13), building blocks, thread, nails, credit card rubbings and light installations.

²³ "Light and Shadows," Kumi Yamashita, 2012, <http://www.kumiyamashita.com/light-and-shadow>.

²⁴ Kumi Yamashita was born in Japan and lives in New York City. She received an MFA from Glasgow School of Art in the UK in 1999. Her work is mostly constructed from everyday objects: building blocks, thread, nails, credit card rubbings, lights. The aim of her process is to explore art beyond the confines of traditional media, and turn ordinary objects into arresting images. Even a simple sheet of paper, if carefully arranged and lit, can create an endless variety of profiles, says Yamashita. Her work has been exhibited at Seattle Art Museum, Boise Art Museum, Yerba Buena Centre, San Francisco, Esplanade in Singapore, Hillside Gallery in Tokyo and the Kent Gallery in New York, among others. ("About," Kumi Yamashita, 2012, <http://www.kumiyamashita.com>)

As a result of the process these ordinary material objects are transformed into arresting yet elusive images. Separate pieces may connect together in a shadow, and a simple piece of paper can create an endless variety of profiles.

Kumi's methods and materials go beyond the confines of traditional media, transforming one medium into something else. With great attention to detail, Yamashita's works are exhaustively complex and precise – yet they remain deeply human.



Figure 14, Kumi Yamashita, Conversation, 1999 H150, W40, D40cm Styrene, motor, single light source, shadow. Kumi Yamashita, 2012, <http://www.kumiyamashita.com>.

By constructing carefully measured sculptures realistic shadows of people are formed when light is projected past them. In the piece called Conversation (or Dialogue) (Figure 14), we see a motorized construction, which produces the illusion of a talking head.²⁵

²⁵ Watch Video c - "Artist Kumi Yamashita - Dialogue."

Each sculpture is a masterpiece that leaves amazing shadows on the walls and each of us can find something new in these shadows, while this sculpture is nothing more than pieces of materials joined together to make the breathtaking chaos. As usual, the artists use ordinary stuff to create the shadow art sculptures and the projector helps the viewers to turn on their imagination and see the projected shadows on the wall.

Yamashita's sculptures illustrate the problem – any number of objects could produce the same retinal projection, just as the same shadow could be produced by many different sculptures. What's really interesting about vision is that the shortcuts and heuristics our visual system relies on to make this inference get it right so often. In *The Ecological Approach to Visual Perception*, Gibson speaks rather disparagingly of what he calls "aperture vision"

The eye is easily deceived, and our faith in the reality of what we see is therefore precarious. For two millenniums we have been told so. The purveyors of this doctrine disregard certain facts. The deception is possible only for a single eye at a fixed point of observation with a constricted field of view, for what I called aperture vision.

This not genuine vision, not as conceived in this book. Only the eye, considered as a fixed camera can be deceived. The actual binocular visual system cannot.²⁶

Gibson's approach to the study of perception emphasizes the way an active observer picks up information from the environment. The central postulates of Gibson's approach are that visual space is defined by information (such as texture gradients) contained on environmental surfaces, the crucial information for perception is information that remains invariant as an observer moves through the environment, and this invariant information is picked up directly, so that no intervening mental processes are necessary for visual perception.

I tend to think that most objects are defined not by their static properties, but by how those properties remain constant (and vary) across changes in view. My problem with the idea that the visual system just "picks up" such invariants is that it has been remarkably hard to identify invariant properties that could define objects in the world in a tractable way. It's easy to show that motion disambiguates, but it's hard to show that something other than the retinal projection is the information source for vision. For that reason, I tend to think that the retinal image and changes to it are the starting point for vision.

²⁶ Gibson, James J. *The Ecological Approach To Visual Perception*, Boston, Houghton Mifflin, 1979, 281.

The flaw in the traditional approach comes not from thinking about the 2D-3D inference problem, but from focusing solely on static images rather than addressing how dynamic changes in view and the accompanying changes to the retinal projection of the world help resolve the inference problem.²⁷

²⁷ For more about Kumi Yamashita, watch Video d - "Kumi Yamashita on Takeshi Kitano's Unbelievable," and Video e - "Peter Esznyi: Four."

