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Designing Creative Technologies

What is Abstract Art?

Abstract art, and more particularly non-objective art, is well known by the public now. Analytical drawing, a class taught by Kandinsky, was an investigation of the structural relationships among objects, revealing important aspects of his theories of abstract art. The purpose of his course is described as an education in looking, precise observation, and the precise representation not of the external appearance of an object, but of constructive elements, the laws that govern the forces, and of logical construction of given objects. In this paper, I would like to investigate whether the process of reconstructing Kandinsky's analytical drawing using my expertise in the area of image processing and computer vision has improved my understanding of abstract art.

1. INTRODUCTION

We are living in the age of artificial intelligence, where technology plays a complex and many-sided role in society and general culture, and helps shape the imagination of the time. This suggests the direct influence of technology on the visual arts including abstract art is encountered. In order to fulfill my personal motivation of understanding abstract art, I wrote a computer program which models Kandinksy's analytical drawing process.

Analytical drawing was part of Kandinsky's preliminary course taught at the Bauhaus. As Kandinsky explained in his article "Analytical Drawing", the teaching of drawing at the Bauhaus is an education in looking, precise observation, and the precise representation not of the external appearance of an object, but of constructive elements, the laws that govern the forces that can be discovered in given objects, and of their logical construction. (Poling, 1986) It follows a series of stages that involve progressively the simplification, analysis, and transformation of the graphic characteristics presented by the motif.

This training, Kandinsky asserted, would develop students' ability to perceive the abstract, the essential form, undistracted by secondary aspects or insignificant features. He conceived of still life as an artistic medium with an important transitional role in the evolution of abstraction. The painter, he declared, "needed discreet, silent, almost insignificant objects" because the outwardly silent forms were felt to be internally resonant with expression. The analytical drawings provide the transitional link between still life and the abstract, through the medium of geometry. They contributed to the formation of a new sensitivity, training the student to see both the evident and the hidden relationships among forms, relationships parallel to underlying natural principles.

As outlined in Kandinsky's 1928 article, analytical drawing was a process in three stages: simplification, analysis, and transformation. (Poling, 1986)

Simplification. The first stage required the students:

> (1) to subordinate the whole complex to one simple overall form, which…must be precisely drawn in; (2) to realize the formal characterization of individual parts of

> the still life, regarded both in isolation and in relation to the other parts; and (3) to represent the whole construction by means of the most concise possible schema.

Analysis. The second stage was designated "development of the structural network". Its tasks were:

> (1) making clear the tensions discovered in the structure, which are to be represented by means of linear forms; (2) emphasizing the principle tensions by means of broader lines or, subsequently, colors; and (3) indicating the structural network by means of starting or focal points (dotted lines).

Transformation. The third stage advances the aspects of the second toward more radical, freer, abstract solutions. It is characterized as:

> (1) Objects are regarded exclusively in terms of tensions between forces, and the construction limits itself to complexes of lines; (2) Variety of structural possibilities: clear and concealed construction; and (3) Exercises in the utmost simplification of the overall complex and of the individual tensions—concise, exact expression.

Figure 1 and Figure 2 are Bella Ullmann-Broner's study in analytical drawing from *Kandinsky's teaching at the Bauhaus*. Consecutive images in Figure 1 show the simplification, network of tensions, and principal tension, respectively. Figure 2 shows the transformation part of analytical drawing. In this paper, I would like to focus my analysis on this student's style of work and proceed further discussion based on it.

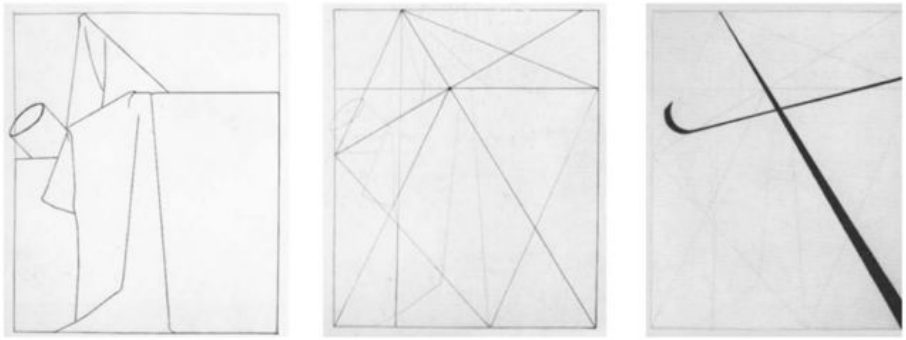

Figure 1: Bella Ullmann-Broner. Representation-Geometric Network with Centerpoint-Depiction of Main Tension, 1920/30. (Figure from *Kandinsky's Teaching at the Bauhaus*)