3.3 Felice Varini: Optical Art

My paintings initially appear to the observer in the form of a deconstructed line, which recalls nothing known or familiar, whence the effect of perturbation they produce. As one moves through the work, the line progressively appears in its composed form. One is thus under the illusion that the work is creating itself before one's eyes.²⁸ - Felice Varini

Swiss artist Felice Varini²⁹ has been creating illusions of flat graphics superimposed on 3 dimensional spaces since 1979 using the same eye-deceiving technique called anamorphosis. The complete shapes can only be seen when viewed at certain angles, otherwise the viewer will only see some random broken pieces.

For Varini it's all about your point of view. Varini takes this idea to its extremely literal conclusion. From the perfect perspective his painted geometric shapes seem to float in front of your eyes.

However, in reality Varini works hard to make only appear this way. In reality his pieces are huge, cover entire structures (at times multiple buildings), and carefully prepared to be seen from a precise viewpoint. His large optical illusions underscore the subjective nature of art – it's all about your point of view.³⁰ The vantage point (Figure 15 and 17) is carefully chosen: it is generally situated at his eye level and located preferably along a well-traveled route, for instance an opening between one room and another, or a clearing, or a landing. He then projects the form devised for the particular space onto its surfaces from the vantage point, then traces and paints.³¹

²⁸ "Bio." Felice Varini, 2013, http://siteprojects.org/varini/varini_bio.html.

²⁹ Felice Varini is a Swiss artist who was nominated for the 2000/2001 Marcel Duchamp Prize, known for his geometric perspective-localized paintings in rooms and other spaces, using projector-stencil techniques. According to mathematics professor and art critic Joël Koskas, "A work of Varini is an anti-Mona Lisa." Felice paints on architectural and urban spaces, such as buildings, walls and streets. The paintings are characterized by one vantage point from which the viewer can see the complete painting (usually a simple geometric shape such as circle, square, line), while from other view points the viewer will see 'broken' fragmented shapes. Varini argues that the work exists as a whole - with its complete shape as well as the fragments. "My concern," he says "is what happens outside the vantage point of view." He was born in 1952 in Locarno, Switzerland and lives in Paris. ("Biographie." Felice Varini, 2011, <http://www.varini.org/04tex/cv00.html>)

³⁰ Watch Video g - "Felice Varini: Galerie Martine Aboucaya, Paris."

³¹ Watch Video f - "Felice Varini."

The finished painting can be viewed from the spot where he originally placed the projector. Felice Varini tends to use simple geometric forms: squares, triangles, ellipses, circles, rectangles, and lines. These forms are usually created in one of the three primary colors: red, blue or yellow, occasionally employing some secondary colors, as well as in black and white.

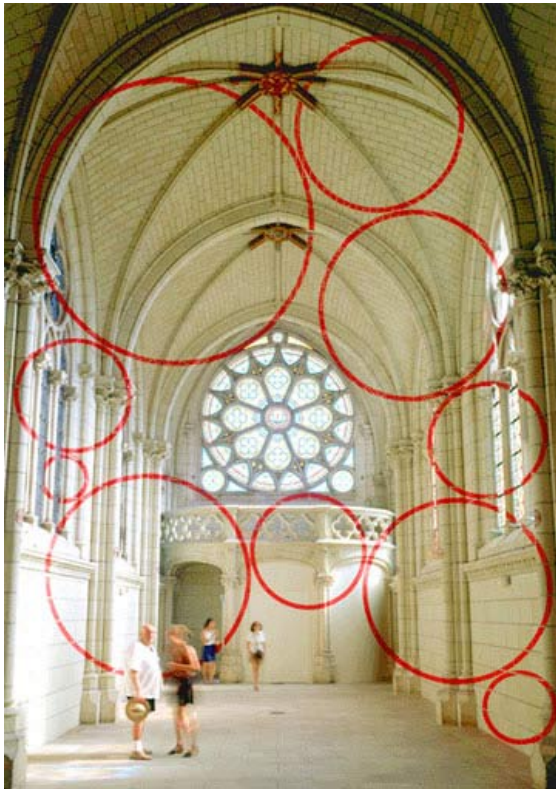


Figure 15, Felice Varini, Surrounding at ten (1999), Thouars, France, red chalk (seen from the vantage point). Dekel, Gil. "I am a Painter." 2008. <http://www.poeticmind.co.uk/interviews-1/i-am-a-painter>.

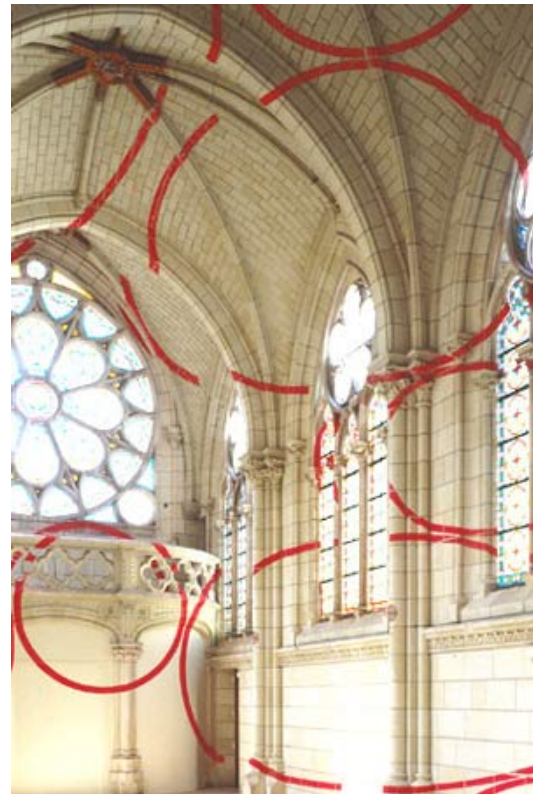


Figure 16, Felice Varini, Surrounding at ten (1999), Thouars, France, red chalk (seen from outside the vantage point). Dekel, Gil. "I am a Painter." 2008. <http://www.poeticmind.co.uk/interviews-1/i-am-a-painter>.

He justifies his choice of simple geometric shapes and basic colors by saying:

If you draw a circle on a flat canvas it will always look the same. The drawn circle will retain the flatness of the canvas. This kind of working is very limiting to me, so I project a circle onto spaces, onto walls or mountainsides, and then the circle's shape is altered naturally because the 'canvas' is not flat. A mountainside has curves that affect the circle, and change the circle's geometry. So, I do not need to portray complicated forms in my paintings. I can just use

the simplicity of forms, because the reality out there distorts forms in any case, and creates variations on its own accord. The same goes for colors. Usually I use one color only, and the space takes care of altering the color's hue. For example, if I use one type of red on a mountainside, the result is many kinds of red, depending on the mountain's surface and the light conditions. Sunlight will affect the different areas on the surface and the same red color may become stronger or darker or clearer in certain areas, depending on how the sunrays hit the surface. The sky can be bright or dark. And if the surface has its own color or a few colors then that will affect the red that I apply on it. So, I do not need to use sophisticated colors. The reality exists with its own qualities, shapes, colors and light conditions. What I do is simply add another shape and color in response to that.³²

Varini's concern is what happens outside the vantage point of view (Figure 16 and 18).

Where is the painting then? Where is the painter? The painter is obviously out of the work, and so the painting is alone and totally abstract, made of many shapes. The painting exists as a whole, with its complete shape as well as the fragments; it is not born to create specific shapes that need to satisfy the viewer. The paintings are not defined by the understanding of the viewer or what the viewer sees, but rather exist in their own right, and have their own relation to the 3-dimensional space in which they were created. He works with the reality itself, with nature.

Unlike the majority of artists, who work within strictly defined limits, Varini uses every dimension. By creating work that is not portable and cannot easily be contained, he sidesteps the temptation to make a cult object of the artwork. For him the "art object" has become a rearguard concept. Indeed he has neither a collection to sell, nor paintings to store.