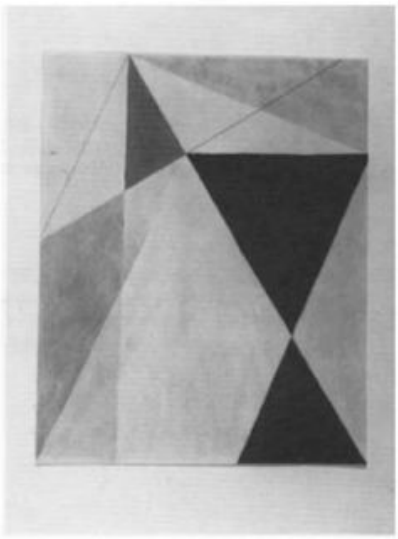

Figure 2: Bella Ullmann-Broner. Colored Treatment of a Network, 1929/30. (Figure from *Kandinsky's Teaching at the Bauhaus*)

2. "ANALYTICAL DRAWING" PROGRAM AND REFLECTION

I have approached the implementation of analytical drawing as in the following. Given a 2D photograph, the program detects objects in the image using object detection techniques. Next, it finds similar 3D shapes to the detected objects. Using the 3D shape information, it extracts 2D projection contour (simplification). Then, it performs corner detection and finds structural networks (analysis). For the transformation part, although results can come in many different

forms for each person, the program shows an example of how students have expressed their ideas in the class. Figure 3 shows a GUI prototype that I have created for showing the steps of analytical drawing.

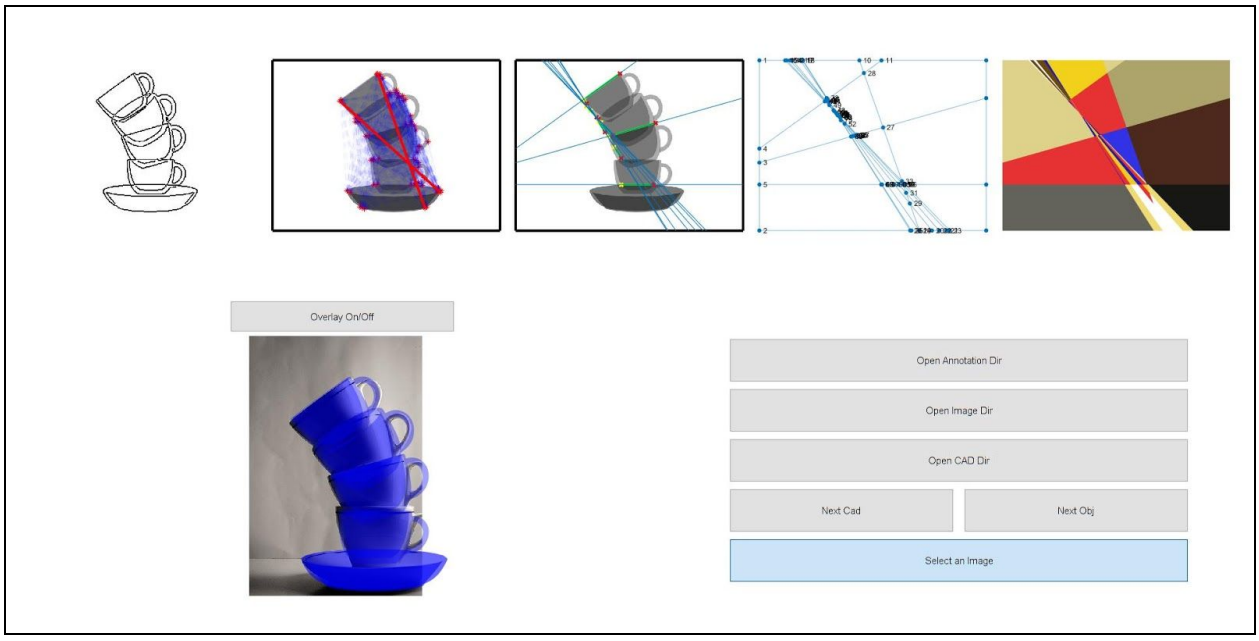

Figure 3: GUI for the program. The GUI shows the steps of analytical drawing for the selected photograph.