He says that he is completely free from material and logistical constraints. Like a musician performing on stage, he asks for a fee from whoever is commissioning the work, whether a gallery, a collector, a town council or an arts centre. This does not prevent Varini's works from being sold on. Once he makes a work it can be removed and remade in a different place, as long as certain guidance is followed.

³² Dekel, Gil. "I am a Painter." 2008. <http://www.poeticmind.co.uk/interviews-1/i-am-a-painter>.



Figure 17, Felice Varini, *Two Circles In Corridor, Red No. 1* (1992), Paris, acrylic paint (seen from the vantage point). Dekel, Gil. "I am a Painter." 2008, <http://www.poeticmind.co.uk/interviews-1/i-am-a-painter>.



Figure 18, Felice Varini, *Two Circles In Corridor, Red No. 1* (1992), Paris, acrylic paint (seen from outside of the vantage point). Dekel, Gil. "I am a Painter." 2008, <http://www.poeticmind.co.uk/interviews-1/i-am-a-painter>.

He writes a description for each work, describing its specifications, and anyone can remake it in another space following the exact instructions for the shapes, sizes, relation to each other, and relation to the space. The new space needs to have similar characteristics to the original one. The result will not be a new work, but rather a remake of the same work. He is not interested in making an object and move it, but in moving the concept, since the object can be remade in the new space.

So apparently Varini is using optical art not to create the reality or manipulate it, but he is trying to discover more things that we can't normally see through the space. The vantage point of the works is really very fragile. In a way it is a mechanical point of view, and it does not encompass reality.³³

In reality our eyes move all the time, and we cannot see with our eyes like the camera does, taking snapshots. We cannot retain a freeze frame with our eyes, so it is difficult for

³³ Watch Video h - "Felice Varini: Three Ellipses for Three Locks - Digital Reconstruction."

anyone to stand at the exact vantage point of his paintings. For Varini, the work is outside the vantage point, where reality allows for all shapes to live.

3.3 Amon Tobin: Stage Performance

Sometimes I ask myself, what is the point of all this musical manipulation? How far should we take the exploration of music performance technology? Then someone manages to combine talent, expertise, and vision all in one amazing application that reminds you – oh that’s why. Because you never know when something magical will emerge.³⁴ - Ean Golden³⁵ on Amon Tobin.

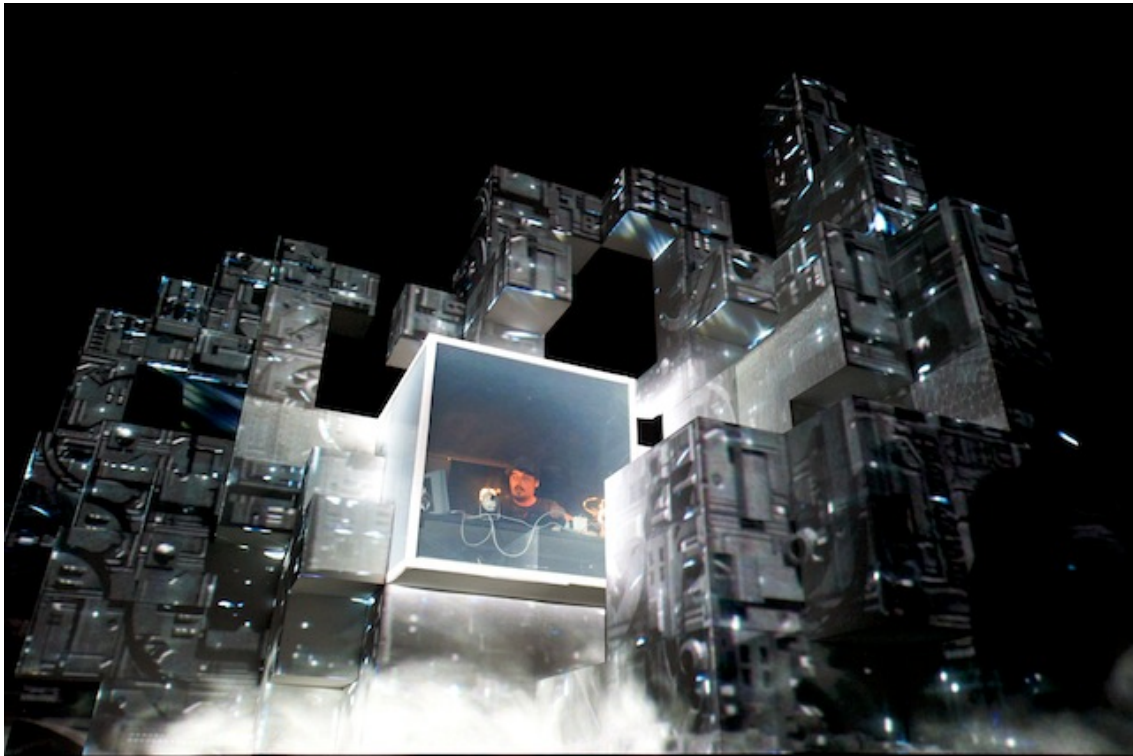


Figure 19, Amon Tobin, from the show Roundhouse. Photo by Valerio Berdini. From liveon35mm.com.

For the better part of two decades, electronic music maven Amon Tobin³⁶ has dazzled audiences with mind-expanding cuts that marry vinyl samples with his uncanny sonic

³⁴ Golden, Ean. "Amon Tobin the worlds most amazing djbooth." Djtechtools. 2011.

<http://www.djtechtools.com/2011/06/07/amon-tobin-the-worlds-most-amazing-dj-booth>

³⁵ Ean Golden is a forward thinking performance dj and technology pioneer who has played a major role in the development of digital djing. Ean designed many of the top selling dj products in the last 5 years and built DJ TechTools the largest online dj community with over 1 million visitors each month. His groundbreaking performance videos have seen over 15 million views worldwide.

³⁶ Brazilian-born Amon Tobin first emerged between 1994-1995 with a string of 12" singles on a small London-based record label called 9Bar Records. The album that followed, *Adventures In Foam*, paved the way for a whole generation of electronic productions and prompted his signing to the prodigious Ninja Tune in 1996. He has since gone on to record seven critically-

sensibility. Despite his impressive résumé, the Brazilian-born visionary balked at touring his new album Isam 2.0. Tobin insisted this latest disc – which he calls a “sound sculpture” of field recordings – didn’t have the right vibe to ignite the dance floor, so the stage show needed to evolve beyond his DJ-centric performances. Going to his performance, fans will experience an audio-visual adventure that has already drawn praise from Cirque du Soleil.

He performs inside a white cube, centrally attached to other cubes, and they were all stacked in a geometrical pattern across the stage. Fast-moving abstract images aligned to the music are projected upon them, both individually and as an entirety, an uneven canvas.³⁷

The wall of cubes resembled something you’d find in nature, like a salt crystal. Most of the time you can’t see Mr. Tobin as he worked in his encasement. But every once in a while a small light turns on inside the cube and there he is, administering his machines, nodding his head, with beard and baseball cap, the man inside the fractal (Figure 19).

What Amon Tobin is working on what is known as projection mapping,³⁸ which it is not necessarily a new technique, though it’s rapidly increasing in both popularity and complexity among the masses making it more difficult for companies producing the content to stay competitive in the craft. Tobin is using the expertise of a technology crew in the creation of his shows: V Squared director Vello Virkhaus, designer and programmer Peter Sistrom and Leviathan chief scientist Matt Daly along with the help of Bryant Place.

acclaimed albums under his own name on Ninja that have since helped define the label as a force in musical innovation and diversity. In addition, Amon has produced a small number of radically diverse original scores ranging from George Palfi's cult cinema oddity *Taxidermia* to Tom Clancy's video game blockbuster *Splinter Cell: Chaos Theory*. The depth and scope of Amon Tobin's work have had a far-reaching influence, garnering respect amongst producers and artists both within and outside electronic music. Whether with the classical avant garde Kronos Quartet or D'n'B legends Noisia, or on his own in some invented form, Amon has established a reputation for musical ingenuity that is unconfined by genre. Over a fifteen-year-long career Amon Tobin remains among one of the most visionary electronic artists of a generation.