The Subject Matter of Abstract Art. Animating objects such as tables, chairs, and baskets is known to be incredibly difficult since these objects are mute and have a lack of motion. However, Kandinksy conceived such "silent" objects as internally resonant forms with expression. To cover most of these object categories, it took a while to decide which database to use for object recognition. I have chosen the ObjectNet3D (Xiang et al., 2016), which is a large scale database for 3D object recognition that consists of 100 categories in Table 1. The fact that the database contained only rigid objects was helpful since most of the objects used in analytical drawing were rigid.

aeroplane	camera	eraser	jar	pencil	shovel	toothbrush
ashtray	can	eyeglasses	kettle	piano	sign	train
backpack	cap	fan	key	pillow	skate	trash bin
basket	car	faucet	keyboard	plate	skateboard	trophy
bed	cellphone	filing cabinet	knife	pot	slipper	tub
bench	chair	fire extinguisher	laptop	printer	sofa	tvmonitor
bicycle	clock	fish tank	lighter	racket	speaker	vending machine
blackboard	coffee maker	flashlight	mailbox	refrigerator	spoon	washing machine
boat	comb	fork	microphone	remote control	stapler	watch
bookshelf	computer	guitar	microwave	rifle	stove	wheelchair
bottle	cup	hair dryer	motorbike	road pole	suitcase	
bucket	desk lamp	hammer	mouse	satellite dish	teapot	
bus	diningtable	headphone	paintbrush	scissors	telephone	
cabinet	dishwasher	helmet	pan	screwdriver	toaster	
calculator	door	iron	pen	shoe	toilet	

Table 1: 100 object categories in the ObjectNet3D database (Xiang et al., 2016).

Color. Kandinsky emphasized the psychic effect of colors in his book *Concerning the Spiritual in Art* (Kandinsky, 2012). He introduced two divisions of color that occur to the mind at the outset: into warm and cold, and into light and dark. The “cold colors” such as blue seem to recede, to move away from the spectator, while the “warm colors” such as yellow seem to come close to the spectator. As Kandinsky explained the effects of color using simple colors (e.g. yellow & blue, white & black), I found it easy to simulate colors in RGB space. In addition, since the intersections of the lines drawn from the steps of analytical drawing are added as nodes to a graph, it was not hard to change the color of the regions to see different color treatments of the network.

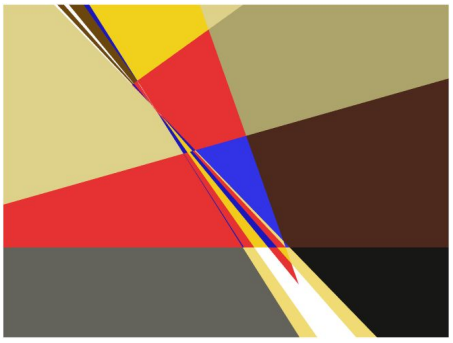

Figure 4: Experiment on Colored Treatment of a Network.

Line. As well-represented in Ullmann-Broner's work, analytical drawing begins with flat outline drawings and progresses towards the linear analysis of the tensions and their relationships discovered in the structure. The outline or the contour of the objects illustrated in the simplification stage is implemented as edge detection (Figure 5, left). While edge detection is obtainable directly from the image, developing the structural network (tensions) in the analysis stage required interpretation. While I was looking for the ways to find the tensions algorithmically, I had some interesting conversations with my advisor. As an engineer, my initial approach to this problem was to find 3d models of the objects in the image and do actual physics simulations to calculate tensions between them. However, my advisor pointed out that I didn't realize the difference between physical tensions and visual tensions. I was focusing on the external appearance of an object rather than constructive elements. It is no wonder that animating "discreet, silent, almost insignificant objects" is difficult and limited for engineers while painters find them internally resonant as Kandinsky put it.