The 2007 album *Foley Room* explored the role of found sound in modern day music. Documented on film, the process of recording minute insects to lions, wolves, engines and foley performances culminated in a much-lauded performance at the birthplace of musique concrete, the GRM Theatre in Paris. More recently, the famed London Metropolitan Orchestra performed selected works from a cross-section of his musical repertoire at the Royal Albert Hall. Amon Tobin will release 3 albums in 2011: a radical new studio album entitled *ISAM*, a new *Two Fingers* album, and an album of remixes of his *Chaos Theory* soundtrack work. (“Bio.” AmonTobin. <http://www.amontobin.com>)

³⁷ Watch Video i -“Visualizing Isam.”

³⁸ The practice of sculpting video content to match the surface geometry it’s being projected on.

The application used is TouchDesigner,³⁹ Derivative's visual programming environment, and does the projection mapping, video playback, Kinect response, real time effects and more. It is pretty clear that the art of Amon Tobin wouldn't be possible without the help of computer graphics and in particular without a software like TouchDesigner.

More, 4D in mathematics is a very abstract concept in which this additional dimension is indistinguishable, yet acknowledged. This unknown relates to the pronounced visual effect the mapped structure of Tobin creates for the viewer. What is fascinating is that he gives viewers an idea of what it might be like to see beyond 3D space, to see all points simultaneously for both the exterior and the virtual interior of the set. The combination of this mapped effect and Amon's music produced some very intense emotional reactions from people. Despite the fact that each show is primarily pre-set and automated, in order to allow the visuals proper synchronization with the album's unctuous tunes, a larger cube, set into the center of the structure, served as the cockpit for Tobin throughout the set. No doubt relying on simpler tools like subtle audio manipulations and dramatic filter sweeps, it was invigorating to see the artist "piloting" his work and directing the flow of the performance.



Figure 20, Amon Tobin, from the performance Roundhouse. Photo by Valerio Berdini. From liveon35mm.com, 2012.

³⁹ TouchDesigner is a visual development platform developed by Derivative Inc. that equips the user with the tools needed to create stunning real time projects and rich user experiences. Whether you're creating interactive media systems, architectural projections, live music visuals, or simply rapid-prototyping your latest creative impulse, TouchDesigner is the platform that can do it all. ("Touch Designer." Derivative, 2012. <http://www.derivative.ca/Events/2012/088BetaRelease/>)

Amon Tobin's stage shows are the most current testament to how astonishingly synchronous a musical performance can be with an accompanying visual display (Figure 20 and 21), and how detailed and attentive said display can be to all of the elements of the audio work.⁴⁰

With no floods, strobes, or lasers to speak of, Tobin's show relies entirely upon images and sound, melding the two at a level that has rarely been seen outside of establishments like the Museum of Modern Art.⁴¹ The complexity and intricacy are truly breathtaking, even for the more party-minded electronic music fan who simply wants a mind bending treat for their eyes to accompany the wildly-encompassing thunderstorm of sound they are entrenched in.

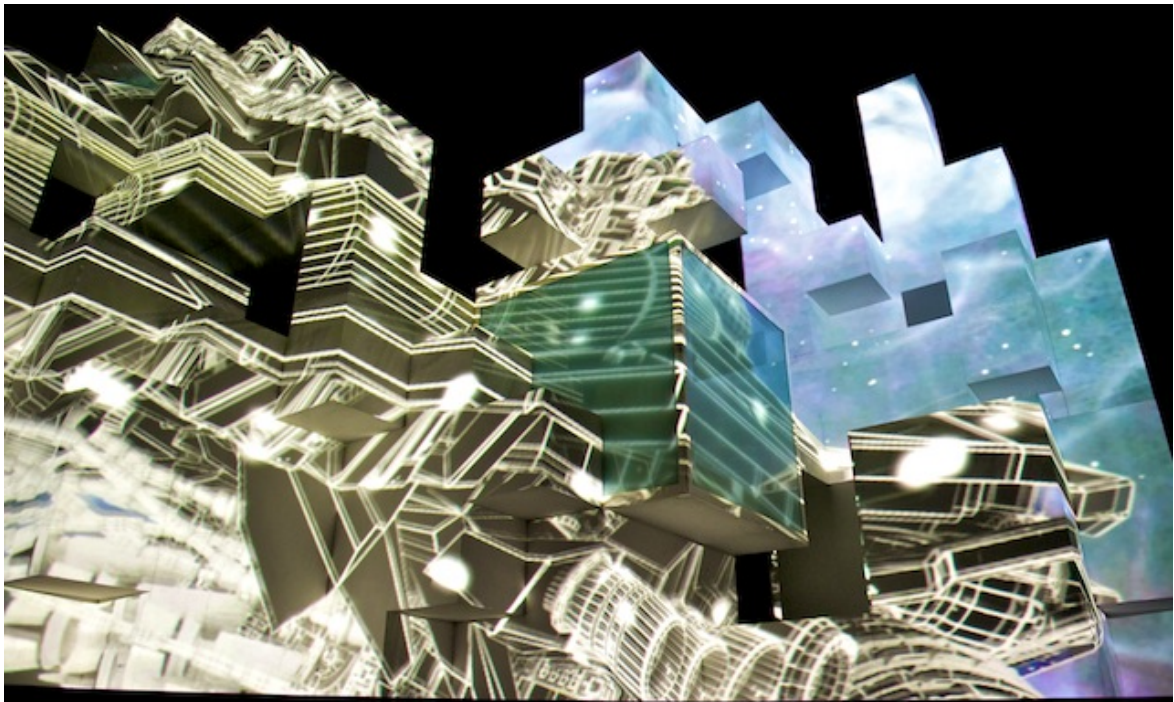


Figure 21, Amon Tobin, from the performance *Isam 2.0*, Photo by Valerio Berdini. From liveon35mm.com, 2012.

One of the most interesting aspects to me about Amon Tobin's work is that he is not just presenting a different reality in a virtual space, but he introduces a different point of view, his point of view. He is, in fact, part of the projection, he is not projecting from the viewer point of view, and he stands inside his own composition and projects on himself.

⁴⁰ Watch Video j - "Amon Tobin, Isam V 2.0."

⁴¹ Charleston, Jenny. "Ground Control to Amon Tobin." *The Grid*. 2011.
<http://www.thegridto.com/culture/music/ground-control-to-amon-tobin>.

This allows him to experience live the reaction of his public. This element is almost a contemporary version of what other painters during the centuries did: painting themselves inside their work. But if during the Renaissance period self-portraits can be seen as projections of self, for contemporary artists it looks like everything is about the interactivity and interaction with the viewers.

Artists like Mantegna and Alberti, Raphael, Parmigianino, Titian, Sofonisba Anguissola, and Annibale Carracci constructed themselves pictorially and used these self-representations. Self-portraits mediated between the creators artistic self and his or her Renaissance audience.

Those artists who experimented with autonomous self-portraiture usually worked for courts, and in the highly competitive court culture, the artists' celebrations of themselves in self-images were part of their jostling for increased social recognition and position. For Amon Tobin his presence in the composition adds a temporary dimension, a live dimension: he is interested in the reaction, and he can see that reaction during his performances.⁴² This is a possibility that contemporary artists can investigate only thanks to technology.

And more, he is not only using technology in his creative process, but also transforming his installation into a show, like theater and music, breaking the forth wall, and interacting with his public. In a way he is using new technology to present his own point of view on music as well. Music is traditionally played with instruments, it can be live, or recorded; music can be played as a jam session with no script or a like classical concert with very strict rules. What Amon Tobin presents is his personal vision on music, made with samplers and loops, no real instruments are involved, but virtual sounds create his original show. If you don't think the sampler can be a musical instrument, you haven't been listening to the music of Amon Tobin.