After realizing this difference and learning about visual dynamics, I started to make better use of my skills. The following are steps I have used to find visual tensions in an image. First, corners in the image are detected. Then, among the lines connecting each corner, a longest tension line and a line that has opposite slope are defined as principal tensions. (Figure 5, middle) In addition, Hough transform, a feature extraction technique used to find imperfect instances of objects within a certain class of shapes by a voting procedure, is performed to detect straight lines in the image (Figure 5, right). These lines are considered as secondary tensions as it can be seen in Ullmann-Broner's work. While constructing these hidden relationships among forms, I got to know the function of lines other than the outline.

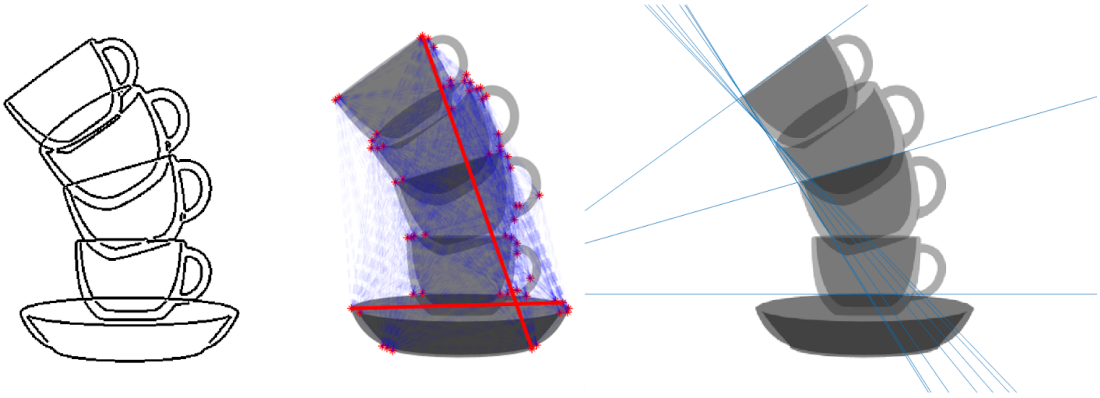

Figure 5: Edge detection (left), corner detection (middle), and Hough lines (right).

Composition and Harmony. The founders of abstract painting and of its theory believed that their art revealed a new aspect of composition, the structure of the work of art as a whole. (Barasch, 2013) Transformation, the third stage of analytical drawing, reveals what Kandinsky might well have suggested to his Bauhaus students for formulating a composition. One possibility of composition was an extremely flat image that fills the rectangular field, exploiting the diagonal in the initial "representation" and rendering the set of abstract relationships diagrammed in the "network" as shown in Ullmann-Broner's work (Figure 2). In this case, harmony, expressive nature of the wholeness of artwork, was achieved by filling in the network with flat areas of color. Considering that the third stage allows most radical, freer abstract solutions, I have tried Kandinsky's way of finding harmony by balancing the contradictions, i.e. compositional use of contrasting pairs of colors such as yellow-blue balance. Although my personal preference had been smooth harmony, I have learned ways of achieving a dynamic equilibrium by trying out Kandinsky's elementary conception of color. Again, it was possible to try many different solutions for composition because the tool existed in the digital domain.

CONCLUSIONS

Abstract art was not very approachable for me due to its characteristic of not being representational. In fact, it has been the most difficult type of art for me to appreciate. This is one of the reasons why I have chosen to study Kandinsky, who is considered as the founder of abstract art.

In the meantime I had studied style transfer, a class of software algorithms that manipulate digital images, or videos, to adopt the appearance or visual style of another image (Wikipedia). Below is an example of neural style transfer presented in the TensorFlow tutorial, where Kandinsky's Composition 7 was used as a style reference. Here, the style of an image is described by the means and correlations across the different feature maps. However, I believe this kind of application comes out from engineers' misunderstanding of artwork. Although the texture of the image might look similar to the reference image, it does not show any attempt to understand the artist's intention or process of making abstract art.

Figure 6: a *content* image (left), a *style reference* image (middle), and the output image (right).

It has always been my interest to search how I can use my background in engineering to promote people's creativity and make artwork. As it can be seen from the above example, it requires a careful investigation when art and technology will be combined. From the professor's

comments in this course (MAT 594X), I have learned that my personal motivation/impulse of building a tool can be a good starting point to help people be more creative. While reconstructing Kandinsky's analytical drawing process through writing a computer program, I believe I was able to step forward in understanding abstract art. I hope to continue this work to gain a fuller understanding of the realm of abstract art.

Works Cited

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