⁴² Watch video k - "Amon Tobin: ISAM Live @ Coachella 2012"

4. Conclusions

We see what we want to see. We perceive the world around us in our own way and sometimes it is far from reality. We have got used to rely on our feelings and emotions when we see or judge something and sometimes this leads to the misinterpretation of the things around us, because feelings and emotions can't be objective.

If perspective is defined in a narrow sense as linear perspective then one of the major reasons for its continued popularity is a growing historical awareness, which seeks both to understand methods developed in the Renaissance and apply new technologies in the analysis thereof. Some of the major themes of the earlier treatises such as regular solids remain significant to this day.

Yet there are significant contrasts between Renaissance methods and modern developments. The Renaissance paid lip service to equations between perspective and vision, while at the same time linking perspective increasingly with geometry and committing themselves to recording geometrical space of the physical world. Some twentieth century artists have continued this tradition in their explorations of realism, hyperrealism, and surrealism. Others have abandoned this commitment and focused increasingly on the exploration of visual space, both exterior and interior. This has led to new goals of art in terms of exploring perceptual, mental, dream, psychological and even psycho-pathological states. As a result, whereas Renaissance artists focused attention on linear picture planes, twentieth century artists are exploring many alternative shapes of picture planes. They are also contradicting the traditional transparency-occlusion principles of perspective in their quest for artistic freedom. Hence whereas Renaissance artists established a one to one correspondence between object and representation, twentieth century artists strive to demonstrate the contrary.

The rapid development of computer graphics, which allows artists to transform one kind of picture plane into another simply by altering the algorithms for the perspectival grids, has added new vigor to these experiments. So has the continued study of psychological aspects of spatial representation and perception.

Optical illusions and visual ambiguities have instilled a new playfulness into these explorations of space, as has the development of virtual reality. The rise of fractals has made

us aware that scale is a factor that needs to be taken into account. Perspective in this sense has yet to be developed even though linear perspective is now some five hundred and seventy years old. Whether in the old or the new sense perspective remains one of the most fascinating expressions of links between mathematics and art.

It is very clear now how artists have evolved to take advantage of the new technologies available to us in the online era. If we think technology we suddenly imagine a smart phone or a computer. Throughout history, technology has provided artists with new tools for expression. Today, these two seemingly distinct disciplines, art and technology are interlinked more than ever, with technology being a fundamental force in the development and evolution of art.

All over the world, people are engineering our future. The Internet, digital fabrication, nanotech, biotech, self-modification, augmented reality, virtual reality, "the singularity" - you name it, all of this is altering our lives and our view of the world and ourselves.

The real turning point of contemporary art is that if throughout history and up until very recently, the public was merely a passive observer, today almost everyone creates. Almost everyone participates. With Internet and new technologies of fabrication, remixing, editing, manipulating and distributing, it is becoming easier to create things - and share them with the world. What is changing and probably - arguably - for the worse is that it is now easier to create "art", and we see a lot of "bad" art being created and exposed.

What looks clear now is that in digital art, the notion of the original becomes obsolete. The experience in art becomes the original especially in the realm of the computer; everything can be processed into something different. This is one of the great differences with traditional art.

With the speed of development of new technology today, new tools are continually introduced to artists, which enable them to explore their ideas and imagination in every possible ways that are seemed to be limited before.

I believe that any modern artist needs to remember about pushing the art forward, inventing, defining new paradigms of expression with powerful meanings. It can be done using new technology, or researching new techniques with old media. It is about the experience the artist delivers to the public - whether it is provocative, whether it changes

how the viewer thinks, feels and views the world. This is what really counts, and it has nothing to do with the techniques that the artist chooses to use. Just as the development of acrylic paints in the 20th century did not mean that oil paints or even the practice of creating one's own paint from pigments fell out of practice, so it is with technology. Just as some artists paint in oils only or acrylics only, some create their work digitally. Image editing and graphic design software programs are yet another tool to add to the artist's palette.

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